Health Economics Review

RESEARCH

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Patients' health care resources utilization and costs estimation across cardiovascular risk categories: insights from the LATINO study

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Abstract

Background Atherosclerotic Cardiovascular Disease (ASCVD) is a global public health concern. This study aimed to estimate the healthcare resource utilization (HRU) and costs stratified by cardiovascular disease (CVD) risk categories using real-world evidence, in a regional population in Portugal.

Methods This is a retrospective observational study, using data from Electronic Health Records between 2017 and 2021. Patients aged ≥ 40 years, and with at least one general practitioner (GP) appointment in the 3 years before 31st of December 2019, were included. CVD risk categories were determined based on 2021 ESC prevention guidelines. HRU encompassed hospital data (hospitalizations, outpatient and emergency room visits) and GP appointments. Total direct costs per patient were calculated based on the reference cost of the Portuguese legislation for payment methodology on Diagnosis-Related Groups (DRGs).

Results Analysis of 3 122 695 episodes, revealed consistent HRU and costs across the five years. Very high-risk patients, showed higher HRU, particularly in hospital admissions. Costs tended to rise with higher CVD risk level. Very high-risk patients with ASCVD had higher costs for hospital admissions, while low-to-moderate risk patients had higher costs for GP visits. Despite a smaller proportion, very high-risk patients with prior ASCVD represent the highest costs per patient across healthcare settings (from 115€ in emergency visits to 2 673€ in hospitalizations), followed by very high-risk patients without prior ASCVD (ASCVD-risk equivalents).

Conclusion This study revealed a substantial HRU and costs by patients with very high CVD risk, particularly those with prior ASCVD. Moreover, ASCVD-risk equivalents emerge as notable consumers, emphasizing the importance of risk assessment and preventive measures in cost-effective management of these patients.

Keywords Atherosclerosis, Cardiovascular diseases, Risk factors, Electronic health records, Health resources, Health care costs

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Background

Atherosclerotic Cardiovascular Disease (ASCVD) is a global and public health problem characterized by the deposition of lipid materials in arterial walls due to inflammatory processes [1, 2]. It remains asymptomatic for extended periods, until manifesting cardiac and cerebrovascular events and peripheral arterial disease [3]. ASCVD mainly involves the heart and brain, causing ischemic heart disease and ischemic stroke, which are the leading causes of death, disability-adjusted life years (DALYs) and early mortality worldwide [4, 5]. In Portugal, diseases of the circulatory system accounted for 28.4% of all-cause mortality in 2019 [6].

Several risk factors, including dyslipidemia, hypertension, diabetes mellitus, obesity, and smoking, influence cardiovascular disease (CVD) risk [7]. The European Society of Cardiology (ESC) 2021 guidelines for CVD prevention in clinical practice classify patients into three CVD risk categories to guide treatment and management (low-to-moderate, high and very high risk) [7]. Considering the importance CVD Risk Categories have in clinical practice, the Lipid mAnagemenT IN pOrtugal (LATINO) study has already shown an increased risk of death and ASCVD hospitalization in patients with a higher CVD risk when compared to lower CVD risk populations [8–10], corroborating previous evidence [11–13].

Healthcare Resource Utilization (HRU) refers to the consumption of healthcare services, including hospital admissions, outpatient visits, emergency department visits, diagnostic tests, and procedures. HRU is a critical component in understanding the burden of diseases and the efficiency of healthcare systems. It encompasses both the frequency of healthcare services used by patients and the associated costs. Costs can be structured by multiple components (direct, indirect costs, overheads, etc.) [14]. An important burden impact are the direct costs in the overall cost for a global vision of disease along its chain of care delivery. Direct costs refer to the expenses directly associated with medical care for CVD. These costs include hospitalizations, medical procedures, medications, outpatient visits, and other healthcare services. The direct costs can vary significantly based on the level of CVD risk, with higher-risk patients generally incurring greater costs due to more intensive and frequent medical care [15]. The ESC notes that high-income countries spend, on average, four times more on healthcare than middle-income countries and this disparity contributes to the overall higher costs associated with managing CVD [16]. ASCVD's suboptimal management leads to significant HRU and costs, with the US spending $378 billion annually on CVD and Europe €210 billion [17, 18]. Of this, 59% [17] and 53% [18], respectively, represent direct healthcare expenditures, with the remainder being mostly attributed to losses in productivity [17, 18]. In Portugal, atherosclerosis represented 1% of GDP and 11% of health expenditure in 2016 [19]. Moreover, the CArdioREnal and MEtabolic disease (CaReMe) study showed that atherosclerotic events significantly contribute to hospitalization costs in high-risk patients with Type 2 Diabetes and Chronic Kidney Disease [20, 21]. Better cardiovascular health have notably lower healthcare expenses compared to high-risk groups, and this cost reduction is also seen when comparing primary to secondary prevention patients [22–24]. There is a significant morbidity, mortality, and economic burden associated with ASCVD. While it is known that these patients incur higher costs, the extent and proportion of these costs by CVD risk level remain unclear.

This study aimed to estimate the HRU and direct costs by CVD risk categories according to the 2021 ESC on CV disease prevention guidelines, in a regional population in Portugal, using Real-World Evidence (RWE) from the LATINO study [9].

Methods

Study design

This is a retrospective observational study conducted at Unidade Local de Saúde de Matosinhos (USLM), an integrated local health unit in the Northern region of Portugal. ULSM comprises 14 Primary Care Health Units, assisted by the same Secondary and Tertiary Care Health Unit, at Pedro Hispano Hospital, the main healthcare population provider of the Matosinhos geographic region. This is a secondary-use data study using the Electronic Health Records (EHR) of patients followed at ULSM.

Study population

All adult subjects, aged ≥ 40 years old, registered in the primary healthcare center at ULSM with at least one General Practitioner (GP) appointment in the three years before the 31st of December 2019 (index date) were considered for analysis. This inclusion criterion ensured that the study population consisted only of "active users" of the healthcare system, defined as patients who had at least one appointment with their primary care provider within the last 3 years [25]. For each year from 2017 to 2021, subjects were classified according to one of the three CVD risk categories [25–29]: low-to-moderate risk; high risk; and very high-risk. Patients with very high risk were subdivided into: very high risk with prior ASCVD (ASCVD) and without prior ASCVD (ASCVD-risk equivalent). The outcomes were analyzed for the period from 2017 to the end of 2021 to capture a comprehensive picture of HRU and direct costs over a five-year span, providing insights into trends and patterns. In an additional analysis, patient cohorts were stratified in age groups [40–65[, [65–80[, and [80–100[years old.

Statistical analysis

Analysis was conducted through local execution of analytical programs developed using VERO technology that were compiled for ULSM target data infrastructure built upon Apache Spark Framework version 3.2.1 and source data harmonized according to the OMOP CDM 5.4 standard. The package implements a complete data engineering pipeline to transform the source data into the final dataset as well as execution of statistical analysis and generation results reports. Continuous variables were reported as mean and standard deviation (SD) or median and interquartile range (IQR). Categorical variables were presented as frequency counts and percentages. Outcomes were computed yearly between 01-01-2017 and 31-12-2021 stratified by CVD risk category, and age categories.

Derivation of patient phenotypes

The ULSM EHR stores patient-level information, including demographics, family structures, clinical diagnosis according to International Classification of Disease, 9th Revision (ICD-9)/International Classification of Disease, 10th Revision (ICD-10) and International Classification of Primary Care, 2nd edition (ICPC-2), laboratory test results, medical procedures and prescriptions. For patient characterization, demographic and clinical information was extracted. All relevant conditions were identified using the corresponding ICPC-2, ICD-9 and ICD-10 codes. Whenever possible, all patient conditions and criteria for CVD risk assessment were reconstructed using the most granular available records of clinical measurements, laboratory results and unstructured note text recorded at ULSM. To compute family history of relevant diseases, we reconstructed familial relationships from primary care family information. We did not use carotid or coronary imaging data, nor ankle brachial index, as this was not available at the time of data extraction. Patient demographic and clinical characteristics were described for the total cohort and for each CVD risk level.

Healthcare resource utilization definitions

HRU related to CV was estimated from hospital and primary care episodes in all settings. We analyzed hospitalizations, outpatient visits, emergency room visits and primary care medical appointments. For each, we described total episode counts, and Length-of-Stay (LoS) of hospitalization episodes.

Derivation of cost

Cost was calculated according to directives for assessing hospital episode cost using Diagnosis-Related Groups (DRG) (*Grupo de Diagnósticos Homogéneos*) classification, under current legislation [26–30]. These reference costs defined by law ensure standardization and comparability across different healthcare settings. It is important to note that the DRGs are a payment model rather than a direct cost model. Cost computation was performed assuming each legislation was in force at the beginning of the calendar year (the HIPAA de-identification standard applied to the EHR data, removed day and month elements from the data). For all medical episodes, cost was estimated using reference values and rules put forward in the legislation at the time of the episode, except for the specific criteria for price calculation sections from the legislations (*Critérios específicos de cálculo de preço*) [29]. For costing purposes of the medical primary care appointments, we considered the price calculation sections from the legislation (*Termos de referência*) [31]. Also due to the inability to adequately determine whether an outpatient appointment was the first or a subsequent visit, we assigned the cost for all outpatient appointments to the category of subsequent appointment costs. DRG codes have different cost values depending on severity level, available on the source data, and used to link to the corresponding DRG cost. The costs included in our analysis were GP medical consultations; Hospital admissions (inpatient costs); Outpatient visits and Emergency room visits for all reasons. This approach was necessary due to the current system's inability to adequately stratify costs by specific disease. Additional direct costs related to diagnostic procedures, medications, laboratory tests and exams were not included, as these are not covered by DRG classification. Indirect costs and other allocated expenses were excluded to make the study more similar to the payment model, ensuring it is more replicable and aligned with how costs are typically managed. The cost contribution from patients is stopped at the time of their death, or when data are exhausted. However, all patients are kept in the denominator for the year, except for the ones that died. In the latter case, the patient contributes with a fraction of the months that she/he was alive during that year. Total direct costs and cost per patient were presented.

Results

A total of 1 011 429 episodes in a hospital setting (n=39 774 hospital admissions, n=763 138 outpatient appointments and n=208 517 emergency room visits), and 2 101 266 in primary care setting (n=1 858 483 scheduled and n=242 783 unscheduled visits) were analyzed.

Table 1 shows the demographic characteristics of the population by year from 2017 to 2021. Regarding CVD risk category, there was a similar distribution in demographic characteristics, across all the analyzed years. The CVD risk could not be calculated for a small subset of the eligible population (ranging from 2.2 to 3.1%) due to incomplete data in their EHR. For the remaining

Table 1 Characteristics of the analyzed population by year

	2017 ***n*** **= 82 742**	**2018** ***n*** **= 83 667**	**2019** ***n*** **= 84 889**	**2020** ***n*** **= 84 777**	**2021** ***n*** **= 88 432**
Female, n(%)	47 617 (57.6)	48 024 (57.4)	48 911 (57.6)	48 837 (57.6)	50 976 (57.6)
Age, median (IQR)	61.0 (21.0)	61.0 (20.0)	61.0 (21.0)	62.0 (21.0)	61.0 (21.0)
[40–64[years, n(%)	49 311 (59.6)	49 232 (58.8)	49 452 (58.3)	48 380 (57.1)	50 834 (57.5)
[64–80[years, n(%)	24 221 (29.3)	24 963 (29.8)	25 627 (30.2)	26 244 (31.0)	27 292 (30.9)
[80–100[years, n(%)	9 210 (11.1)	9 472 (11.3)	9 810 (11.6)	10 153 (12.0)	10 306 (11.7)
LoS in days, median (IQR)	4.0 (7.0)	4.0 (7.0)	4.0 (8.0)	5.0 (9.0)	5.0 (8.0)
CVD Risk Category					
Low-to-moderate risk, n(%)	39 892 (48.2)	39 441 (47.1)	39 086 (46.0)	37 743 (44.5)	39 320 (44.5)
High risk, n(%)	18 573 (22.4)	19 104 (22.8)	19 868 (23.4)	20 007 (23.6)	20 791 (23.5)
Very high risk, n(%)	22 162 (26.8)	23 094 (27.6)	24 029 (28.3)	24 693 (29.2)	25 553 (28.9)
- ASCVD, n(%)	9 290 (11.2)	9 493 (11.3)	9 456 (11.1)	9 516 (11.2)	9 720 (11.0)
- ASCVD-risk equivalent, n(%)	12 872 (15.6)	13 656 (16.3)	14 573 (17.2)	15 177 (17.9)	15 833 (17.9)
Risk category unknown	2 115 (2.6)	2 028 (2.4)	1 906 (2.2)	2 334 (2.8)	2 768 (3.1)
Number of episodes					
Hospital admissions, n(%)	8 560 (1.3)	8 309 (1.3)	8 125 (1.3)	7 120 (1.2)	7 660 (1.2)
Hospital outpatient visits, n(%)	161 925 (25.4)	160 862 (25.4)	156 564 (24.5)	129 350 (22.5)	154 437 (24.6)
Emergency visits, n(%)	44 205 (6.9)	41 145 (6.5)	42 560 (6.7)	38 549 (6.7)	42 058 (6.7)
Primary care scheduled visits, n(%)	355 716 (55.7)	356 582 (56.2)	363 873 (57.0)	374 882 (65.2)	407 430 (65.0)
Primary care unscheduled visits, n(%)	67 747 (10.6)	67 322 (10.6)	67 311 (10.5)	25 001 (4.3)	15 402 (2.5)

ASCVD: very high-risk patients with prior Atherosclerotic Cardiovascular Disease; LoS: length of stay; IQR; interquartile range

majority of the eligible population, we were able to compute the CVD risk categories. The low-to-moderate risk group was the largest one, accounting for almost half of the population (ranging from 44.5 to 48.2%). In the very high-risk group, around 39.8% were ASCVD patients (ranging from 38.0 to 41.9%) across all analyzed years. Regarding primary care appointments unscheduled visits, there was a relatively stable count between 2017 and 2019, however, in the years of pandemic restrictions (2020 and 2021), there was a significant drop.

The analyzed direct costs show that, regardless of the year, most money was spent with hospitalization episodes (ranging from 53 655 671€ −62 998 246€), followed by primary care visits (20 988 121€ −25 882 976€), hospital outpatient visits (6 338 150€ −7 934 325€), and, finally, at emergency room visits (4 320 186€ −4 954 054€). Regarding cost evolution per year, costs have not changed over the years, despite including the years of the pandemic.

HRU and costs by CVD risk

Very high-risk patients tend to have higher HRU compared to other CVD risk groups, particularly in hospital admissions (Fig. 1). In 2021, the low-to-moderate risk group was responsible for 19.7% of the total episodes of hospital admissions, the high-risk for 19.1% and the very high-risk (with and without ASCVD) for 60.1% (Non-computable CV risk accounted for 1.1% of episodes). The direct costs associated with HRU differed also according to the CVD risk category. Over the years, in very high-risk patients, approximately 73.5% of the total direct costs are related to hospital admissions (ranging from 72.4 to 76.1%, see Figure S1 of Additional file), whereas in

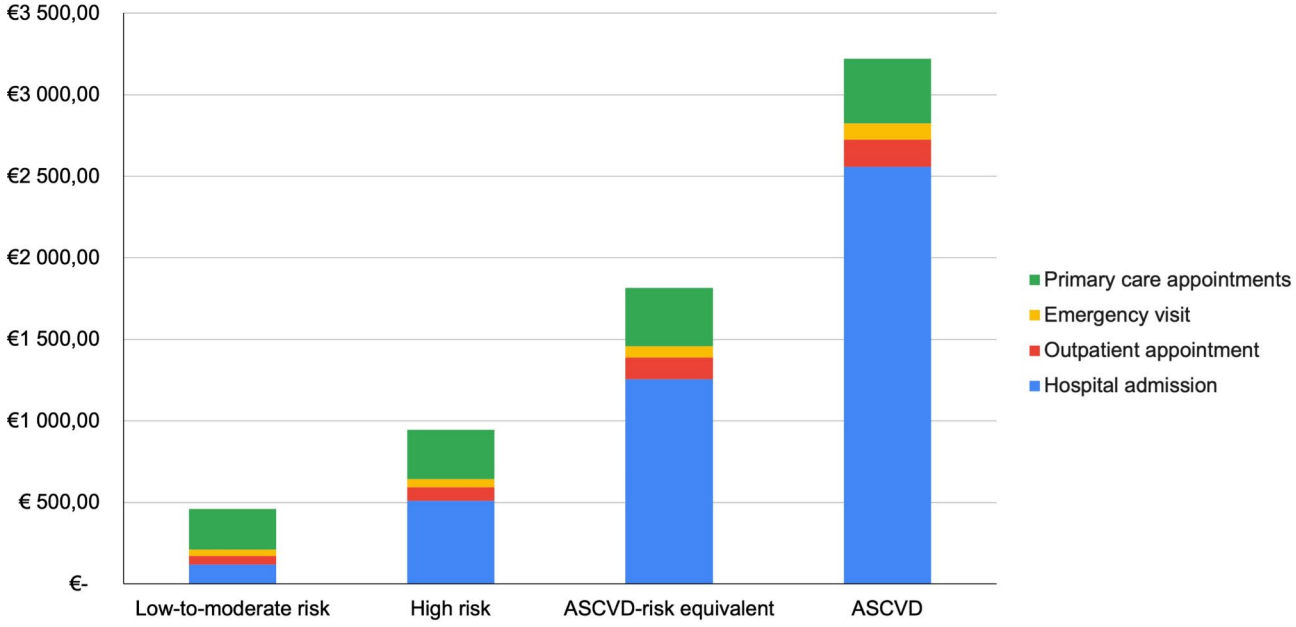

Fig. 1 Direct costs per patient by CVD risk categories, in 2021. ASCVD-risk equivalent: Very high CVD risk without prior ASCVD; ASCVD: Very high CVD risk with prior ASCVD

Table 2 Average direct cost per patient in each type of healthcare services, by risk category, across 2017–2021

	Low-to-moderate risk	High risk	Very high risk: ASCVD-risk equivalent	Very high risk: ASCVD
Hospital admissions, mean (min-max)	148 € (120–172)	474 € (400–557)	1 247 € (1 197-1 287)	2 673 € (2 523-2 878)
Hospital outpatient appointment, mean (min-max)	58 € (48–65)	85 € (71–94)	131 € (113–141)	166 € (140–184)
Emergency visits, mean (min-max)	40 € (38–43)	63 (49–94)	71 € (64–78)	115 € (100–118)
Primary care appointment, mean (min-max)	224 € (210–247)	285€ (258–304)	330 € (308–359)	365 € (343–395)

low-to-moderate and high-risk patients, the higher costs were due to primary care visits (Figure S1 of Additional file).

Overall, as the risk increases, the costs of hospitalizations, outpatient appointments, emergency visits, and primary care visits tend to rise (Fig. 1). In 2021, very high-risk individuals incurred the highest hospital admissions (44 754 344€, about 4 604€/patient) and hospital outpatient appointment costs (3 702 342€, about 381€/patient), whereas the low-to-moderate risk patients had the highest primary care visits costs (9 720 179€, about 247€/patient), despite lower overall direct costs (18 040 747€, about 459€/patient).

The direct costs per patient of an episode increased with the CVD risk level, with very high-risk patients with ASCVD and ASCVD-risk equivalent patients having the highest costs across all types of healthcare services (Table 2).

In 2021, direct costs related to very high-risk patients (with and without prior ASCVD) represented the majority of total direct costs, across all healthcare settings (Fig. 2). A similar pattern was observed across all years. Costs related to ASCVD patients accounted for one-third of the total direct costs, similar to those without prior ASCVD.

Similar to previous years, in 2021 the costs for hospitalizations rose as the CVD risk level increased, whereas, in the low-to-moderate risk group, the highest costs were associated with primary care settings.

The cost per episode at the hospital varies, with inpatient stays ranging from €1349 to €1584, outpatient consultations from €8.3 to €10.4, emergency visits from €20.7 to €23.8, and primary healthcare services from €9.99 to €12.32.

ASCVD and ASCVD-risk equivalent patients

Among ASCVD patients, hospital admissions represented the largest proportion (41.2%) of episode costs (Fig. 3). On the other hand, primary care settings, despite accounting for a substantial proportion

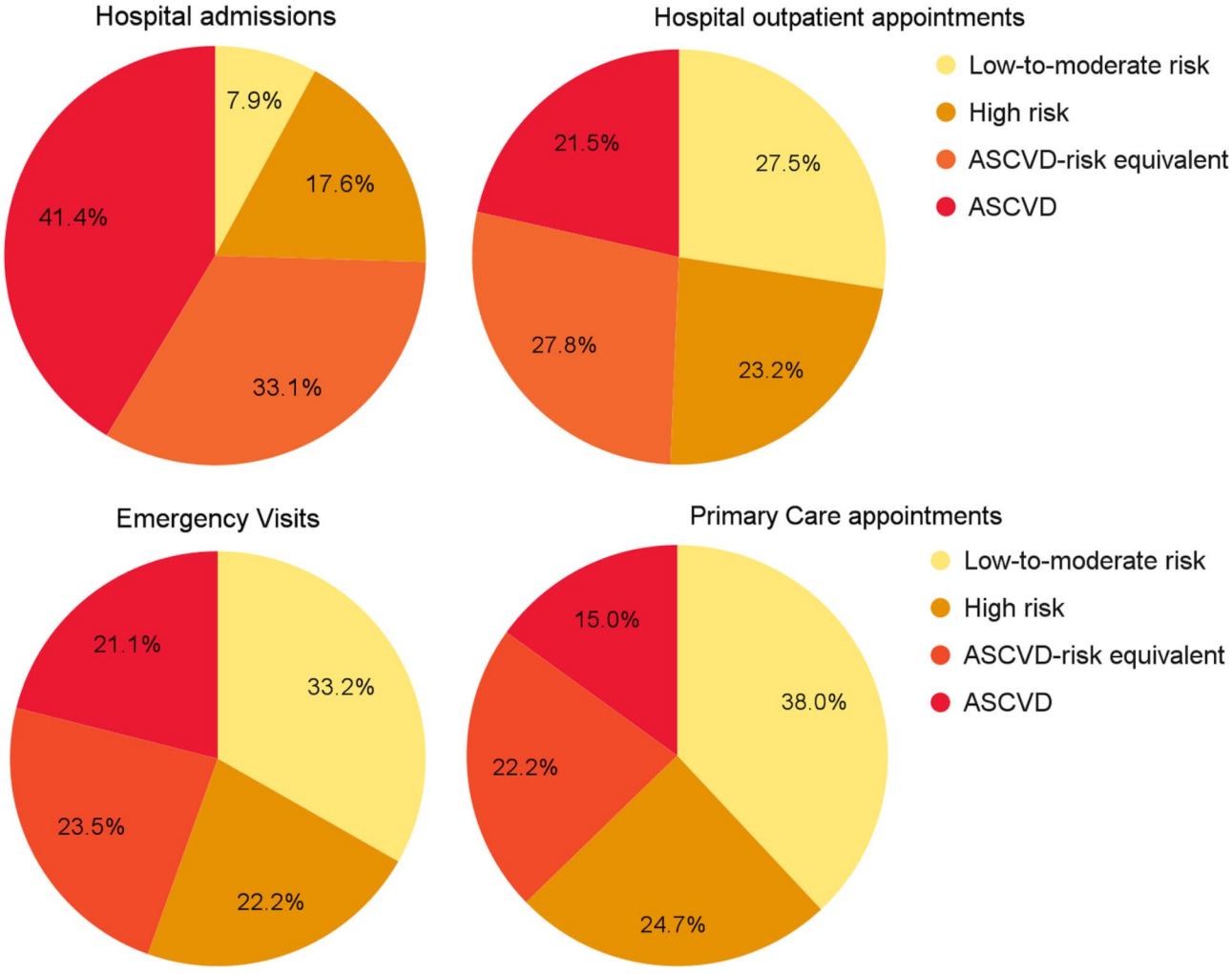

Fig. 2 Distribution of the costs in each different medical setting by CVD risk categories, in 2021. ASCVD-risk equivalent: Very high CVD risk without prior ASCVD; ASCVD: Very high CVD risk with prior ASCVD

of episode counts, showed lower episode costs (14.9%) (Fig. 3). Approximately one-third of the episodes of hospital admissions were attributed to patients with ASCVD, regardless of the year (see Figure S2 of Additional file). Within this group, hospitalizations consistently represented the highest percentage of total direct costs, regardless of the year (see Figure S3 of Additional file).

The analysis by age groups showed that among patients with ASCVD, the proportion of hospitalization costs increased with age (Fig. 4). However, this was not observed among those with ASCVD-risk equivalent. In this group, for patients between 65 and 80 years old group and older, the proportion of costs across all healthcare settings was similar. When analyzing the cost per patient in patients with ASCVD and ASCVD-risk equivalent, we observed that for both groups, the cost of hospitalization admissions substantially escalates with advancing age, with individuals above 80 years incurring significantly higher costs (Table 3). For primary care appointments, the costs remain stable, regardless of age.

Discussion

This study was designed to assess HRU across the ESC/EAS CVD risk categories. To the best of our knowledge, no previous study has focused on analyzing costs of managing cardiovascular conditions taking into consideration these categories. A clear trend emerges from the data, indicating that as the risk level increases, so do the associated costs for each type of episodes. Moreover, our results not only highlight substantial HRU across the entire spectrum of CVD risk but also reveal a significant surge in costs among individuals with the highest CVD risk, particularly those with ASCVD. This group incurred higher costs compared to individuals in the high-risk and very high-risk categories without ASCVD.

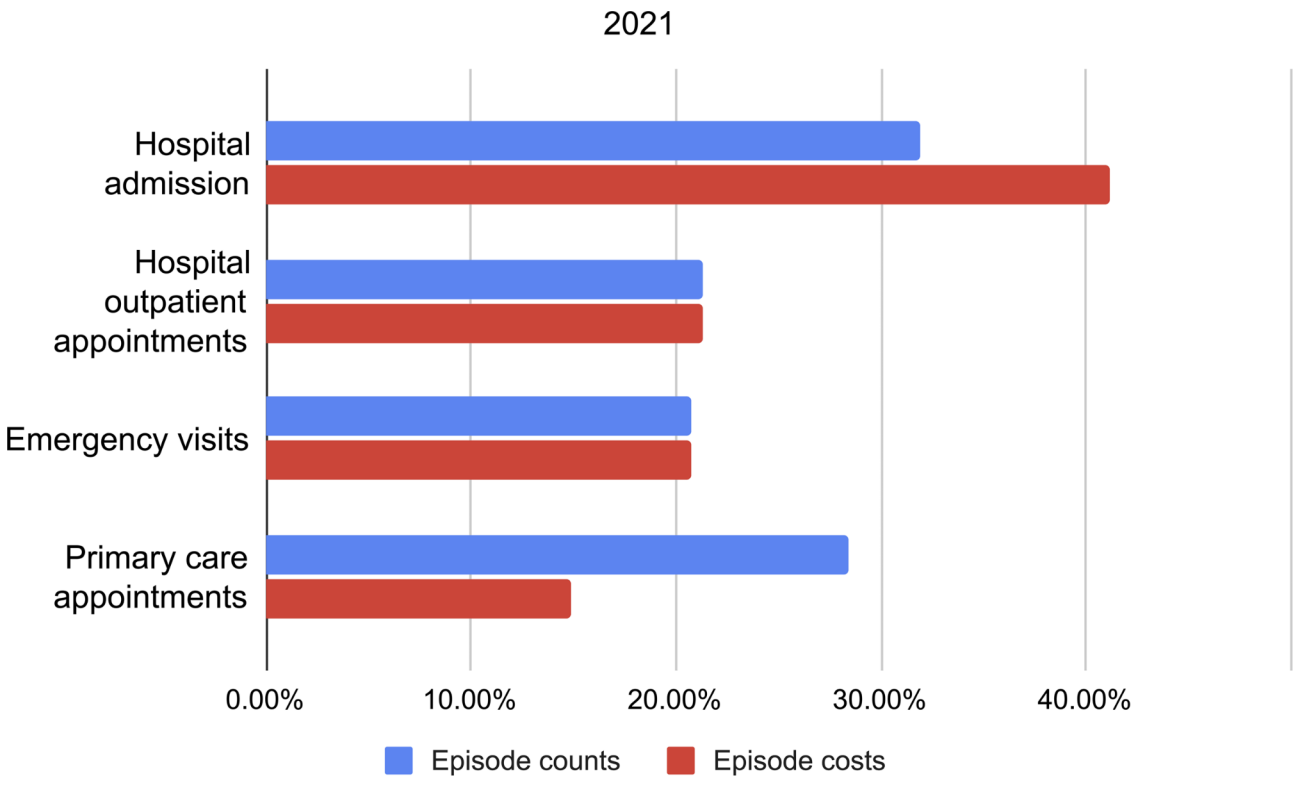

Fig. 3 Proportion of each medical setting episode counts over the total episodes and costs over the total costs among ASCVD patients, in 2021. ASCVD: Very high CVD risk with prior ASCVD

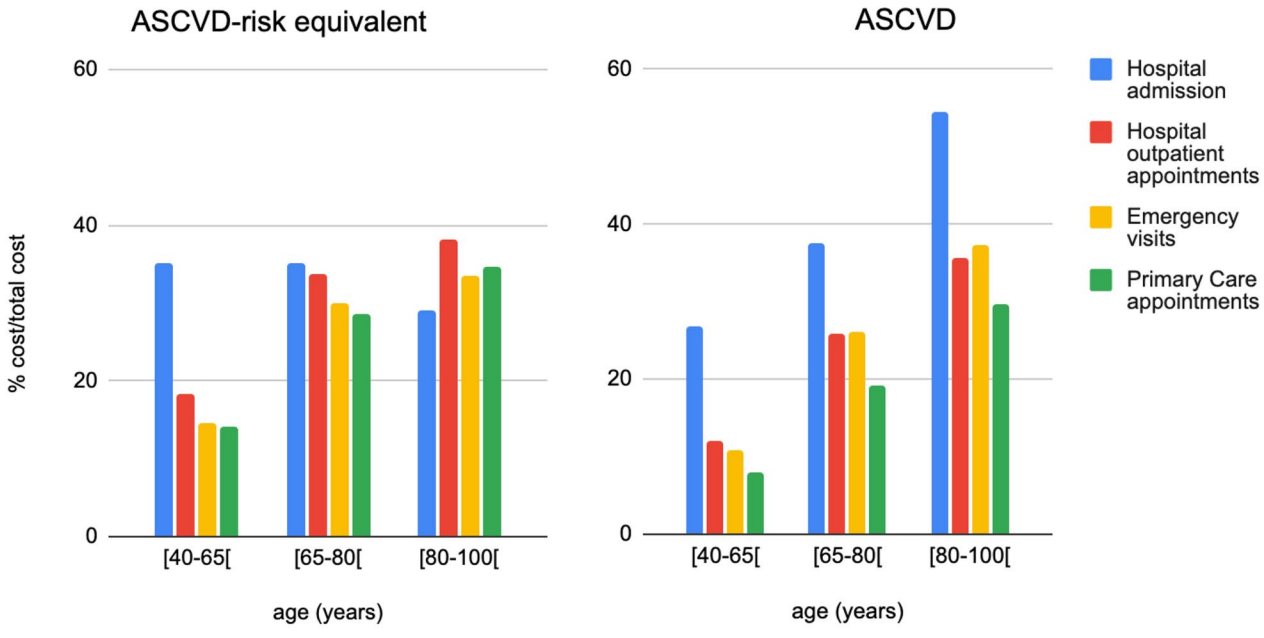

Fig. 4 Proportion of costs attributed to patients with ASCVD-risk equivalent and ASCVD, over total costs, stratified by age group, in 2021. ASCVD-risk equivalent: Very high CVD risk without prior ASCVD; ASCVD: Very high CVD risk with prior ASCVD

Table 3 Average direct cost per patient for ASCVD and ASCVD-risk equivalent category, regarding each healthcare setting, stratified by age, in 2021

	[40–65[years	[65–80[years	[80–100[years
Very high risk: ASCVD-risk equivalent			
Hospital admissions	996 €	1 124 €	1 955 €
Hospital outpatient appointment	115 €	141 €	139 €
Emergency visits	64 €	61 €	92 €
Primary care appointment	357 €	354 €	372 €
Very high risk: ASCVD			
Hospital admissions	1 467 €	2 016 €	4 528 €
Hospital outpatient appointment	146 €	183 €	160 €
Emergency visits	91 €	90 €	127 €
Primary care appointment	393 €	399 €	393 €

Notably, the highest costs are observed in the very high-risk category for all types of HRU, particularly in hospitalizations among patients with ASCVD. Despite most of the reported episodes taking place in primary care facilities, the highest costs within this group were associated with hospitalizations, representing about 41% of the total healthcare expenditure. This fact is in agreement with previous results found in the literature, which demonstrated that patients with more favorable cardiovascular health when compared to high-risk populations, have significantly lower healthcare expenses [24]. The same trend is apparent when comparing primary with secondary prevention patients [31]. Supporting these findings, a study by Carlsson (2021) revealed that individuals with ASCVD had mean annual total direct costs that were three times higher than individuals without any ASCVD (€2 772 vs. €892). In this study, inpatient costs comprised 74% of total annual mean direct costs over the 5-year follow-up, while outpatient and drug costs contributed 15% and 11%, respectively [32]. However, to compare absolute values across countries, it is essential to consider differences between populations, data sources, countries' retirement policies, or study methodology, including CVD definitions and hazard ratio specificity of cost differentiation. For instance, global health expenditure data from the World Bank indicates significant variations in per capita health expenditure across countries, highlighting the need for contextualized analysis when comparing healthcare costs globally [33].

This study also showed that most of the patients fell under the low-to-moderate risk category, representing the largest portion of the cohort. Very high-risk patients, regardless of prior ASCVD, had a higher consumption of resources in all of the analyzed settings, including in primary healthcare centers. This disparity is especially evident in hospital care. When hospitalization was required.

Although the high-risk category already showed an increase of in total direct costs compared with low-to-moderate risk, the economic burden for the health system peaked in caring for the very high-risk group. Despite only a minority of the total episodes are attributed to very high-risk patients, these were responsible for a significant portion of total direct costs. It is important to highlight that we only took into account the number of days in-hospital to estimate hospitalization costs for very high-risk patients, and did not consider additional costs associated with disease severity.

Our findings suggest that adequate screening and risk factor management at the primary care setting, and consequent decrease in hospitalizations, could have an impact on the economic burden of ASCVD on health systems. Therefore, we believe that our data may help to inform the possible impact of strategies aiming to provide better prevention and disease management in the highest CVD risk patients. Beyond high-risk patients, broader public health policies are needed, including initiatives to promote healthy lifestyles, public health education, and integrating cardiovascular disease prevention into routine primary care. These strategies can help identify and manage at-risk individuals earlier, reduce severe cardiovascular events, and achieve significant cost savings. Overall, a comprehensive approach combining individual risk management with population-wide preventive measures as well as a shift on the healthcare system regarding the therapeutic response to a more preventive approach is essential to reduce the burden of cardiovascular disease and enhance healthcare system efficiency.

Strengths and limitations

This study covers a large volume of patients over an extensive time period, with a minimal selection bias, loss of follow-up and a small amount of missing data. As the ULSM serves a vast majority of the residents and with minimal migration rates, it is reasonable to generalize

our findings to the local population, and those of comparable baseline characteristics. Consequently, this study provides robust data, supporting the feasibility and value of expanding to a multicentric approach. Additionally, the secondary use of data from EHR allows for a more accurate understating of the population's reality, and minimizes errors arising from generalizations [34]. Furthermore, our study has unveiled a significant finding relating to individuals with higher CVD risk bear the highest burden of total costs across all healthcare settings. This emphasizes the critical imperative of early adoption of preventive measures targeting major CVD risk factors.

Despite these strengths, some limitations are noteworthy. The USLM primarily serves an urban population with extensive access to primary healthcare services, which might not be representative of all Portuguese regions. The cost analysis was estimated based on the Diagnosis-Related Groups (DRG) (estimated values by disease group according to the values proposed by the Portuguese authority) on the typical patient and the standard care. The use of DRGs, a bundled payment model, may not accurately reflect the real costs incurred, but rather underestimate it. Additionally, when extrapolating cost estimates for the primary care setting, we focused exclusively on medical expenses, excluding nursing care. The estimation method relying on the DRG values may provide an approximation of the payer's costs without being stratified by pathology, and not an accurate reflection of the actual expenses for the Portuguese health system in managing cardiovascular patients in this cohort. Moreover, our cost analysis did not include additional costs related to diagnostic procedures, medications, laboratory tests, and exams. This limitation should be considered when interpreting the results, as these excluded costs could significantly impact the overall cost distribution. Importantly, our study did not assess indirect costs, such as lost productivity and absenteeism, which recent studies have shown can be substantial and, in some cases, may equal or exceed direct healthcare costs [32].

To overcome these limitations and obtain more accurate cost assessments, future research endeavors should incorporate a real-world cost methodology. It will also be important to compare costs with a standard patient without cardiovascular pathology. This comparison would enable the calculation of hazard ratios, allowing us to understand not only the intergroup costs but also the direct consumption dispersion for patients with cardiovascular disease. Addressing these risk factors proactively may lead to substantial reductions in both healthcare costs and the overall burden on healthcare systems.

Conclusion

Patients at high cardiovascular risk have been consuming a substantial portion of healthcare resources across all healthcare settings, regardless of their age group. This suggests a possible association between the severity of the risk level and the financial strain on medical care, emphasizing the importance of conducting risk assessments and implementing preventive measures, especially for individuals with higher CVD risk factors, particularly within the context of ASCVD.

List of abbreviations

ASCVD	Atherosclerotic Cardiovascular Disease
CaReMe	CArdioREnal and MEtabolic
CKD	Chronic Kidney Disease
CVD	Cardiovascular Disease
DALYs	Disability-Adjusted Life Years
DRG	Diagnosis-Related Groups
EHR	Electronic Health Records
ESC	European Society of Cardiology
GP	General Practitioner
HRU	Healthcare Resource Utilization
ICD-10	International Classification of Disease, 10th Revision
ICD-9	International Classification of Disease, 9th Revision
ICPC-2	International Classification of Primary Care, 2nd edition
IQR	Interquartile Range
LATINO	Lipid mAnagemenT IN pOrtugal
LoS	Length-of-Stay
RWE	Real-World Evidence
SD	Standard Deviation
ULSM	Unidade Local de Saúde de Matosinhos
WHO	World Health Organization

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s13561-024-00550-2.

Supplementary Material 1

Acknowledgements

The authors would like to acknowledge the editorial support, namely the constructive review of the manuscript and raised comments. The authors also wish to acknowledge Filipe Costa from Nova Health & Economics Management Knowledge Center - Nova SBE for his valuable insights and manuscript review, and Ana Sá-Sousa from MTG Research and Development Lab for her extensive manuscript review. The authors also would like to acknowledge Hospital Pedro Hispano Hospital for granted permissions for this study and to Daniel Santos, Tiago Morais and José Castanheira from the Department of Information Technologies for conducting data extraction.

Author contributions

CG, MAS, CM, RA, IC, and TTG participated in study design, methodology, and writing the original draft of the manuscript; AB, IF, MCP, DS, FA participated in the writing and critical review of the manuscript. All authors read and agreed with the final version of the manuscript.

Funding

The analysis that gave rise to this manuscript was fully funded by Novartis Portugal. This study was conducted within the scope of a collaboration protocol in clinical research between Novartis Farma - Produtos Farmacêuticos SA, and Sociedade Portuguesa de Aterosclerose."

Data availability

No datasets were generated or analysed during the current study.

Declarations

Ethics approval and consent to participate

The database use was authorized by the Ethical Committee and Data Protection Officer of ULSM (translated from *Comissão de Ética para a Saúde da Unidade Local de Saúde de Matosinhos*) under approval codes N.º21/CE/JAS.

Consent for publication

Not applicable.

Competing interests

MAS and IC are employees at Novartis Portugal. All other authors have no conflicts of interest related to this manuscript to declare.

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Received: 25 March 2024 / Accepted: 21 August 2024
Published online: 12 September 2024

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