ΕΘΝΙΚΟ ΚΑΙ ΚΑΠΟΔΙΣΤΡΙΑΚΟ ΠΑΝΕΠΙΣΤΗΜΙΟ ΑΘΗΝΩΝ
ΙΑΤΡΙΚΗ ΣΧΟΛΗ
ΘΕΡΑΠΕΥΤΙΚΗ ΚΛΙΝΙΚΗ ΝΟΣ. ΑΛΕΞΑΝΔΡΑ

ΠΡΟΓΡΑΜΜΑ ΜΕΤΑΠΤΥΧΙΑΚΩΝ ΣΠΟΥΔΩΝ
«ΚΛΙΝΙΚΕΣ ΜΕΛΕΤΕΣ: ΣΧΕΔΙΑΣΜΟΣ ΚΑΙ ΕΚΤΕΛΕΣΗ»
MSc: "Clinical Trials: Design and Conduct"

Διευθυντής
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Καρδιαγγειακή υγεία σε περιόδους οικονομικής κρίσης κατά τον 20ο και 21ο αιώνα: συστηματική ανασκόπηση, Περίπτωση 2

Cardiovascular health in times of economic crisis in the 20th and 21 st century: a systematic review, Case 2

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ΑΘΗΝΑ 2021

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Table 1. Terms and abbreviations.

ACS	Acute Coronary Syndrome
AHA	American Heart Association
AHRQ	Agency for Health Research and Quality
AMI	Acute Myocardial Infarction
APC	Annual Percentage Change
ASR	Age Standardised Mortality Rates
BAV	Bicuspid Aortic Valve
BCTC	Business cycle or trade cycle
BKC	Bankruptcy Count
BMI	Body Mass Index
BNP	Brain Natriuretic Peptide
BRFS	Behavioral Risk Factor Surveillance System
CABG	Coronary Artery Bypass Graft
CAD	Coronary Artery Disease
CEE	Central and Eastern Europe
CHD	Coronary Heart Disease
CHF	Chronic Heart Failure
CI	Confidence Interval
COPD	Chronic Obstructive Pulmonary Disease
COVID-19	Coronavirus disease of 2019.
CPI	Consumption Price Index
CT	Computed Tomography
CV	Cardiovascular
CVA	Cerebrovascular Accident
CVD	Cardiovascular Disease
CVMR	Cardiovascular Mortality Rate
DM	Diabetes Mellitus
e.g.	Exempli Gratia (for example)
ED	Emmergency Department
EDS	Ehlers-Danlos Syndrome
EF	Ejection Fraction
ELSTAT	Hellenic Statistical Authority
EU	European Union
FCO	Full Corporate Offer
FGR	Federal German Republic
GDP	Gross Domestic Product
GRACE	Global Registry of Acute Coronary Events
HF	Heart Failure
HFmrEF	HF mid-range ejection fraction
HFpEF	HF with preserved ejection fraction
HFrEF	HF with reduced ejection fraction
HI	High Income

HR	Hazard Ratio
i.e.	Id Est (that is)
IBRD	International Bank for Reconstruction and Development
ICD	International Classification of Diseases
IHD	Ischemic Heart Disease
IL	Interleukin
ILRs	Implantable Loop Recorders
IMF	International Monetary Fund
IS	Ischemic Stroke
ISTAT	Istituto Centrale di Statistica (Italian: Italian National Statistics Institute)
LV	Left Ventricular
LVH	Left Ventricular Hypertrophy
MI	Myocardial Infarction
MRI	Magnetic Resonance Imaging
MS	Marfan Syndrome
NCD	Non-communicable Diseases
NESARC	National Epidemiologic Survey on Alcohol and Related Conditions
NHANES	National Health and Nutrition Examination Survey
Non-STEMI (NSTEMI)/UA	Non-ST-segment Myocardial Infarction and Unstable Angina
NOS	Newcastle Ottawa Scale
NW	Non-Worker
OA	Office Clerk & Administrative Staff
OPEC	Organization of the Arab Petroleum Exporting Countries
OR	Odds Ratio
PAD	Peripheral Arterial Disease
PCI	Percutaneous Coronary Interventions
PICO	Patient/Population, Intervention, Comparison and Outcomes
PM	Professional & Manager
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses Guideline
PRR	Prevalence Risk Ratio
RII	Relative Index of Inequality
RR	Rate Ratio / Relative Risk
SES	Socioeconomic Status
SF	Short Form
SII	Slope Index of Inequality
SPECT	Single-Photon Emission Computed Tomography
STEMI	ST-Segment Myocardial Infarction
SW	Skilled Work

TIA	Transient Ischemic Attack
TLoC	Transient Loss of Consciousness
UAE	United Arab Emirates
UK	United Kingdom
UN	Unskilled Worker
US/USA	United States of America
vs	Versus
WHO	World Health Organization

Abstract

Background: Economic crises threaten public health worldwide and related to cardiovascular morbidity and mortality. This systematic review investigates the association of factors contributing to cardiovascular health and to observe changes in the trends and the severity of the established CVD, among the general population living in countries exposed to financial crises.

Methods: Systematic search conducted in PubMed, EMBASE and Google Scholar databases (end-of-search:May 12,2020). Studies examined the relationship between economic crisis and cardiovascular health in 20th and 21st century. The quality of included studies was assessed using the Newcastle-Ottawa Quality scale and AHRQ standards.

Results: 44 eligible studies focused on impact of economic downturns on IHD, hypertensive, cerebrovascular diseases, and HF;28 ecological studies, 10 cohort studies, 4 register-based studies and 2 cohort surveys included. Of those, 22(50%) were considered as high, 20(45%) at moderate, and only 2(5%) at low risk of bias. Although there were observed equivocal findings, there was some evidence that incidence of IHDs and cerebrovascular diseases in women was increased after economic crisis; ACS, STEMI, or NSTEMI occurs more often in men than in younger women, but after 75 years, this was reversed. Regarding hypertension, women are more affected than men. Moreover, a positive relationship found between HF and economic recessions.

Discussion: Stress, worklessness, low income, lifestyle and changes in SES, constitute probably the main reasons why the cardiovascular health might deteriorate in times of economic hardship. The CVDs associated with unemployment are mainly CHD and hypertension. Additional quantitative analysis on CVDs and economic factors seems desirable.

Keywords: economic crisis; recession; cardiovascular health; heart diseases; systematic review

A. Introduction

A1. Assessment and ascertainment of an economic crisis

The widespread effect of the global financial crises highlights the importance of having a solid understanding of crises.

When comparing the timelines for "depression" and "recession", it is apparent that they moved on similar levels from the 1960s onwards, whereas earlier decades, not just following the Great Depression, had seen much more frequent use of the notion of "depression". Overall, after World War II, downswings in business cycles have been much milder on average than previous historical experiences. This may very well explain why the terminology shifted more towards the notion "recession" which refers to a less severe period of economic dearth. Interestingly, it is noticed an enormous increase in the frequency of the term "crisis" since the 1960s in recent years. This might be interpreted to imply a shift away from discussions of the business cycle as a whole and towards the particular event of the crisis, which might be in accordance with the focus on shocks which is widespread in standard workhorse approaches to business cycle analysis over the past four decades. The frequency of "BCTC" ("business cycle" or "trade cycle") also similarly increased since the 1970's, however. Additionally, it may be argued that "crisis" is a term with a broader applicability, also outside of the mainly macro, business cycle theory context, whereas 'recession' is very specific to the latter (Kufenko and Geiger, 2016)

Crises are extreme manifestations of the interactions between the financial sector and the real economy and are generally associated with significant declines in a wide range of macroeconomic aggregates. It is acknowledged that a financial crisis is an amalgam of events including substantial changes in credit volume and asset prices, severe disruptions in financial intermediation, notably the supply of external financing, large scale balance sheet problems (of firms, households, financial intermediaries, and sovereigns), and the need for large scale government support. While these events can be driven by a variety of factors, financial crises often are preceded by asset and credit booms that then turn into busts. Recessions following crises exhibit much larger declines in consumption, investment, industrial production, employment, exports and imports, compared to those recessions without crises. In order to understand financial crises, it is required an interpretation of macro-financial linkages (Claessens and Kose, 2013).

The indicators that are usually used for macroeconomic activity are: the gross domestic product (GDP) per capita; the unemployment rate (labour market statistics); the gross private domestic investment; the consumption price index (CPI); the stock market index; the house price; and the bankruptcy rates. The most common lagging indicator of economic activity is GDP that measures the total value of all final goods and services that are newly produced within the borders of a country over the course of a year (D' Alisa *et al*, 2015). Generally, financial crises tend to have a permanent negative effect on the level of GDP, while could also weigh on the long-term growth of output.

It is pointed out that economic research is prone to move in cycles and react to events such as crises and recessions. The term "cycle" is used to describe a process that moves sequentially between a series of clearly identifiable phases in a recurrent or periodic fashion. Economists of the nineteenth and early twentieth centuries were persuaded that they saw

such a pattern exhibited in the overall level of economic activity, and enthusiastically sought to characterize the observed regularities of what came to be known as the "business cycle" (Hamilton, 2005).

The "business cycle" is a broad term that connotes the inherent fluctuations in the GDP around its long-term natural growth rate. It explains the expansion and contraction in economic activity that an economy experiences over time (Arnold, 2002). This cycle is completed when it goes through a single boom and a single contraction in sequence. The time-period to complete this sequence is called the length of the business cycle. A boom is characterized by a period of rapid economic growth whereas a period of relatively stagnated economic growth is a recession. These are measured in terms of the growth of the real GDP, which is inflation-adjusted.

Business cycle literature recognizes two types of cycle. One type of cycle is known as the "classical" cycle, which can be recognized from the fact that it involves an absolute decline in economic activity from the peak and an absolute rise in activity from the trough. The other type of cycle is a "deviation" or "growth cycle" (occasionally growth rate) where the underlying idea is that the business cycle can be identified as a cycle relative to a trend (Artis and Okubo, 2009).

There are six stages that describe a business cycle: the "expansion" stage, which is characterized by an increase in positive economic indicators (i.e., employment, income, output, wages, profits, demand, and supply of goods and services); the "peak" stage, that marks the reversal point in the trend of economic growth since the economy reaches a saturation point, or peak. In this stage, the maximum limit of growth is attained whereas, the economic indicators do not grow further, and prices are at their peak; the "recession" stage where the demand for goods and services starts declining rapidly and steadily. Moreover, prices as well as all positive economic indicators consequently start to fall; the "depression" stage, where there is a commensurate rise in unemployment and the economy's growth rate becomes negative, since the growth in the economy continues to decline and this falls below the steady growth line; the "trough" stage, which features a further decline until the prices of factors, as well as the demand and supply of goods and services, contract to reach their lowest point. In this stage, the economy reaches the trough with a negative saturation point. There is also extensive depletion of national income and expenditure; and finally, the "recovery" stage, where there is a turnaround in the economy which begins to recover from the negative growth rate. In this phase, demand starts to pick up due to low prices and, consequently, supply begins to increase. Recovery continues until the economy returns to steady growth levels. In this way, a full business cycle of boom and contraction is completed, as it shown in Fig.1. (Artis and Okubo, 2009; Jerelin, 2021).
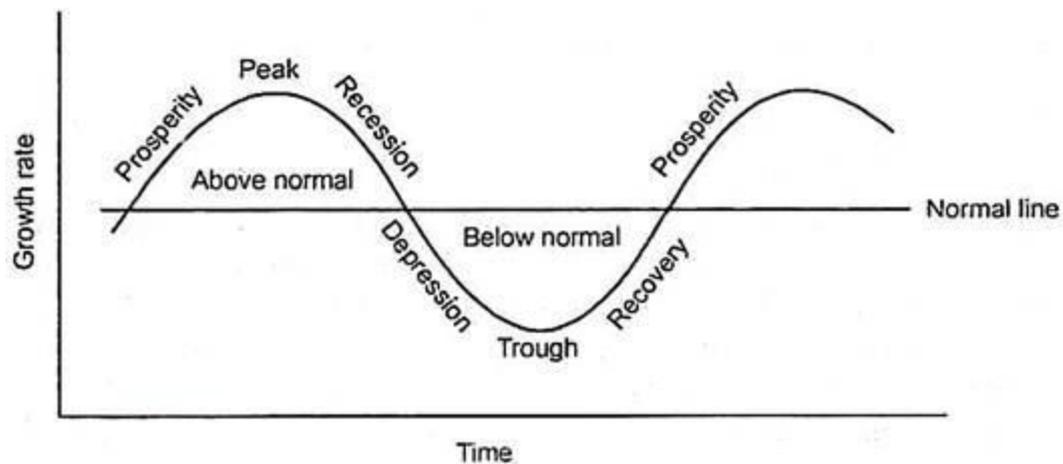
Figure 1. Business Cycles. The phases of a business cycle follow a wave-like pattern over time regarding GDP, with expansion leading to a peak and then followed by contraction [by Jerelin R., retrieved March 14, 2021 from https://www.economicsdiscussion.net/term-paper/business-cycles-term-paper/term-paper-on-the-business-cycles-economics/27393]

A1.1. Economic crises in the 20th century

A1.1.1. The "Great Depression" in the 1930s (1929-1939)

The "Great Depression" was a severe worldwide economic depression that started in the United States around September 4, 1929, after the stock market crash of October 29, 1929, which is known as "Black Tuesday". The timing of the Great Depression varied across the world; in most countries, it started in 1929 and lasted until the late 1930s. It was the longest, deepest, and most widespread depression of the 20th century (Garraty, 1987). Between 1929 and 1932, worldwide GDP fell by an estimated 15%. Over the subsequent 4 years, unemployment in the USA increased more than sevenfold, industrial output plummeted, over 3000 banks collapsed, and world trade shrank even further as countries retaliated against rising US tariffs with their own protective tariffs. Recovery began in early 1933, and while the precise reasons remain the subject of debate, many attributes it to Roosevelt's New Deal, a package implemented that year that included relief for the unemployed and impoverished farmers, reform of financial regulation and government promotion of recovery through programs of support for wages and prices (Stuckler, 2011). Some economies started to recover by the mid-1930s. However, in many countries, the negative effects of the Great Depression lasted until the beginning of World War II (Garraty, 1987). Modern scholarship regards the Depression as an international phenomenon, rather than as something that affected different countries in isolation. The thread that bound countries together in the economic collapse was the gold standard. While debt and reparations from World War I made the international financial system fragile throughout the 1920s, the real problems began in mid-1928 when the United States and France began attracting large amounts of gold from the rest of the world. This deprived other central banks of the gold reserves that they needed to back the currency they issued, forcing them to tighten their monetary policies. Once deflation began, a whole host of related problems developed: high real interest rates led to a collapse of investment, debt deflation led to insolvent debtors and a weaker banking system, which led to depositor runs on bank deposits, which in turn further weakened the banking system, and so forth. Many of these problems were mutually reinforcing and helped put the world economy into a death spiral, but central banks did little to address the situation.

These restrictive policies led to the onset of worldwide deflation starting in mid-1929 (Irwin, 2014).

A1.1.2. The "Oil crisis" or "Oil Shock" in the 1970s

The world economic situation changed with the quadruple of oil prices in 1973/1974 and the world recession of 1974/1975 (Balassa,1981). The drop in real oil prices coincides with increases in US oil consumption. By the early 1970s, it was clear that the United States was consuming more and more oil, but at the same time, oil expenditures as a fraction of GDP were extremely low hovering at levels below 2%. In October of 1973, the members of the Organization of Arab Petroleum Exporting Countries (OPEC) announced a US oil embargo. The embargo, partly in retaliation for the US support of Israel during the Yom Kippur War, lasted through March of 1974. World oil prices rose sharply to an average of $52.85 (in 2011 dollars) during 1974 and the United States spent over $300 billion on oil, nearly 7% of GDP. Expenditures on oil imports exceeded 2% of GDP. The full impact of the embargo, including high inflation and stagnation in oil importers, resulted from a complex set of factors beyond the proximate actions taken by the Arab members of OPEC. It is clear that the Arabs had an aggressive policy of reducing the supply of oil. The Arabs divided their oil importers into three categories: friendly, neutral and supporters of Israel. Oil supply was treated in a different way for each category. For example, America, the Netherlands, South Africa, Rhodesia and Portugal were completely embargoed since they were categorized as pro-Israeli. However, each Arab state had its own list of 'neutral' countries which received a limited reduction, for example 5% cut to Italy, the FGR, Belgium, Ireland, Denmark and Luxemburg. No embargo was applied to the 'friendly' countries, which included most Arab states (until December 1973), the UK, France, Spain and other Muslim countries (FCO 55/1099). Britain was fortunate since the Arabs did not consider London as pro-Israeli during the war. The President of the UAE, Sheikh Zayed for example had said that the decision to cut oil production was not directed against Britain and France who were friends to the Arab world (Zakariah, 2011). Prices stabilized at these higher levels until 1979 when a second oil shock occurred in the wake of the Iranian Revolution. Protests in Iran hampered oil production and led to the suspension of Iranian oil exports. With Iranian production accounting for roughly 10% of world oil production, these disruptions had a large effect on prices. This was followed by the Iran-Iraq War which lowered production in both countries. (Knittel, 2014)

A1.1.3. The "Early 1990s Recession"

The "early 1990s recession" or the "Post-communist Depression" describes the period of economic downturn affecting much of the Western world in the early 1990s. This widespread recession across Central and Eastern Europe accompanied the collapse of the Soviet Union. The primary factors that led to this recession include among others; restrictive monetary policy enacted by central banks, primarily in response to inflation concerns, the loss of consumer and business confidence as a result of the 1990 oil price shock the end of the Cold War and the subsequent decrease in defense spending, the savings and loan crisis and a slump in office construction resulting from overbuilding during the 1980s. The US economy returned to 1980s level growth by 1993 and global GDP growth by 1994 (Nardone *et al*, 1993). President Ronald Reagan's economic policy, or "Reaganomics", had a profound effect on the United States. By cutting taxes on the very wealthy, the policy resulted in both an economic boom and insufficient funding of expenditures. This policy eventually led to large deficits and played a role in "Black Monday" and the Stock Market Crash of 1987. The Federal Reserve Bank sought to counter these concerns by embracing a restrictive monetary

policy to curb inflation and stabilize prices. As a result, it was observed a dramatic limit in economic growth and one of the major causes of a recession that began in July 1990 and ended in March 1991 (The Recession of the Early 1990s, 2015). Although the recession was mild relative to other post-war recessions, it was characterized by a sluggish employment recovery, most referred to as a jobless recovery. Unemployment continued to rise through June 1992, even though economic growth had returned the previous year (Gardner, 1994).

A1.1.4. The "Finnish Banking crisis" (1991-1993)

The Finnish economy experienced a severe recession during the 1990-1993 period in which the seasonally adjusted GDP index fell from 102.4 in May 1990 to 90.9 in November 1991. It took more than two years for the economy to recover from this sharp downturn, as GDP remained flat at about 90 until March 1994, when the economy finally began to recover.

The fall in GDP coincided with slowing of the growth rates of money supply and exports, as well as a steep increase and then rapid decline in banks' loans. In regard to the latter trends, it is noteworthy that bank credit expanded well beyond money supply levels in the late 1980s and early 1990s. The economic downturn in the early 1990s was preceded by excessively strong growth in the 1980s. This rapid expansion was driven in large part by financial deregulation and accommodative tax policies. Concerning financial deregulation, bank credit and savings rate regulations were eliminated in the 1983-1986 period, companies and municipal governments were allowed for the first time to acquire long-term foreign debt in the mid-1980s, households were permitted to make foreign investments in 1990, and previous restrictions on foreigners acquiring Finnish stocks and other property were removed in 1993. These changes enabled banks and savings institutions to expand their deposit and stimulated the money and capital markets. At the same time the government changed tax policies to treat earnings more favorably on capital investments. Due to these stimulatory forces, the late 1980s was marked by an accelerating expansion of credit, including foreign credit exposures. The foreign trade balance rapidly declined from a surplus of 1.7% of GDP in 1987 to 72.0% of GDP in 1989 and did not recover until 1991. Importantly, while exports to the former Soviet Union normally accounted for over 20% of total Finnish exports, this proportion gradually decreased throughout the 1980s and was about 10% by 1990. The fall of Soviet communism caused a further decline in this proportion to only about 2% of total exports in 1991 and 1992. Consumption and investment contractions eventually stabilized the balance of payments by 1993. Also, the weakened currency and rationalizations in industrial production improved Finland's competitiveness in international markets. By 1993 industrial production began to increase with steady growth continuing into 1996. Stock prices rebounded in 1994 and 1995 but residential and commercial property values did not totally recover in the mid-1990s. The boom-bust cycle had finally ended by year-end 1996 (Anari *et al*, 2002).

A1.1.5. The "Asian Financial crisis" in the 1990s (1997-1999)

The fourth economic crisis of the twentieth century took place in South East Asia. The "Asian Financial Crisis" of 1997-1999 originated in Thailand and Malaysia and quickly spread throughout the region affecting many Asian countries including South Korea, Indonesia, Singapore and the Philippines (Deesomsak *et al*, 2009). Initially, the Thai government had tied the baht to the US dollar but was no longer able to defend its currency against intense speculative pressure. Careless lending by banks created an unsustainable bubble. Once international investors realized the true state of the economy the Baht was forced to devalue by 50%. Problems spread rapidly to Thailand's neighbors, leading to mass

withdrawal of capital and rapidly rising unemployment across the region (Stuckler *et al*, 2009). The "Asian Crisis" affected all the "emerging markets" open to capital flows. Measures of corporate governance, particularly the effectiveness of protection for minority shareholders, explain the extent of exchange rate depreciation and stock market decline better than standard macroeconomic measures. A possible explanation is that in countries with weak corporate governance, worse economic prospects result in more expropriation by managers and thus a larger fall in asset prices (Johnson *et al*, 2000).

Even after the Asian crisis was over, other emerging market economies fell into crisis: Russia in 1998, Brazil in 1998-1999, Turkey in 2000-2001, and Argentine in 2000-2001.

A1.1.6. The "Argentine Great Depression" (1998-2002)

One of the most paradigmatic cases of the exchange rate crisis was the experience and outcome of the convertibility regime applied in Argentine between 1991 and 2001. The economy of Argentine finds itself submerged in a great depression that deepened after mid 2001 with average quarterly falls of deseasonalized GDP with respect to the previous quarter of 5% for the last two quarters of 2001 and the first of 2002. This violent deepening of the recession occurred just at the moment that economic agents, almost universally, became convinced of the impossibility of sustaining the Convertibility Plan. The currency-board-like Convertibility Plan that the Argentine government had adopted in 1991 was spectacularly successful in reducing inflation. Many commentators argue that, by fixing the value of the Argentine peso to the US dollar, however, this plan resulted in an 'overvaluation' of the peso (Kehoe, 2003) and This situation was facilitated by the enormous flow of capital that entered Argentine as a result of privatizations and the repatriation of funds from abroad. The peso had, in real terms, appreciated from 30 to 40% by 1998, with the consequent loss of competitiveness of Argentine's exports and a fall in the level of activity in some sectors, especially the local manufacturing industry (Zelmanovitz *et al*, 2020). According to this popular theory, this overvaluation made the Convertibility Plan unsustainable, and the inevitable collapse of the plan produced the Argentine crisis (Kehoe, 2003).

A1.1.6. The "Russian Financial crisis" (1997-1998)

After the collapse of communist and socialist regimes at the beginning of 1990s, a number of Central and Eastern European (CEE) economies started their journey into capitalism by establishing private property and capital markets. As a result, several stock markets have been established in the region. Since then, they displayed considerable growth in size and degree of sophistication. CEE stock markets attracted interest from academics due to several reasons. After a period of relative calm in international bond markets during the first part of 1998, a shock was felt on August 17, 1998 when Russia announced a real devaluation by widening the trading band of the ruble. Russia also declared its intention to restructure all official domestic currency debt obligations falling due to the end of 1999 and imposed a 90-day moratorium on the repayment of private external debt. The period in the lead up to these events also held evidence of stress. The Russian default appears to have led to a reassessment of credit and sovereign risks across global financial markets, evidenced by large jumps in liquidity spreads and risk premia (Dungey *et al*, 2002). In March – May 1998 there followed a further 20 % decline in stock market prices. The government crisis, a worsening deficit of the balance of payments and issue of new debt induced foreign investors continue selling Russian securities. Despite financial aid provided by IMF and IBRD in July, further decline in prices of the Russian securities took place. The crisis of the Russian banking system

provided an additional reason. Russian banks, facing increased claims from the foreign lenders, were induced to sell securities to maintain their currency reserves. As a result, a new wave of price declines took place (Lucey and Voronkova, 2004). The direct cause of the crisis has been the Russian government's failure to address fiscal imbalances. Less direct but more fundamental causes have been structural problems. The government has an inefficient tax regime that fails to generate sufficient revenues to meet fiscal obligations. More fundamentally, incomplete economic restructuring has left an economy, much of which is run on barter, that masks inefficient and even "value-subtracting" economic activities, and that makes attaining fiscal balances even more arduous (Cooper, 1999). The financial crisis during August-September 1998 marks a very interesting event because, unlike other recent financial crises, the shocks during this period seem to have been transmitted across countries with little in common-including countries that do not fit traditional explanations of contagion based on trade links, competitive devaluation or regional effects (Dungey *et al*, 2002)

A1.2. Economic crises in the 21st century

A1.2.1. The "Great Recession" (2008)

The "Great Recession" was a period of marked general decline (recession) observed in national economies globally that occurred between 2007 and 2009. The scale and timing of the recession varied from country to country. The recession was not felt equally around the world; whereas most of the world's developed economies, particularly in North America, South America and Europe. The global financial crisis of 2007 has cast its long shadow on the economic fortunes of many countries, resulting in what has often been called the "Great Recession". What started as seemingly isolated turbulence in the sub-prime segment of the US housing market mutated into a full-blown recession by the end of 2007. The old proverbial truth that the rest of the world sneezes when the US catches a cold appeared to be vindicated as systemically important economies in the European Union and Japan went collectively into recession by mid-2008. Overall, 2009 was the first year since World War II that the world was in recession, a calamitous turn around on the boom years of 2002-2007 (Islam and Verick, 2010). The causes of the Great Recession include a combination of vulnerabilities that developed in the financial system, along with a series of triggering events that began with the bursting of the United States housing bubble in 2005-2006. When housing prices fell and homeowners began to abandon their mortgages, the value of mortgage-backed securities held by investment banks declined in 2007-2008, causing several to collapse or be bailed out in September 2008. This 2007-2008 phase was called the subprime mortgage crisis. The combination of banks unable to provide funds to businesses, and homeowners paying down debt rather than borrowing and spending, resulted in the Great Recession that began in the U.S. officially in December 2007 and lasted until June 2009.

A2. Cardiovascular Diseases

A2.1. Epidemiology of Cardiovascular diseases

Cardiovascular diseases (CVDs) are a group of disorders of the heart and blood vessels consisting of ischemic heart disease (IHD), stroke, heart failure, peripheral arterial disease (PAD), and several other cardiac and vascular conditions, constitute the leading cause of global mortality and are a major contributor to reduced quality of life. In 2016, CVD caused an estimated 17.9 million deaths worldwide, comprising 31% of all global deaths (Fig.2), corresponding to 330 million years of life lost and another 35.6 million years lived with disability (Mensah *et al*, 2019). According to the World Health Organization (WHO), in the same year, ischemic heart disease and stroke alone accounted for 15.2 million deaths globally and have remained the leading causes of deaths in the last 15 years (World Health Organization, 2018. Retrieved from: https://www.who.int/news-room/fact-sheets/detail/the-top-10-causes-of death).
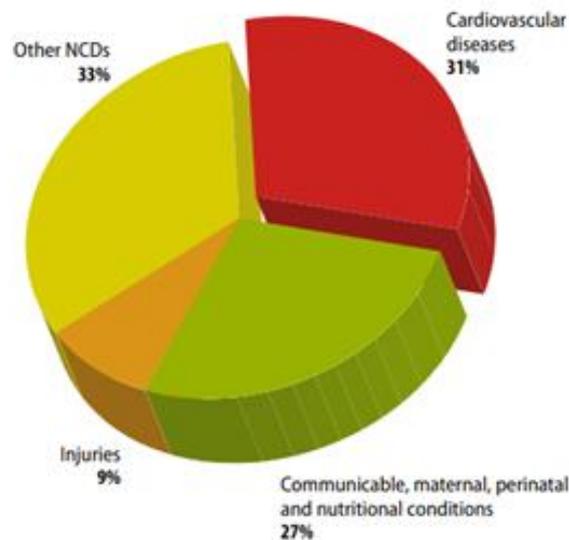
Figure 2. Distribution of major causes of death including CVDs [Retrieved by Mendis *et al* (ed.), 2011]

A2.1.1 Global Burden of Cardiovascular Diseases

CVD has become the single most important and largest cause of NCD deaths worldwide, at over 50% (McAloon *et al*, 2016). In the past few decades, the burden of CVD has grown disproportionally in low-income and middle-income countries, where over 80% of CVD deaths occur. By 2030, approximately 23·6 million people are predicted to die from CVDs annually. The huge and still growing burden of CVDs on individuals, families, and health-care systems indicates an urgent need for research on these diseases and implementation of preventive measures (Song *et al*, 2020).

The pattern and global burden of disease has evolved considerably over the last two decades from primarily communicable, maternal, perinatal and nutritional causes to non-

communicable diseases (NCDs). This change is an example of the widespread urbanization that has occurred during the last century. Moreover, the progression of society through industrialization reflects our changes in health status. Thus, as societies shift from rural to urban settings, major changes occur in the types of food consumed, which often runs in parallel with an increased sedentary lifestyle (Fuster, 2014). This process is well described in the literature as the "epidemiological shift" which can occur between distinct diseases or within the same disease category.

Different countries, or even areas within the same country, can be at varying stages in this transition. Countries in the earliest stages of development are expected to have a higher burden of rheumatic heart disease. Sub-Saharan Africa has one of the highest percentages of mortality related to rheumatic heart disease globally. Proceeding along the epidemiological transition, as the infection rates decrease and nutrition improves, the burden of hypertension prevalence increases. This leads to increased rates of hemorrhagic stroke and hypertensive heart disease. Life expectancy increases and smoking tobacco, high-fat diets, and sedentary lifestyle predominate (Yusuf *et al*, 2001). This reflects the global impact of atherosclerotic disease and identifies why IHD, and strokes are the commonest cause of death globally. The transition progression demonstrates the increasing extent of NCD globally, especially in high income (HI) countries. Finally, as a consequence of better-developed health care systems, HI countries are able to diagnose and treat IHD and stroke, or their causal risk factors and thus delay negative outcomes (McAloon *et al*, 2016).

Although the burden of CVD was highest in Western countries during much of the twentieth century, the highest rates of CVD in our days occur among certain Asian and Middle Eastern regions. The high burdens of CVD in the developing countries are attributable to the increasing incidence of atherosclerotic diseases, perhaps due to urbanization and higher risk factor levels (such as obesity, diabetes, dyslipidemia, hypertension, etc.), the relatively early age at which they manifest, the large sizes of the population, and the high proportion of individuals who are young adults or middle-aged in these countries (Fig. 3&4). The CVD burden affects both men and women, with IHD shown as the predominant manifestation of CVD and is responsible for 46% of all deaths in men and 38% in women, followed by cerebrovascular disease at 34 percent and 37 per cent, respectively (Fig. 5).
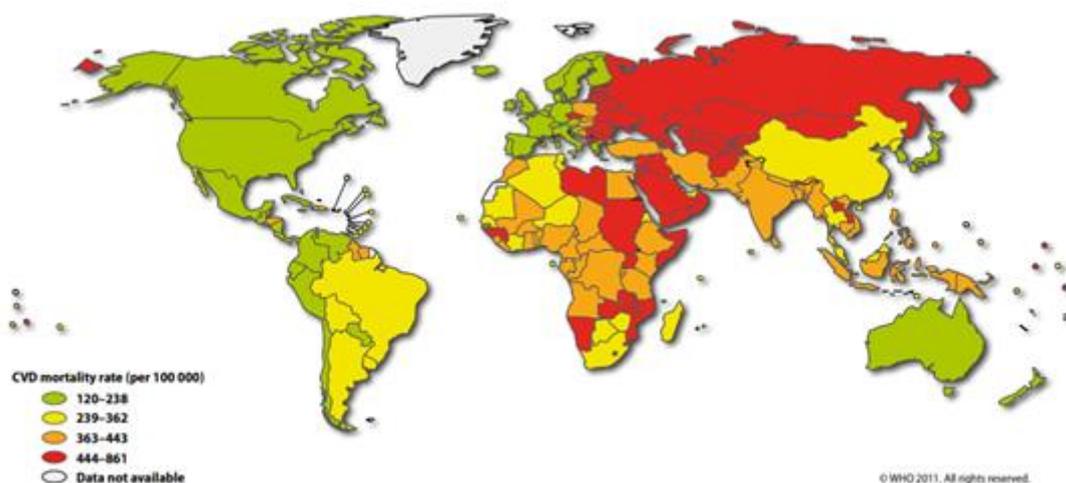
Figure 3. Global distribution of CVD mortality rates in males, age-standardized per 100,000 [Retrieved by Mendis *et al* (ed.), 2011]
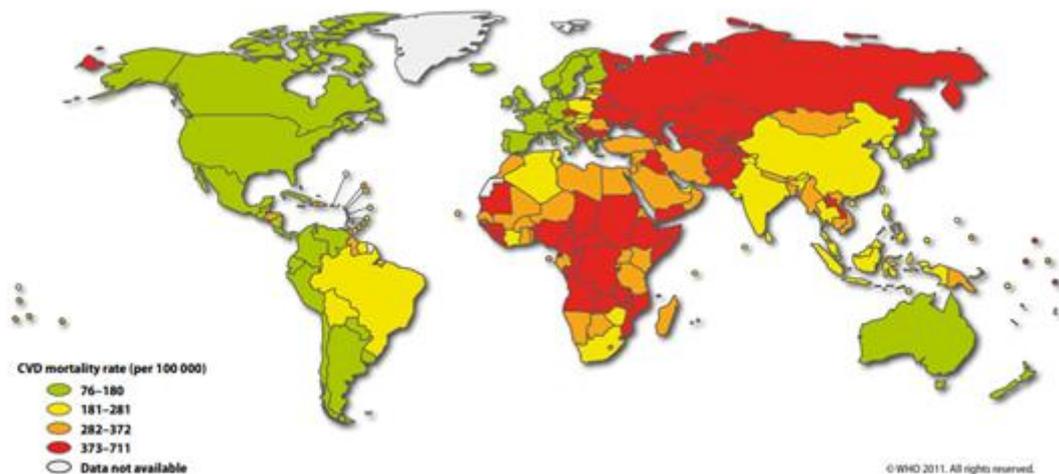
Figure 4. Global distribution of CVD mortality rates in females, age-standardized per 100,000 [Retrieved by Mendis *et al* (ed.), 2011]
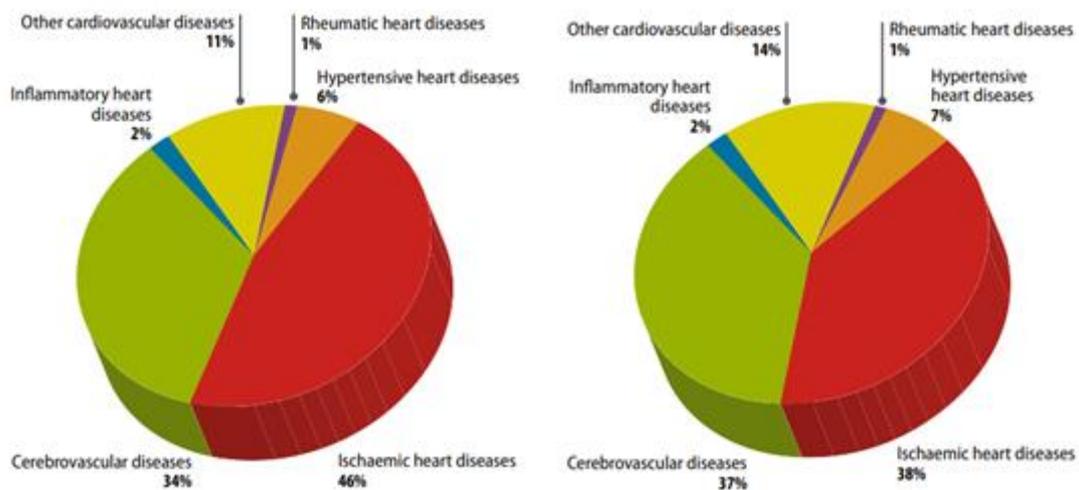
Figure 5. Distribution of CVD deaths due to heart attacks, strokes and other types of cardiovascular diseases in males (left) and females (right) [Retrieved by Mendis *et al* (ed.), 2011]

Individual populations face differing health challenges, and each specific population has unique health burdens, however, CVD continues to remain one of the greatest health challenges worldwide. The specific pattern and severity of disease burdens can vary greatly between populations, regions, genders, age, and ethnic groups. One of the greatest factors influencing variations in global health and CVD burden is prosperity.

Cardiovascular epidemiological studies have demonstrated the association of many risk factors with the development of CVD. Exposure to certain risk factors within specific populations drives the local CVD health burden and contributes to the worldwide burden.

Key risk factors include, but are not limited to, diet, exercise, tobacco smoking, hypertension, dyslipidemia, and alcohol consumption. The regional variation in the presence of lifestyle risk factors varies between countries and cultures influencing CVD burden.

There are several reporting metrics of CVD global burdens used to define fatal and nonfatal CVD. A standard definition of health conditions must be applied globally for these specific metrics to be comparable to each other. The International Classification of Diseases Eleventh Edition (ICD-11) is the standard diagnostic tool for epidemiology, health management, and clinical purposes. All WHO member states use the ICD-11, which has been translated into different languages. The ICD-11 is used to code all health diagnoses, and most member states use it to define primary mortality diagnosis (McAloon *et al*, 2016).

A.2.2. Specific CVD conditions

A.2.2.1 Ischemic Heart Diseases

Ischemia is defined as inadequate blood supply (circulation) to a local area due to blockage of the blood vessels supplying the area. Ischemic means that an organ (e.g., the heart) is not getting enough blood and oxygen. Ischemic heart disease, also called coronary heart disease (CHD) or coronary artery disease (CAD), is the term given to heart problems caused by narrowed heart (coronary) arteries that supply blood to the heart muscle. Although the narrowing can be caused by a blood clot or by constriction of the blood vessel, most often it is caused by buildup of plaque, called atherosclerosis. When the blood flow to the heart muscle is completely blocked, the heart muscle cells die, which is termed a heart attack or myocardial infarction (MI). Most people with early (less than 50 percent narrowing) CHD do not experience symptoms or limitation of blood flow. However, as the atherosclerosis progresses, especially if left untreated, symptoms may occur. They are most likely to occur during exercise or emotional stress, when the demand for the oxygen carried by the blood increases (Institute of Medicine (US), 2010).

Types of IHDs include stable and unstable angina, myocardial infarction, non-fatal MI and sudden cardiac death. The discomfort experienced when the heart muscle is deprived of adequate oxygen is called angina pectoris. This is a clinical syndrome characterized by discomfort in the chest, jaw, shoulder, back, or arms that is typically aggravated by exertion or emotional stress and relieved promptly with rest or by taking nitroglycerin. Angina usually occurs in patients with CHD, but also can occur in individuals with valvular disease, hypertrophic cardiomyopathy, and uncontrolled hypertension. Infrequently, patients with normal coronary arteries may experience angina related to coronary spasm or endothelial dysfunction (Gibbons *et al*, 2002).

CHD can be diagnosed in several ways. Patients with documented (prior) MI or coronary artery revascularization (either with PCI or CABG) have CHD. Moreover, the presence of typical angina suggests a clinical diagnosis of CHD, but most often requires confirmation by additional diagnostic tests, such as coronary angiography. However, this test is an invasive and relatively costly procedure associated with a low, yet definite, risk of an adverse event. Coronary angiography is most often performed following an abnormal stress test or in the setting of an acute coronary syndrome (unstable angina or heart attack) in individuals who are candidates for revascularization (either by PCI or CABG) (Institute of Medicine (US), 2010).

Coronary heart disease (CHD) accounts for the greatest proportion of CVDs, and risk factors such as hypertension, cigarette smoking, diabetes mellitus or elevated glucose level, elevated

cholesterol levels, and obesity or being overweight are the top six causes of death globally (Wong, 2014).

A.2.2.2. Vascular Diseases

Vascular disease is a class of diseases of the blood vessel function that is a leading cause of death around the world. The heritable diseases of blood vessels include conditions affecting both the large conducting arteries, such as the aorta, and those involving the microvasculature. These peripheral abnormalities are primarily associated with connective tissue problems that result in capillary fragility and, sometimes, impaired coagulation in response to this local injury (Baxter, 2005). Disorders in this vast network of blood vessels, can cause a range of health problems which can be severe or prove fatal. These include among others, Marfan syndrome (MS), Ehlers-Danlos syndrome (EDS), bicuspid aortic valve (BAV), erythromelalgia, peripheral artery disease, renal artery stenosis, Buerger's disease, Raynaud's disease and disseminated intravascular coagulation.

A.2.2.3. Cerebrovascular Diseases

The word cerebrovascular is made up of two parts – "cerebro" which refers to the large part of the brain, and "vascular" which means arteries and veins. Hence, cerebrovascular disease is defined as any pathological process involving blood vessels in the brain. The vascular pathology can include lesions of the vessel wall, occlusion of the vessel, rupture of the vessel, or malformation. Cerebrovascular disease includes stroke, carotid stenosis, vertebral stenosis and intracranial stenosis, aneurysms, and vascular malformations (Weinstein and Swenson, 2006). In more details, restrictions in blood flow may occur from vessel narrowing (stenosis), clot formation (thrombosis), blockage (embolism) or blood vessel rupture (hemorrhage). Lack of sufficient blood flow (ischemia) affects brain tissue and may cause a stroke (fatal or nonfatal). Stroke can be categorized as ischemic stroke, intracerebral hemorrhage, and subarachnoid hemorrhage (Yew and Cheng, 2009). Hypertension (high blood pressure) is the most important contributing risk factor for stroke and cerebrovascular diseases as it can change the structure of blood vessels and result in atherosclerosis.

The majority of cerebrovascular problems can be identified through diagnostic imaging tests. These tests allow neurosurgeons to view the arteries and vessels in and around the brain and the brain tissue itself. Computed tomography (CT) scans are considered sufficiently sensitive for detecting mass lesions, such as a brain mass or abscess, as well as detecting acute hemorrhage. However, CT scans may not be sensitive enough to detect an ischemic stroke, especially if it is small. The purpose of a CT scan is to *rule out* certain stroke mimics and detect hemorrhage, not necessarily to *rule in* the diagnosis of ischemic stroke. In other words, a normal CT scan does not rule out the diagnosis of ischemic stroke. Multimodal magnetic resonance imaging (MRI) sequences, particularly diffusion-weighted imaging, have better resolution than CT; therefore, they have a greater sensitivity for detecting acute ischemic stroke and can diagnose about one half of all cases of transient ischemic attacks (TIAs) (Yew and Cheng, 2009).

A.2.2.4. Hypertensive Diseases

Hypertension is a disorder characterized by constantly high blood pressure. Blood pressure readings are given as two numbers. The top number is called systolic blood pressure, and it represents the pressure generated when the heart beats. The bottom number is called diastolic

blood pressure, and it represents the pressure in vessels when the heart is at rest. Persistent high blood pressure can lead to abnormal changes in the heart (Rogers and O' Connor, 2020).

Hypertension remains a major public health problem associated with considerable morbidity and mortality. Hypertensive heart disease is a constellation of abnormalities that includes left ventricular hypertrophy (LVH), systolic and diastolic dysfunction, and their clinical manifestations including arrhythmias and symptomatic heart failure. The classic paradigm of hypertensive heart disease is that the left ventricular (LV) wall thickens in response to elevated blood pressure as a compensatory mechanism to minimize wall stress. Subsequently, after a series of poorly characterized events ("transition to failure"), the left ventricle dilates, and the LV ejection fraction (EF) declines (Drazner, 2011).

In order to diagnose hypertensive heart diseases, it commonly used electrocardiogram, echocardiogram, cardiac stress test, chest X-ray and coronary angiogram.

A.2.2.5. Heart Failure

Heart failure (HF) is a complex clinical syndrome characterized by the reduced ability of the heart to pump and/or fill with blood. From a physiological point of view, HF can be defined as an inadequate cardiac output to meet metabolic demands or adequate cardiac output secondary to compensatory neurohormonal activation (generally manifesting as increased left ventricular filling pressure. HF has recently been classified into three subtypes, namely HF with reduced ejection fraction (HFrEF), HF with preserved ejection fraction (HFpEF) and HF mid-range ejection fraction (HFmrEF), according to the ejection fraction, natriuretic peptide levels and the presence of structural heart disease and diastolic dysfunction (Savarese and Lund, 2017).

Heart failure generally is a chronic condition (chronic heart failure-CHF) in which bouts of worsening symptoms and signs can occur that may require hospitalization. Alternatively, heart failure may present acutely, with occurrence of severe symptoms and signs within 24 h. Although, many conditions can cause heart failure (coronary artery disease, hypertension, cardiomyopathies, valvular and congenital heart disease, arrhythmias, pericardial disease, myocarditis, pulmonary hypertension, and cardiotoxic substances-including alcohol), the predominant cause of heart failure in the western world is ischaemic heart disease (Mosterd and Hoes, 2007).

No diagnostic criteria have been agreed on as the gold standard for heart failure. The National Institute for Health and Care Excellence recommends measuring brain natriuretic peptide (BNP) followed by an ultrasound of the heart if positive (Dworzynski *et al*, 2014).

A3. Aim

Economic crisis poses an immense threat to public health worldwide and has been linked to cardiovascular morbidity and mortality. Even though, both the short and longer-term impacts of economic conditions on cardiovascular disease are unclear, due to the multitude of determinants of cardiovascular health. Some are known to get more favorable during times of economic hardship, such as smoking and alcohol misuse and others are known to become less favorable, such as psychological morbidity. Similarly, the determinants of cardiovascular health include both long-term determinants that make the individual more vulnerable, as well as short-time stressor, making it important to examine effects with a different time lag. Aside from the factors mentioned, unemployment and income are examined here as possible mediators in the relationship, as they have been found to be positively associated with cardiovascular mortality and morbidity, possibly through changed behavior and consumption patterns. As the literature has moved towards more detailed exploration of possible mechanisms underlying the relationships explored (Birgisdóttir *et al*, 2017). However, to the best of our knowledge, no recent systematic review has investigated the overall significance and clinical impact of the findings of relevant studies.

The aim of this systematic review is to examine evidence from relevant studies on factors influencing cardiovascular health and to observe any potential changes in the trends and the severity of the established cardiovascular disease, among the general population living in countries exposed to financial crises.

B. Methods

A systematic review was conducted in order to detect current scientific literature referring to the correlation between the economic crises during 20th and 21st centuries and cardiovascular health.

B1. Literature search and eligibility criteria

A literature search was based on Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement (Liberati *et al*, 2009). The protocol of the wider systematic review was prepared and agreed in advance by the two independent evaluators (DT, MB) and approved by the senior supervisor (TNS). The protocol has subsequently been adapted to the purpose of this study and is provided as Appendix 1.

Eligible studies were identified in PubMed, Embase, and Google Scholar and the end-of-search date was May 12, 2020. No restrictions regarding publication language, publication status, geographical region or participant age were adopted. The details about the search algorithm are provided in Appendix 1 (Protocol, section #8).

Studies examining the relationship between economic crisis and cardiovascular health in the 20th and 21st century, were included. Case-control, cohort, cross-sectional, ecological studies, surveys, registries, investigating any potential changes in the incidence and severity of the cardiovascular disease (CVD), (namely overall incidence of CVD, overall mortality from CVD, Ischemic Heart Diseases (IHDs), hypertension, cerebrovascular diseases, arrhythmias, heart failure (HF), embolism/peripheral thrombosis, other) where eligible. The studies therefore had to present comparisons performed in terms of descriptive statistics or with the use of hypothesis testing were deemed eligible. The studies therefore had to present at least two time points of observation (i.e., pre- and/or during, and post-crisis periods).

Papers, the title or abstract of which did not contain the keywords or the content of which did not explicitly refer to the correlation between economic crisis and cardiovascular diseases were excluded from further review. The following groups of studies were excluded:

- In vitro studies, animal studies.
- Case reports, case series, reviews and meta-analyses.
- Studies looking at the impact of macroeconomic indicators on health outcomes without clearly defining the period of the crisis.
- Studies on impact of economic crises on health system performance and general health effects of poverty, unemployment, socioeconomic status without a direct link to economic crises.
- Studies reporting on outcomes of health care utilization (i.e., not on health outcomes).
- Conference proceedings, symposium/consensus reports, posters' abstracts, oral presentations, commentaries/letters to the Editor, editorials, that did not present relevant original data.
- Studies not referring to CVDs or incidence/mortality.
- Studies reporting only on risk factors.
- Studies reporting different times of economic crisis and CVDs assessment.

B2. Study selection process

Two reviewers (DT and MB) independently screened the search results by title, abstract and full text, for relevance to the topic. Disagreements were resolved by discussion with the supervisor (TNS) and team consensus. Results from the bibliographic databases were merged and duplicates were removed. A systematic search in the reference lists and citations of the selected papers and relevant reviews for potentially eligible articles was performed ("snowball" procedure).

B3. Data extraction and analysis

Data were extracted using a standardized data extraction form that included: first author's name, publication year, study design, study period, geographical region, demographics (males' percentage, mean age, age range), health outcome, definition and ascertainment of economic crisis, categorization (comparison) of economic crisis, adjusting factors, type of effect estimate, main findings. Additionally, regarding cohort studies, the cohort size, number of incident cases, cohort characteristics and definition/features of CVDs in cohort were abstracted.

In case of overlapping study populations, the larger study was ultimately included; however, if an overlapping study reported an additional health outcome, the latter was evidently retained. Two reviewers (DT, MB) independently performed the selection of studies; in case of disagreement, the final decision was reached by the final decision was reached by consultation with the supervisor (TNS) and team consensus. For the purpose of this study are presented studies that analyzed the following CVD outcomes: Ischemic diseases, Cerebrovascular diseases, Hypertension Diseases and Heart Failure. The custom data extraction tables are provided in the Appendix 2-5.

B4. Risk of bias assessment

The quality of included studies was assessed using the Newcastle-Ottawa Quality scale (Wells *et al*, 2011). With respect to ecological and cohort studies, the cut-off value was *a priori* set at 1 year regarding the desirable length of follow-up, whereas the cut-off value for completeness of follow-up was set at 85%. The studies were rated by two independent reviewers (DT and MB); in case of disagreements, final decision was reached by team consensus. A 'star system' was used to assess each eligible study on three broad perspectives: the selection of the study groups; the comparability of the groups; and the ascertainment of outcome, respectively.

Studies were given a rating for each domain according to the thresholds for converting the Newcastle-Ottawa scales to AHRQ standards (Wells *et al*, 2014) (good, fair and poor) as following:

- Good quality: 3 or 4 stars in selection domain AND 1 or 2 stars in comparability domain AND 2 or 3 stars in outcome domain.
- Fair quality: 2 stars in selection domain AND 1 or 2 stars in comparability domain AND 2 or 3 stars in outcome domain.
- Poor quality: 0 or 1 star in selection domain OR 0 stars in comparability domain OR 0 or 1 star in outcome domain.

The evaluation of the eligible studies custom table is provided in the Appendix 6.

C. Results

C1. Characteristics of included studies

The results of this review process are shown in Fig. 6. Initially, 9314 studies were identified and screened by title and abstract for possible inclusion in the review. In total, 9002 non-duplicate items were obtained and assessed for eligibility. In addition, 202 articles were excluded for special reasons and are provided in the Appendix 7. Fifty-eight studies met the eligibility criteria and were included in the initial systematic review which assessed all the selected CVD outcomes. Of these, 44 (Gurfinkel *et al*, 2005; Kim *et al*, 2003; Patel *et al* , 2019); Olfson *et al*, 2018); Angrisani and Lee, 2016); Falconi *et al*, 2016); Noelke and Avendano, 2015; Li *et al*, 2014; Schwartz *et al*, 2012; Garcia *et al*, 2015; Kaviratne *et al* , 2012; Fiuzat *et al*, 2010; Vardakas *et al*, 2019; Sanidas *et al,* 2018; Samentas *et al*, 2014; Makaris *et al,* 2013; Panagiotakos *et al,* 2013; Katsanos *et al,* 2016; Voulgari *et al,* 2019; Dapontas, 2019; Regidor *et al*, 2019; Nolasco *et al*, 2018; Zapata-Moya *et al*, 2015; Bartoll *et al*, 2019; Shin *et al*, 2015; Khang *et al*, 2005; Kim *et al*, 2004; Guojonsdottir *et al*, 2012; Birgisdottir *et al*, 2017; Eiriksdottir *et al*, 2015; Sosa Liprandi *et al*, 2019; Valkonen *et al*, 2000; Lammintausta *et al*, 2012; Verso and Picciotto, 2014; Savu *et al*, 2016; Franco *et al*, 2013; Wada and Gilmour, 2016; Bunn, 1979; Men *et al*, 2003; Osman M. and Osman A., 2017; Guberan, 1979; Niedzwiedz *et al*, 2019; Tapia Granados and Ionides, 2017; Bilal, 2014) are related to the purpose of this study.

Especially, the health outcomes that this work studied included: **IHDs (n=30)** (Gurfinkel *et al*, 2005; Noelke and Avendano, 2015; Li *et al*, 2014; Schwartz *et al*, 2012; Garcia *et al*, 2015); Kaviratne *et al*, 2012; Dapontas et *al,* 2019; Fiuzat *et al*, 2010; Vardakas *et al*, 2019; Sanidas *et al,* 2018; Samentas *et al*, 2014; Makaris *et al,* 2013; Regidor *et al*, 2019; Nolasco *et al*, 2018; Zapata-Moya *et al*, 2015; Bartoll *et al*, 2019; Khang *et al*, 2005; Kim *et al*, 2004; Guojonsdottir *et al*, 2012; Lammintausta *et al*, 2012; Valkonen *et al* , 2000; Verso and Picciotto, 2014; Savu *et al* , 2016; Franco *et al* , 2013; Wada and Gilmour, 2016; Bunn, 1979; Men *et al*, 2003; Osman M. and Osman A., 2017; Tapia Granados and Ionides, 2017; Bilal,2014) **hypertensive diseases (n=13)** (Kim *et al*, 2003; Patel *et al*, 2019; Olfson *et al*, 2018; Angrisani and Lee, 2016; Panagiotakos *et al,* 2013; Voulgari *et al,* 2019; Nolasco *et al*, 2018; Shin *et al*, 2015; Khang *et al*, 2005; Birgisdottir *et al*, 2017; Eiriksdottir *et al*, 2015; Guberan, 1979); Niedzwiedz *et al*, 2019), **cerebrovascular diseases (n=16)** (Falconi *et al*, 2016; Noelke and Avendano, 2015;Vardakas *et al*, 2019; Katsanos *et al,* 2016; Voulgari *et al,* 2019; Regidor *et al*, 2019; Nolasco *et al*, 2018; Khang *et al*, 2005; Kim *et al*, 2004; Sosa Liprandi *et al*, 2019; Valkonen *et al*, 2000; Franco et al, 2013; Wada and Gilmour, 2016; Men *et al*, 2003; Osman M. and Osman A., 2017); Guberan, 1979) and **heart failure (n=3)** (Gurfinkel *et al*, 2005; Vardakas *et al*, 2019; Sosa Liprandi *et al*, 2019). Appendix 2-5 present the data extraction of the papers that were included in this study.

The content of this study assesses the impact of the economic crisis on cardiovascular health in the 20th and 21st centuries. The vast majority of the papers focused on the United States of **America** (n=10) (Patel *et al*, 2019; Olfson *et al*, 2018; Angrisani and Lee, 2016; Falconi *et al*, 2016; Noelke and Avendano, 2015; Li *et al*, 2014; Schwartz *et al*, 2012; Garcia *et al*, 2015; Kaviratne *et al*, 2012; Fiuzat *et al*, 2010) and **Greece** (n=8) 44 (Vardakas *et al*, 2019; Sanidas *et al*, 2018; Samentas *et al*, 2014; Makaris *et al,* 2013; Panagiotakos *et al,* 2013; Katsanos *et al,* 2016; Voulgari *et al,* 2019; Dapontas, 2019). Other countries included were **Spain (n=4)** (Regidor *et al*, 2019); Nolasco *et al*, 2018); Zapata-Moya *et al*, 2015); Bartoll *et al*, 2019), **Korea (n=4)** (Kim *et al*, 2003); Shin *et al*, 2015); Khang *et al*, 2005); Kim *et al* 2004), **Iceland (n=3) (**Guojonsdottir *et al*, 2012); Birgisdottir *et al*, 2017); Eiriksdottir *et*

al, 2015)**, Argentine (n=2)** (Gurfinkel *et al*, 2005; Sosa Liprandi *et al*, 2019), **Finland (n=2)** (Valkonen *et al*, 2000); Lammintausta *et al*, 2012)**, Italy (n=1)** (Verso and Picciotto, 2014)**, Canada (n=1)** (Savu *et al*, 2016), **Cuba (n=1)** (Franco *et al*, 2013)**, Japan (n=1)** (Wada and Gilmour, 2016),**Australia (n=1), Russia (n=1)** (Men *et al*, 2003)**, Ireland (n=1)** (Osman M. and Osman A., 2017) **and Switzerland (n=1)** (Guberan, 1979). Three papers used data from more than one country, either to collectively analyze the data or to compare outcomes across countries.

The eligible studies reflect the following economic crises: **Oil Crisis (1970s) (n=1)** Guberan, 1979) **Early 1990s Recession (n=1)** (Franco *et al*, 2013) , **the Finnish Banking Crisis (1991–1993) (n=2)** (Valkonen *et al*, 2000); Lammintausta *et al*, 2012)**, Asian Financial Crisis (1997-1999) (n=3)** (Kim *et al*, 2003); Khang *et al*, 2005); Kim *et al*, 2004)**, Russian Financial Crisis (1998) (n=1)** (Men et al, 2003)**, Argentina Great Depression (1998-2002) (n=1)** (Gurfinkel et al, 2005) and the **Global Economic Crisis (n=6)** (Shin *et al,* 2015); Verso and Picciotto, 2014) Savu *et al*, 2016); Niedzwiedz *et al*, 2019); Tapia Granados and Ionides, 2017); Bilal, 2014), which encompasses the **Irish Financial Crisis (2007–2008) (n=1)** (Osman M. and Osman A., 2017)**, the US Great Recession (2007–2008) (n=9)** (Patel *et al*, 2019; Olfson *et al*, 2018; Angrisani and Lee, 2016; Falconi *et al*, 2016); Li *et al*, 2014); Schwartz *et al*, 2012); Garcia *et al*, 2015); Kaviratne *et al*, 2012); Fiuzat *et al*, 2010), **the Icelandic Financial Crisis (2008–2011) (n=3)** (Guojonsdottir *et al*, 2012; Birgisdottir *et al*, 2017; Eiriksdottir *et al*, 2015) **the Greek Financial Crisis** (which started in 2008) **(n=8)** (Vardakas *et al*, 2019; Sanidas *et al,* 2018; Samentas *et al*, 2014; Makaris *et al,* 2013; Panagiotakos *et al*, 2013; Katsanos *et al,* 2016); Voulgari *et al,* 2019); Dapontas, 2019), **and the Spanish Financial Crisis** (which started in 2008) **(n=4)** (Regidor *et al*, 2019; Nolasco *et al*, 2018; Zapata-Moya *et al*, 2015; Bartoll *et al*, 2019). **Four papers (n=4)** (Noelke and Avendano, 2015; Sosa Liprandi *et al* 2019; Wada and Gilmour, 2016; Bunn, 1979) analyzed more than one economic crisis.

Of the 44 selected studies, **28 were ecological studies** (Patel *et al*, 2019; Angrisani and Lee, 2016; Falconi et al, 2016; Schwartz *et al*, 2012; Garcia *et al*, 2015; Vardakas *et al*, 2019; Makaris *et al*, 2013; Dapontas, 2019; Regidor *et al*, 2019; Nolasco *et al*, 2018; Zapata-Moya *et al*, 2015; Bartoll et al, 2019; Shin *et al*, 2015; Khang *et al*, 2005; Kim *et al*, 2004; Birgisdottir *et al*, 2017; Sosa Liprandi *et al*, 2019; Valkonen *et al*, 2000; Verso and Picciotto 2014; Savu *et al,* 2016; Franco *et al*, 2013; Wada and Gilmour, 2016; Men *et al*, 2003; Osman M. and Osman A. (2017); Guberan (1979); Niedzwiedz *et al* (2019); Tapia Granados and Ionides, 2017), **10 were cohort studies** (Gurfinkel *et al*, 2005; Olfson *et al*, 2018; Li *et al*, 2014; Fiuzat *et al*, 2010; Sanidas *et al,* 2018; Samentas *et al*, 2014; Panagiotakos *et al,* 2013; Voulgari *et al,* 2019; Eiriksdottir *et al*, 2015; Bunn, 1979), **4 were register-based** (Kaviratne *et al*, 2012; Katsanos *et al,* 2016; Guojonsdottir *et al*, 2012; Lammintausta *et al* 2012) studies and **2 were cohort surveys** (Kim *et al*, 2003; Noelke and Avendano, 2015). Study characteristics are shown in the custom Appendix 2-5.

Identification

Records identified through database searching.
PubMed (n=3,314)
EMBASE (n=5,000)
Google Scholar (n=1,000)
Total initial records (n=9,314)

Additional records identified through other sources. **"Snowball" procedure (n=63)**

Screening

Records **after duplicates removed**.
(n=9,002)

Records **screened**
(n=9,002)

Irrelevant articles **excluded (n=8,742)**

Eligibility

Articles **assessed for eligibility**
(n=260)

Articles **excluded with reasons (n=202)**

Reasons for exclusion:
- Reviews, meta-analyses (n=24)
- Overlaps (n=11)
- No reference to economic crisis (n=30)
- Impact of unemployment and SES without link to economic crisis (n=24)
- Healthcare system expenditures / Functionality / Healthcare costs (n=34)
- Conference proceedings / letter to the editor without relevant data (n=17)
- No CVD health outcome (n=15)
- No comparison pre-post-crisis (n=28)
- Related with risk factors (n=17)
- Different time of economic crisis and CVD assessment (n=2)

Included

Studies **included in qualitative synthesis**
(n=58)

Studies **included about ischemic, cerebrovascular, hypertensive diseases, and heart failure.**
(n=44)

Figure 6. PRISMA flow diagram 2009. Search strategy and result of the effect of economic crisis on the cardiovascular health outcomes.

C2. Risk of bias assessment

The quality of the studies was assessed, taking into account the following components: selection, comparability and outcome. From the 44 studies reviewed, twenty-two (50%) were rated as poor, showing a high risk for bias in at least three domains. Twenty studies (45%) were rated as fair, showing a high risk for bias in up to two domains. Only two studies (5%) were rated as good in the overall risk assessment (full details are provided in custom Appendix 6). Allowing for the acknowledged limitations of ecological studies, the selection of non-exposed, the demonstration that outcome of interest was not present at start of study and the adequacy of follow-up, were the weakest areas in the majority of studies reviewed.

C3. Cardiovascular Diseases and economic crises

C.3.1 Ischemic Heart Diseases (IHDs)

Among fifty-eight selected studies, thirty of them investigated the impact of economic fluctuations on IHDs (Gurfinkel *et al*, 2005; Noelke and Avendano, 2015; Li *et al*, 2014; Schwartz *et al*, 2012; Garcia *et al*, 2015); Kaviratne *et al*, 2012; Dapontas et *al,* 2019; Fiuzat *et al*, 2010; Vardakas *et al*, 2019; Sanidas *et al,* 2018; Samentas *et al*, 2014; Makaris *et al,* 2013; Regidor *et al*, 2019; Nolasco *et al*, 2018; Zapata-Moya *et al*, 2015; Bartoll *et al*, 2019; Khang *et al*, 2005; Kim *et al*, 2004; Guojonsdottir *et al*, 2012; Lammintausta *et al*, 2012; Valkonen *et al* , 2000; Verso and Picciotto, 2014; Savu *et al* , 2016; Franco *et al* , 2013; Wada and Gilmour, 2016; Bunn, 1979; Men *et al*, 2003; Osman M. and Osman A., 2017; Tapia Granados and Ionides, 2017; Bilal,2014). The vast majority of these studies revealed an increase so in mortality, as in incidence of IHDs. Furthermore, men seemed to be more affected by recessions.

Early 1990s Recession

In the period of the economic crisis in Cuba, lasting from 1991 to 1995, three chronological phases examined by Franco *et al*. (Franco *et al*, 2013)) for IHDs. From 1980 to 1996, mortality from Coronary Heart Disease (CHD) fell consistently by 8.8% (0.5% per year). After the crisis in the period of 1996-2002, mortality decreased sharply by 34.4% (6.5% per year). After 2002, the rate of decline slowed to 7.4% (1.4% per year), similar to pre-crisis rates.

Finnish Banking Crisis (1991-1993)

Examining the changes in socioeconomic disparities in the incidence of CHD and mortality in Finland on the early 1990's Lammintausta *et al*. (Lammintausta *et al*, 2012) found that among men, the incidence rate ratio was 2.5 before the recession and 2.0 after the recession. Among women, the corresponding incidence rate ratios were 2.9 and 3.4 and mortality rate ratios 4.3 and 5.9, respectively. In a similar way, Valkonen *et al*. (Valkonen *et al*, 2000) assessed that in women the absolute increase in the CVDs was 3 deaths from IHDs, whereas in men the absolute increase was 24 deaths per 100,000 from 1981-1985 to 1986-1990. In addition, in men the absolute decrease in the CVDs deaths from IHDs was -18 deaths and in women -1 death per 100,000 from 1986-1990 to 1991-1995.

Asian financial crisis in 1990s (1997-1999)

Analyzing the impact of the economic crisis on the South Korean economy, Khang *et al*. (Khang *et al*, 2005) and Kim *et al*. (Kim *et al*, 2004)) found that there was an increase in the mortality rate of IHDs. In particular, Khang *et al*. (Khang *et al*, 2005) observed an increase

in the mortality rate ratios between 1996-2002 among both sexes aged 35-64 in IHD cause of death [$RR_{(1998/1996)}$ =1.14, $RR_{(2002/1996)}$=1.28 for males, $RR_{(1998/1996)}$=1.16, $RR_{(1996/2002)}$=1.35 for females] and among both sexes aged 65-79 [$RR_{(1998/1996)}$=1.2, $RR_{(2002/1996)}$=1.56 for males, $RR_{(1998/1996)}$=1.24, $RR_{(2002/1996)}$=1.65 for females]. Likewise, Kim et al. [43] concluded that the average number of deaths caused by IHD before the crisis was 508 per month and began to increase gradually after the crisis. Excess mortality per 100,000 population was 3.4 in 1998 and 5.8 in 1999; CVD mortality began to increase immediately after the economic crisis.

Russian Financial Crisis (Ruble crisis or Russian Flu) (1998)

Evaluating data obtained from the "Russian State Statistics Committee" for 1991-2001, Men *et al*. (Men *et al*, 2003)) documented that the increase in mortality from IHDs during 1998-2001 was dramatic.

Argentina Great Depression (1998-2002)

Reporting to the Argentina cohort of the international multicenter Global Registry of Acute Coronary Events (GRACE) Gurfinkel *et al*. (Gurfinkel *et al*, 2005) established that there was a higher incidence of in-hospital complications during the crisis, including myocardial infarction (MI) (OR 2.504, 95% CI: 1.663, 3.773).

Great Recession (2008)

Twenty studies investigated the response of IHDs to the global financial crisis which occurred in 2008(Li *et al* (2014); Schwartz *et al* (2012); Garcia *et al* (2015); Kaviratne *et al* (2012); Fiuzat *et al* (2010); Vardakas *et al* (2019); Sanidas *et al* (2018); Samentas *et al* (2014); Makaris *et al* (2013); Regidor *et al* (2019); Nolasco *et al* (2018); Zapata-Moya *et al* (2015); Bartoll *et al* (2019); Khang *et al* (2005); Kim *et al* (2004); Guojonsdottir *et al* (2012); Lammintausta *et al* (2012); Verso and Picciotto (2014) Savu *et al* (2016); Franco *et al* (2013); Gurfinkel *et al* (2005);Wada and Gilmour (2016); Bunn (1979); Men *et al* (2003); Osman M. and Osman A. (2017); Tapia Granados and Ionides (2017); Bilal (2014)).

The study by Bilal (Bilal *et al*, 2014) evaluated the effects of economic changes on mortality trends from IHDs in Europe for the period 1980-2010 and found that economic recession was associated with a 2-year lagged 1.49% increase in IHD mortality in men (p=0.016) and 1.74% increase in women (p=0.019). Sensitivity analyses using unemployment as a second measure of economic recession showed similar results. On the contrary, Tapia Granados & Ionides (Tapia Granados & Ionides, 2017) examined 27 countries sorted in 3 groups according to the severity of the economic recession in 2007-2010 and mentioned that for IHD mortality rates, the greatest reduction occurred in the group of countries in which the recession had been the most severe. A one-percentage point increase in unemployment was associated with reductions of age-standardized mortality from IHD by 0.3%. Analyzing demographic data from National Statistics Institute (ISTAT) related to Italian and Sicilian populations covering the period before and following 2008, roughly 2002 to 2012, Verso & Picciotto (Verso & Picciotto, 2014) found that IHD remained the leading cause of mortality, although mortality from MI was reduced from 30% to 10% in the first decade of the millennium.

In Greece, during the Greek Financial Crisis, Dapontas (Dapontas *et al*, 2019) and Vardakas *et al*. (Vardakas *et al*, 2019) reported that mortality due to IHDs and notably, myocardial infarction, showed an increase during the crisis. Sanidas *et al*. (Sanidas *et al*, 2018) studied

clinical and angiographic data of 3,895 hospitalized patients and found that more individuals with one vessel disease (20.5% vs. 23%, p<0.001) and less with two (20.2% vs. 18.9%, p<0.001) or three vessels disease (35.6% vs. 23%, p<0.001) were examined during the financial crisis. On the other hand, during the financial crisis, Sanidas *et al*. (Sanidas *et al*, 2018) found that regarding ACS, less patients were presented compared to the pre-crisis period (45.5% vs. 39.9%, p<0.001) as well as the number of patients with Coronary Artery Disease (CAD) was decreased. However, Samentzas *et al*. (Sametzas *et al*, 2014) observed an increase in the number of admissions in "Elpis General Hospital of Athens" due to AMI in both sexes during the crisis period compared to the pre-crisis period. This increase was statistically significant (p<0.001) in women (14.6% in pre-crisis vs. 22.3% in crisis) but not in men (23.3% in pre-crisis vs. 28.2% in crisis period). In addition, the prevalence of AMI was increased in patients younger than 45 years old during the crisis period, but the increase was statistically significant only for women (17.6% in the pre-crisis period vs. 22.8% in crisis period, p<0.01). Likewise, Makaris and colleagues (Makaris *et al*, 2013) examining a total number of 2,554 AMIs noticed that the number of AMI events increased from 1,046 to 1,508 as the incidence of AMI was higher in the crisis period compared with the pre-crisis period respectively with a rate ratio equal to 1.40 (95%CI: 1.29-1.51, p<0.001). It was noticed that the economic crisis mostly inflicted men and elders.

Four studies investigated changes in IHDs during the Spanish financial crisis. Specifically, Regidor *et al*. (Regidor et al,2019) found that the Annual Percentage Changes (APCs) in mortality were negative in the first period (2003-2007) -1.0 (-6.0 to 4.2) and positive in the second (2008-2011) 4.5 (-2.5 to 12.0) in women aged 25-64 years, whereas an opposite effect was observed in men; as the effect sizes (and 95%CI) were 5.6 (-3.1 to 15.2) in women and -1.8 (-4.0 to 0.4). Another study by Nolasco *et al. (*Nolasco *et al,* 2018) mentioned that IHD mortality showed a decrease in age-standardised mortality rates (ASR) with men found to be more affected in the period 2008-2013 compared to 2002-2007. Furthermore, Bartoll *et al*. (Bartol *et al*, 2019) examined trends in socioeconomic inequalities in mortality due to IHD and found a gradient of increasing standardised death rates of IHD through less educational level. Absolute inequalities' death rates of IHD decreased in the last period 2009-2012, except for women from 50 to 64 years. In a different way, Zapata Moya and colleagues (Zapata-Moya *et al*, 2015) investigated the prevalence of MIs and found that it decreased for men and remained stable for women between 2006 and 2011.

Collecting electronic medical records of the National University Hospital in Reykjavík during economic collapse in Iceland, Guðjónsdóttir *et al*. (Guðjónsdóttir *et al*, 2011) focusing on visits due to IHDs, claimed that the corresponding RR (95%CI) for women and men were 1.24 (0.66 to 2.31) and 0.88 (0.55 to 1.40) in 2006 and 1.05 (0.54 to 2.03) and 1.15 (0.71 to 1.87) in 2007, respectively whereas in 2008, the RR was statistically significantly increased among women (RR=1.79; 95%CI: 1.01 to 3.17) but not among men (RR=1.07; 95%CI: 0.71 to 1.62).

Finally, Osman M & Osman A (Osman M. & Osman A, 2017) aimed to investigate the potential impact of the 2008 economic crisis on the annual IHD mortality in Northern Ireland and demonstrated that the average annual IHD deaths were 2,782 deaths per year prior to the economic crisis and 2,084 afterwards. A significant rise in IHD-deaths was observed during the financial crisis years in males and females over the age of 65 (β=49.466, p=0.003; β=57.721, p=0.001, respectively). The rest of the age groups were not significantly affected in terms of IHD mortality. Similarly, an overall rise in the males annual AMI rate by 2.96% was noted (95%CI: 0.16%-5.84%), that was significant statistically (p=0.004).

Savu *et al*. (Savu *et al*, 2016) noticed that regions in Canada with higher rates of AMI corresponded to those with higher levels of economic and financial stress, as indicated by personal bankruptcy rate, and vice-versa. Specifically, an increase of 100 in bankruptcy count (BKC) was associated with an increase of 1.5 (p=0.02) in the AMI event count in the following year.

Five studies looked for differences in IHD mortality or prevalence during the US Great Recession. Fiuzat *et al*. (Fiuzat *et al*, 2010) found that during a period of stock market decrease (September 2008 to March 2009), AMI rates were significantly higher (p=0.01). Similarly, Garcia and colleagues (Garcia *et al*, 2015) observed that the average prevalence of Acute Coronary Syndrome (ACS) admission diagnosis during the year of the financial crisis (14.61%) was significantly higher as compared to the pre-crisis year period (8.75%) and the post-crisis year period (11.92%) (p<0.01) in South Florida. Obtaining percutaneous coronary interventions (PCI) data through Dartmouth dynamic registry, which has a catchment area that encompasses New Hampshire, Vermont and Maine, Kaviratne *et al*. (Kaviratne *et al*, 2012) observed a steady increase in PCI volume of 935 cases in 2001 to high of 1,477 in 2005 but steadily declined to 1,029 PCIs in 2010. During the same time STEMI cases have steadily increased from 10% to 28% of total volume, while the PCIs due to NSTEMI/UA and stable angina percentage remained between 25%-30% of the total PCI volume but overall numbers declined. Unemployment rate was highly correlated with the STEMI rate (correlation coefficient 0.87, p<0.001). Moreover, Li *et al*. (Li et al, 2014) identified 1,491 cases of AMIs grouped based on the average incomes of their residence districts in the Raritan Bay region. After the onset of the recession, the MI occurrences trended up in the low-income area group but not in the high-income area group and peaked in March 2011. However, one study by Schwartz et al. (Schwartz *et al*, 2012) investigated the relation between a stock market crash and cardiac death in Los Angeles and demonstrated that the absolute CHD death rates have decreased since 1985 (0.243%) and even from 2005 (0.141%) through 2008 (0.121%).

Multiple crises

Trends in Australian heart disease mortality were assessed for association with the business cycle by Bunn (Bunn, 1979) who studied the Great Depression and the 1961 Recession and found a year-by-year association between the business cycle and IHD. More specifically, mortality increases steeply after 1930 and appears to peak in the late 1950s. After 1961, there was a renewed increase reaching a peak in the mid-1960s and declining after 1968 seemed that IHD mortality triggered in part by the economic stress of the Great Depression and moving over time through the population. Another interesting study by Noelke & Avendano (Noelke & Avendano, 2015) evaluated the effect of job loss in IHDs during the recession of the early 1990s and Great Recession in 2009-2010 and found that recessionary labor demand conditions were associated with increased risk of CVD among individuals having experienced a job loss (HR=2.54, 95%CI:1.39-4.65), reflecting positive selection into job loss during recessions compared with booms. In contrast, among controls workers who remained employed recessionary labor market conditions were associated with lower CVD risk (HR=0.50, 95%CI: 0.31-0.78) suggested that recessions might be protective in the absence of job loss but hazardous in the presence of job loss. The last relevant study by Wada & Gilmour (Wada & Gilmour, 2016), who studied two different recessions, proved that the unemployed category showed a non-significant reduction in IHDs with a RR equal to 0.83 (95%CI: 0.66-1.03) after 2000. Mortality for those in professional roles also showed a downward trend after the spike in 2000.Characteristics of eligible studies about IHDs are provided in the Appendix 2.

C3.2. Cerebrovascular Diseases

Sixteen studies (Falconi *et al*, 2016; Noelke and Avendano, 2015; Vardakas *et al*, 2019; Katsanos *et al,* 2016; Voulgari *et al,* 2019; Regidor *et al*, 2019; Nolasco *et al*, 2018; Khang *et al*, 2005; Kim *et al*, 2004; Sosa Liprandi *et al*, 2019; Valkonen *et al*, 2000; Franco et al, 2013; Wada and Gilmour, 2016; Men *et al*, 2003; Osman M. and Osman A., 2017); Guberan, 1979) examined the impact of different economic crises on cerebrovascular mortality and morbidity with ambiguous results.

Oil crisis or oil shock (1970s)

Guberan (Guberan,1979) investigated the trends in major CVDs during the period of 1951-1976 in Switzerland and found that the decline in cerebrovascular mortality was constant for both sexes, although a little greater in females than in males reducing by 47% and 36%, respectively from 1951 to 1976. The change in death rates from cerebrovascular diseases between 1951-1976 was -36.2% and -46.6% and the total reduction in deaths due to cerebrovascular diseases was 14.8% and 14.4% for men and women, respectively.

Early 1990s Recession

During the deepest period of the economic crisis in Cuba, lasting from 1991 to 1995, Franco *et al*. (Franco *et al*, 2013) evaluated the mortality from stroke evolved in three phases. A modest decrease of 6.9% lasting from 1980 to 2000 (0.4% per year) and a sharp fall between 2000 and 2004 of 13.6% (5.3% per year) was observed. From 2004 to 2010, mortality fell by 1.3% (0.01% per year), similar to the pre-crisis rates. Five years after the start of the economic crisis in 1996, an abrupt downward trend was observed in mortality from stroke. The period lasted an additional six years, during which energy intake status gradually recovered and physical activity levels were progressively reduced; in 2002, mortality rates returned to the pre-crisis pattern. From 2002 to 2010, declining rates of stroke slowed to annual decreasing rates similar to those before the crisis.

Finnish Banking Crisis (1991-1993)

Valkonen *et al* (Valkonen *et al*, 2000) ascertained an absolute increase in cerebrovascular mortality that were 2 deaths among women and 7 deaths among men per 100,000 from 1981-1985 to 1986-1990 in Finland.

Asian financial crisis in 1990s (1997- 1999)

Khang *et al*. (Khang *et al*, 2005) mentioned that mortality from CVAs accounted for ~30% of all deaths in 1996 and ~26% in 2002. Moreover, observed a decrease in the mortality rates between 1996-2002 among both sexes aged 35-64 years [$RR_{(1998/1996)}$=0.90, $RR_{(2002/1996)}$=0.77 for males, $RR_{(1998/1996)}$=0.84, $RR_{(1996/2002)}$=0.63 for females] and among both sexes aged 65-79 years [$RR_{(1998/1996)}$=0.94, $RR_{(1996/2002)}$=0.79 for males, $RR_{(1998/1996)}$=0.93, $RR_{(1996/2002)}$=0.83 for females]. On the contrary, Kim et al. (Kim *et al*, 2004) using monthly mortality for the entire country of South Korea demonstrated that there was an annual increase of 155 deaths after the economic crisis, which was significant in cerebrovascular disease. Furthermore, mortality from cerebrovascular disease per 100,000 population was 4.6 in 1998 and 7.1 in 1999, which showed that the influence of the economic crisis persisted.

Russian Financial Crisis (Ruble crisis or Russian Flu) (1998)

Analyzing data obtained from the Russian State statistics committee for 1991-2001 Men *et al*. (Men et al, 2003) found an increase in mortality from cerebrovascular diseases during 1998-2001 as well as a decrease in mortality during 1994-8 among both men and women. Additionally, death rate by cerebrovascular disease at age 35-69 years per 100,000 for men were: 204 (1991), 302.4 (1994), 256.9 (1998) and 300.7 (2001) and for women:123.6 (1991), 167(1994), 145.7(1998), 159.7(2001).

Great Recession (2008)

Katsanos *et al*. (Katsanos *et al*, 2016) and Vardakas *et al*. (Vardakas *et al*, 2019) assessed the impact of economic crisis on cerebrovascular events during the Greek Economic Crisis. In particular, Katsanos *et al*. (Katsanos *et al*, 2016) collecting data from "Greek Stroke Registry" established in 2008, revealed that more patients with a prior history of cerebrovascular events (IS or TIA) admitted after the onset of financial crisis. Vardakas *et al*. (Vardakas *et al*, 2019) using data from the Hellenic Statistical Authority showed that regarding cerebrovascular disease, the continuous decline in mortality before the crisis (mean 0.03/1000 per year) was reversed during the crisis (0.02/1000); the reversal occurred in 2012 and 2013 and affected both genders. Furthermore, Voulgari *et al.* (Voulgari *et al* , 2019) conducted a retrospective analysis of patients with ischemic-stroke and ascertained that patients after the economic crisis were found to have a higher incidence of a previous stroke ($p<0.001$).

Contrary to the above, concerning the Spanish financial crisis, Nolasco *et al*. (Nolasco *et al*, 2018) demonstrated that cerebrovascular mortality decreased (29.07% in men, 28.90% in women). Likewise, Regidor *et al*. (Regidor *et al*, 2019) ascertained that the APCs (95%CI) in mortality rate by cerebrovascular diseases in women were negative in the first period (2003-2007) and positive in the second (2008-2011) whereas an opposite effect showed in men. Trend before recession: -4.2(-8.2 to -0.1); during recession: -4.2 (-9.7 to1.6) effect size: 0.0(-7.0 to 7.6) p=0.994 and before recession: 0.8 (-1.5 to 3.1); during recession: -5.7 (-8.7 to -2.7) effect size: -6.5 (-10.1 to -2.8) $p<0.001$, in women and men, respectively.

Extracting data from Northern Ireland Statistics and Research Agency database, Osman M.& Osman A (Osman M. & Osman A., 2017) investigated the potential impact of the 2008 economic crisis on the annual cerebrovascular accidents (CVA) in Northern Ireland. Specifically, CVA-mortality in the post-crisis years rose significantly for females who were 65 years or older (β=56,010, p=0.005) but not for males. It was observed an overall, statistically insignificant CVA mortality rate following the 2008 economic recession.

Based on mortality data from California, Falconi *et al*. (Falconi *et al*, 2016) tested the hypothesis that stroke accounted for a larger fraction of deaths during the Great Recession and proved that among the white men, the monthly odds of a stroke-attributed death, increased an average of 5% between May 2008 and December 2010.

Multiple crises

Extracting data from the Occupation-specific Vital Statistics, Wada & Gilmour (Wada & Gilmour, 2016) aimed to assess the difference in magnitude of changes in mortality associated with the economic stagnation ''Lost decade'' in 1991-2001 and Great Recession 2008 by occupation in Japan. This study demonstrated that the mortality rates significantly increased for cerebrovascular disease, by 2.12 (95%CI: 1.38-3.26)) after 2000. Sosa Liprandi

et al. (Sosa Liprandi *et al*.2012) analyzed two economic crises: The Southeast Asia crisis (1998-1999) and the end of the convertibility system (2001-2002) in Argentina and proved that mortality rates due to stroke decreased by 38.06% between 1995 and 2005. Concerning early 1990s Recession and Great Recession in 2008, Noelke & Avendano (Noelke & Avendano, 2015) used longitudinal, nationally representative data from Americans 50 years of age or older who were enrolled in the "Health and Retirement Study" and surveyed every 2 years from 1992 to 2010 about their employment status and whether they had experienced a stroke. There were observed associations between labor market conditions and stroke risk for individuals who experienced job loss compared with those who did not experience job loss. Recessionary labor demand conditions were associated with an increased risk of stroke among individuals who experienced job loss (HR=2.02, 95%CI: 0.68-5.98). In contrast, among individuals who did not experience job loss, recessionary labor market conditions were associated with lower risk of stroke (HR=0.61, 95%CI: 0.33-1.14).

Characteristics of eligible studies about cerebrovascular diseases are provided in the Appendix 3.

C3.3. Hypertensive Diseases

Observing the results related to hypertensive diseases, we noticed two different outcomes: mortality and morbidity/prevalence of hypertension. In the first case, it was mainly reported a decline after the economic crisis period and in the second case it was mentioned as a stable condition, as well as an increase of hypertension prevalence. Males were more affected in both circumstances.

Oil crisis or oil shock (1970s)

Examining the trend in death rates due to hypertensive diseases from 1951 to 1976 in Switzerland, E. Guberan (Guberan, 1979) found a steady decline of 40% occurred in females; this decrease was of 50% to 60% except in the two oldest age groups of 75-84 and >85 years (-38% and -4%). In males, however, the decline was much more moderate (between -6% and -16%) except in the youngest age group of 23-34 years (-40%).

Asian financial crisis in 1990s (1997-1999)

Two studies examined the impact of Asian financial crisis on hypertensive diseases in Korea. Firstly, Khang *et al*. (Khang *et al*, 2005) found a decrease in the mortality rate ratios between 1996-2002 among both sexes aged 35-64 in hypertensive disease cause of death [$RR_{(1998/1996)}$=0.59, $RR_{(2002/1996)}$=0.35 for males, $RR_{(1998/1996)}$=0.33, $RR_{(1996/2002)}$=0.39 for females] and among males aged 65-79 [$RR_{(1998/1996)}$=0.57 and $RR_{(1996/2002)}$=0.43]. Secondly, Kim *et al*. (Kim *et al*, 2003) mentioned that the hypertension morbidity was 606 (1.16%) before the crisis and 1952 (4.47%) after the crisis p<0.01.

Great Recession (2008)

Ten studies, analyzing hypertensive disease outcomes, among others, during the Great Recession and found mixed results. In Korea, hypertension prevalence demonstrated an increase in 2009 compared to 2007 with statistically significant differences regarding stress as observed by Shin et al. (Shin *et al*, 2015)

In a cross-national analysis of 16 European countries, Niedzwiedz and colleagues, (Niedzwiedz *et al*, 2019) noted that high blood pressure was highest in Germany (16.4%) and lowest in Ireland (6.0%).

Three studies exploring the impact of the US Great Recession on hypertensive diseases. Using panel data from the "Health and Retirement Study" over the period 2004–2010, Angrisani & Lee (Angrisani and Lee, 2016) related changes of hypertension status with state-level unemployment rate, house prices and stock market prices. It was mentioned that the likelihood of developing hypertension is negatively related to changes in house prices. A 10% decrease in state-level house prices increases the probability of a new hypertension diagnosis by 0.2% (significant at 5%) with males being the more affected. Among Americans over the age of 50, the likelihood of being newly diagnosed with hypertension increases as local housing market conditions deteriorate. Olfson *et al*. (Olfson *et al*, 2018) extracting nationally representative data from the 2001-2002 and 2012-2013 "National Epidemiologic Survey on Alcohol and Related Conditions" (NESARC and NESARC III, respectively) found that the prevalence of measured hypertension remained hardly changed between 1999-2000 (30.1%) and 2011-2012 (30.8%). Patel *et al*. (Patel *et al*, 2019) analyzed data on adults ages ≥20 years from the "NHANES" from economic-recession (2007-2010) and post-recession (2011-2016) periods and noticed that in the low socioeconomic stratum, the prevalence of participants with an ideal blood pressure (<120/80 mm Hg) decreased significantly from 50% (95% CI: 44%-56%) in 2007-2010 to 38% (95% CI:29%-47%) in 2015-2016 (P-linear=0.02).

In Greece, Panagiotakos *et al*. (Panagiotakos *et al*, 2013) and Voulgari *et al*. (Voulgari *et al*, 2019) did not notice any significant differences regarding the prevalence of hypertension after the Greek economic crisis.

Collecting data from a nationally representative sample, fixed-effect estimations and mediation analyses were performed by Birgisdóttir and colleagues (Birgisdóttir *et al*, 2017) to explore the relationship between the Icelandic economic collapse in 2008 and the longer-term impact on hypertension. It was observed an increased probability of having hypertension during the economic recovery by 7.39 percentage points compared to pre-crisis for females, but a decrease of 4.69 percentage points for males. In addition, changes in unemployment explain 10.55% of the recovery effect on hypertension in females. Another study by Eiríksdóttir *et al*. (Eiríksdóttir *et al*, 2015) aimed to assess potential change in prevalence of pregnancy induced hypertensive disorders (preeclampsia and gestational hypertension) during the first years of the major national economic recession in Iceland. It was suggested a transient increased risk of gestational hypertension among pregnant women in Iceland in the first and most severe year of the national economic recession. More specifically, compared with the pre-collapse period, it was observed an increased prevalence of gestational hypertension in the first year following the economic collapse (2.4% vs. 3.9%; 95%CI: 1.13–1.91) but not in the subsequent years. No changes were observed for preeclampsia between the pre- and post-collapse periods. The overall prevalence of pregnancy-induced hypertensive disorders remained stable during the period 2007-2012.

Nolasco *et al*. (Nolasco *et al*, 2018) described the evolution of mortality due to hypertensive disease between 2002-2007 (before the Spanish economic crisis) and 2008-2013 (during the Spanish economic crisis), nationally and by province and showed that there was a countercyclical effect, especially in men. Specifically, different results were obtained for two sexes. Hypertensive disease as a cause of death increased among men (-2.26% percentage decrease) but decreased significantly among women (16.75%).

Characteristics of eligible studies about hypertensive diseases are provided in the Appendix 4.

C3.4. Heart Failure

Following the review of three relevant studies, it was noticed that there was a positive relationship between heart failure and economic recessions.

Argentine Great Depression (1998-2002)

Gurfinkel *et al*. (Gurfinkel *et al*, 2005) analyzing data from 3,220 patients resulted in a higher incidence of sustained in-hospital complications of heart failure (16% Vs. 11%, $p<0.01$) in the crisis period versus post-crisis, respectively.

Great Recession (2008)

Vardakas *et al*. (Vardakas *et al*, 2019) examined mortality changes in Greece prior to and during the financial crisis and found that mortality due to heart failure showed an increase during the crisis.

Multiple crises

Mortality rates due to heart failure decreased by 22.95% from 1995 to 2005 as referred by Sosa Liprandi *et al*. (Sosa Liprandi *et al*, 2012) whose paper discussed two economic recessions, as already reported.

Characteristics of eligible studies about heart failure are provided in the Appendix 5.

D. Discussion

After evaluating carefully all the selected eligible studies it was found that the effect of the crisis was different across CVD outcomes. Therefore, the results were plenty and different. The main findings shed some light on the groups most affected during the financial crisis. The results on demographic factors such as gender and age were somehow contradictory, but, overall, men seemed to be more severely affected, as figured by CVD trends and self-rated health. It is commonly believed that cardiovascular diseases seem to reflect differently on genders. This is due to the fact that men and women have dissimilarities on epidemiology, pathophysiology, treatment response and outcomes of some common heart diseases. Interestingly, plenty of studies showed a different timing of response across genders; with males showing a more immediate response and dwindling with time, and females showing a delayed response during the economic recovery as opposed to the height of the crisis. This later-time appearance indicates a lingering female response that may have taken longer to come through (Birgisdóttir *et al*, 2017 and Jarroch *et al*, 2021), in consistence with previous studies was found that women tend to develop cardiovascular disease about 10 years later in life than men (EUGenMed *et al*, 2016). Moreover, hypertension is more common in women than in men in the elderly population (Birgisdóttir *et al*, 2017 and EUGenMed *et al*, 2016). Also, it has been noticed that for females, the change in trend was more than two times stronger than it was for males, suggesting that women have carried a bigger burden of the crisis, which made the previous results puzzling (Laliotis *et al*, 2016). It is generally known that women develop high blood pressure, particularly systolic hypertension, at an increased rate as they age, and that this age-related blood pressure increase is exaggerated by the menopause (Rosenthal and Oparil, 2000).

These gender differences exist in various CVDs, including coronary heart disease, stroke, heart failure and aortic diseases (Gao *et al*, 2019). There is also some evidence that IHD in younger women are increasing; ACS, STEMI, or NSTEMI occurs three to four times more often in men than in women below age 60, but after 75 years, women represent the majority of patients (EUGenMed *et al*, 2016).

It is well known that a period of economic crisis may bring up to stressful situations for the majority of the population. The role of acute mental stress as a trigger of cardiovascular events is, however, well established and indicates that neuroendocrine activation and inflammatory responses associated with acute stress may contribute to the risk of myocardial ischaemia (Guðjónsdóttir *et al*, 2011). In this regard, evidence shows reliable, stress-related increases in circulating levels of inflammatory mediators, including interleukin (IL)-6, IL-1β, and C-reactive protein. These circulating signaling proteins are assumed to reflect systemic inflammation, with higher levels predicting increased risk for inflammatory disease (Prather *et al*, 2009). Inflammation, measured by interleukin-6, C-reactive protein and fibrinogen, is predictive of CVD in populations with depressed mood (Zagożdżon *et al*, 2014).

Gender and age differences have caused widespread concerns and the consideration of these factors is of great importance for the prevention, diagnosis, treatment, and management of CVD. Women differ from men in the distribution of risk factors and stroke subtype, stroke severity and outcome. Differences in stroke pathology and differences in functional anatomy or plasticity of the brain between sexes may account for these findings. Cerebrovascular disease is a major public health issue for older women. On the other hand, estrogens have a beneficial effect on serum lipids and coagulation profile and on preventing coronary heart

disease. Gender-specific differences disappear in the 65- to 84- year age group, and the frequency of stroke for the very elderly was higher in women than in men. This finding is in agreement with previous observations showing that after menopause, there is a rapid increase in the frequency and severity of cerebral atherosclerosis and a rapid increase in the incidence of cerebrovascular events in women due to estrogen alteration of lipid metabolism (Arboix *et al*, 2001). Hypertension is the strongest independent risk factor predisposing to all stroke subtypes both in women and men. However, hypertension was more frequent among women (Jørgensen *et al*, 2017). Intriguingly, by 2030, approximately 20% of the population will be aged 65 or older. With the progressive increase of population in this age group, it is crucial to understand the interaction between aging and cardiovascular diseases (Stern *et al*, 2003).

Most of the studies included in the present review demonstrated that economic downturns were important stressors that had a negative impact on the CV health of workers and the general population. It is highlighted that the cardiovascular diseases associated with unemployment are mainly CHD and arterial hypertension. As far as is known, unemployment has negative effects in the target organs of the cardiovascular system. This is associated with distress, individuals' daily habits and changes in socioeconomic status. Firstly, stress perception affects biochemical and physiological parameters, such as a reduced condition of immunity, increased release of cortisol or an increase in the cholesterol concentration (Weber and Lehnert, 1997). In addition, pathophysiological mechanisms, linked to financial problems and changes in social relationships, can make individuals prone to psychosomatic disorders after job loss, as distress reacts on the autonomic nervous system, which contributes to the pathogenesis of hypertension after a short-term economic crisis (Shin *et al*, 2015). Secondly, changes in individual lifestyle (i.e., increase in the consumption of nicotine, alcohol or drugs and changes in dietary habits) induced consequent damage. Finally, financial problems with changes in social relationships are regarded as predisposing to certain (psycho)somatic disturbance (Weber and Lehnert, 1997). Results showed that SES (educational grade, occupation or income) was adversely associated with psychosocial factors related to CHD. These results accord with most previous literature on financial crises and CVDs and support the existence of a link between unemployment and poor cardiovascular health. It is, however, not clear if the relation between unemployment and mortality found in previous studies is causal. The increased relative risk of mortality among the unemployed could, at least partly, be a consequence of health-related selection (Lundin *et al*, 2010). Moreover, sociologists and health scientists present the "stress model" to be favored by in the genesis of cardiovascular diseases as the "stressor" unemployment, could be regarded as an important factor promoting manifestation (Weber and Lehnert, 1997). Following job loss, individuals decrease their social involvement and consequently receive less social support, especially in less affluent areas. It was also found that job loss is a significant risk factor for acute cardiovascular events and risks were particularly elevated during the first year of unemployment (Dupre *et al*, 2012).

Last but not least, it is important to note that new methods in treatments and secondary prevention of cardiovascular diseases were adopted, as the research is constantly evolving, and this resulting in increased life expectancy.

Strengths and limitations of study

As with the majority of studies, the design of the current study is subject to limitations. First of all, most of the studies were ecological, cohort surveys and register-based, while only 10 were cohorts. It is well-established that ecological studies have substantial limitations and,

although valid for hypothesis generation, are not considered useful for hypothesis testing because of unmeasured and uncontrolled confounding. The potential impact of such confounding has been well described and is so same individuals regarding exposure ,was frequently observed.

It is important to highlight that different statistical methodological approaches could generate different results and lead to bias (Cohen, 2005). Furthermore, the fact that the data used might have initially been collected for other purposes may lead to selection bias.

It is widely acknowledged that the term "ecological fallacy" is commonly given to efforts to make inferences on the individual level from data collected on an aggregate level (Cohen, 2005). Moreover, there are several differences in the coding, classification, and diagnosis of the CVD diseases as in the measurement of exposures among countries. Furthermore, the fact that some studies looking at the same population but not the same individuals. In addition, self-report studies suffer from specific disadvantages due to the way that subjects generally behave and commonly lead to bias. Also, some of the selectable studies were not full-text and their abstracts may contain less information which may lead to allegiance biases.

Moreover, the present study includes articles that focus on the impact of economic crisis on cardiovascular health outcomes. Of the 44 studies that met the eligible criteria and were analyzed, the vast majority centered on the Great Recession which is supposed as the most severe and widespread financial crisis, since the second half of the 20th century, after the Great Depression. Expectedly, the United States and Greece were predominated in most of these studies. It is generally known that this catastrophic recession began with the housing price crisis in the United States and affected critically many sectors of the economy and several countries (James *et al*, 2008). Greece was the most afflicted than any other European country and faced huge unemployment rates and enormous debt loads of the Greek government. In addition, Spain drew the attention, as it follows a similar path to Greece.

In the present study there is plenty of bias, therefore, the commentary of the results should be done carefully. There were only two studies that were rated as "good" in the overall risk assessment; the studies by Fiuzat *et al*. (Fiuzat *et al*, 2010) and Regidor *et al*. (Regidor *et al*, 2019). The first authors' team described an increase in AMI rates at the same time-period in the US. Whereas the latter authors' team observed that the APCs in IHD and cerebrovascular mortality were negative in the first period (2003-2007) and positive in the second (2008-2011) in women whereas an opposite effect was observed in men. Additionally, Regidor *et al*. (Regidor *et al*, 2019) found a positive impact on cerebrovascular mortality during the crisis.

Also, it is important to take into account that a country which was hit by an economic hardship is not necessarily linked with individuals' bankruptcies. Moreover, this study also contained narrative analysis, rather than meta-analysis, but this was due to the heterogeneity of study designs, outcomes, and exposures. Finally, several studies were excluded if their abstract or title were not relevant with the main topic.

In spite of these limitations, the present study is distinguished by crucial strengths. Initially, it was performed an updated search via three online databases that cover the most of relevant literature and no restrictions are placed on language, geographical region, participant age etc. Other key strengths of this work include the broad search algorithm, the strict and meticulous adherence to the PRISMA guidelines (Liberati *et al*, 2009) as well as the careful, systematic search in reference lists (''snowball'' procedure) for the maximization of eligible articles. Although there is a well-established literature on the role of SEP in cardiovascular

disease (CVD) development during the normal life cycle, it is noteworthy that this is the first research of the literature focused on the effect of the financial crises - that plagued the global community over the last two centuries - on cardiovascular health. In this regard, the main findings of this study can be influential for a wider range of studies looking at the effects of socioeconomic factors on health.

Future research

The superiority of studies that investigated the impact of financial downturns in CVD health covered a short period of time after economic hardship, although it is well-known that a longer follow-up period was needed. It is widely known that the adverse events of CVDs tend to appear years later, so it will excite the interest for further research to investigate the recession's physiological adverse events in long term.

A quantitative analysis is based mainly on the high value of having easily measured numerical data collected from large populations and offers the opportunity to critically evaluate and statistically combine results of comparable studies. Generalization, which is an act of reasoning that involves drawing broad inferences from particular observations, is widely acknowledged as a quality standard in quantitative research and is more controversial in qualitative research.

Overall, there has been a growing interest in health research to study economic recessions and their impact on population health. The economically catastrophic COVID-19 pandemic will certainly trigger a surge of studies in this field. Already earlier studies have shown that macroeconomic catastrophes and prolonged financial crises weaken health systems and expenditure on health. More attention should be given to health policies and preparatory measures at all levels of society, keeping in mind that economic crises are recurrently expected to happen.

Conclusions

The ambition of this study is to inspire experts to foster the engagement across areas of cardiac health and economic crisis. Results from other studies regarding this relationship are mixed between methodologies, and thus our results conform to some while being conflicting to others. The main findings of this study were equivocal and concluded that gender, age, and unemployment were the three key factors which linked most with CVDs. It is necessary to examine further each specific cause or group of causes. More quantitative studies and better quality of data are needed to explore financial downturns and CVD outcomes. This study adds to the strand of literature concerning the relationship between economic cycles and CVD health and provides a motivation for further investigation.

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F. Appendices

Appendix 1. Protocol of the systematic review, according to the PRISMA guidelines.

Section/topic	#	Checklist item	
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	Ischemic heart, hypertensive, cerebrovascular diseases and heart failure in times of economic crisis in the 20th and 21st century: a systematic review.
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	The relationship between business cycles and health has been studied to a significant extent. Economic crisis constitutes an enormous threat to public health worldwide and has been linked to cardiovascular morbidity and mortality. The Great Recession has attracted interest and opportunities to pursue this line of research further. The relationship between economic downturns and cardiovascular health is intricate. Both the short and longer-term impacts of economic conditions on cardiovascular disease are ambiguous, due to the multitude of determinants of cardiovascular health. Cardiovascular events have

			been shown to be responsive to stressful factors. For this reason, cardiovascular outcomes have been of interest in the health and business cycle literature. However, to the best of our knowledge, no recent systematic review has investigated the overall significance and clinical impact of the findings of relevant studies. The aim of this systematic review is to examine evidence from relevant studies on factors influencing cardiovascular health and to observe any potential changes in the trends and the severity of the established cardiovascular disease, among the general population living in countries exposed to financial crises.
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	To investigate factors influencing cardiovascular health and to observe any potential changes in the trends and the severity of the established cardiovascular diseases. Studies will be included if they examine: (i) exposure to a specific economic crisis (ii) changes in cardiovascular health outcomes or behaviors over time; and (iii) statistical data on associations of cardiovascular health risk and/or protective factors with health outcomes/behaviors. Case-control, cohort and cross-sectional studies, surveys, register based, cohort surveys and ecological studies will be reviewed and included in the analysis. The respective PICOS are described below. PICOS: (P) General population, (I) Economic crisis, (C) pre- and/or during, and post-crisis periods (O): cardiovascular health outcomes, (S): case-control, cohort, cross-sectional, register based, surveys, ecological studies and cohort surveys will be reviewed and included in the analysis.
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	Protocol registration will not be performed.

Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	All studies examining the relationship between economic crisis and cardiovascular health in the 20th and 21st century, will be included. Case-control, cohort, cross-sectional studies, register-based, ecological studies, surveys and cohort surveys investigating any potential changes in the trends and the severity of the established cardiovascular disease (IHDs, hypertension, cerebrovascular diseases and heart failure); studies should present a comparison between a pre- vs. during and/or post-crisis periods. Comparisons performed in terms of descriptive statistics or with the use of hypothesis testing were deemed eligible. We will exclude in vitro studies, animal studies, case reports, case-series, reviews and meta-analyses, studies looking at the impact of macroeconomic indicators on health outcomes without clearly defining the period of the crisis, studies reporting on outcomes of health care utilisation (i.e., not on health behaviours or outcomes), studies on impact of economic crises on health system performance and general health effects of poverty, unemployment, socioeconomic status without a direct link to economic crises/shocks/recession, conference proceedings, symposium/consensus reports, posters' abstracts, oral presentations, commentaries/letters to the editor, editorials, that did not present relevant original data, studies not referring to CVDs or incidence/mortality, studies reporting only on risk factors, studies reporting different times of economic crisis and CVDs assessment. No language, publication date, publication status, geographical region or participant age restrictions will be imposed.
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	Studies will be identified by searching in the electronic databases, scanning reference lists of articles and consultation with experts in the field. The search will be applied to PubMed, Google Scholar and EMBASE. No language, publication date or publication status restrictions will be imposed.
Search	8	Present full electronic search strategy for at least one database, including any limits used, such	We will use the following algorithm to search in the selected databases: (recession OR austerity OR "economic shock" OR "economic crisis"

				OR "financial crisis" OR "fiscal crisis" OR "banking crisis" OR "economic depression" OR "economic hardship" OR "economic insecurity" OR "economic downturn" OR "economic breakdown" OR "economic turmoil" OR "economic stagnation" OR "economic turbulence" OR "macroeconomic fluctuation" OR "financial shock" OR "financial depression" OR "financial hardship" OR "financial insecurity" OR "financial constraint" OR "financial downturn" OR "financial breakdown" OR "financial turmoil" OR "financial stagnation" OR "financial turbulence" OR "stock market crash" OR "great depression" OR bankruptcy) AND (cardiovascular OR vascular OR cerebrovascular OR stroke OR heart OR infarction OR ischemia OR ischaemia OR ischemic OR ischaemic OR arterial OR angina OR coronary OR fibrillation OR arrhythmia OR thrombosis OR embolism OR hypertension OR tachycardia OR bradycardia OR "heart rate" OR aortic OR aorta OR mitral OR aneurysm).
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	Eligibility assessment will be performed independently in a blinded standardized manner by 2 reviewers (MB, DT) and disagreements will be resolved by consensus. If no agreement is reached, the decision will be made by consultation with a third independent referee (TNS) and team consensus.
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	Extraction of articles will be performed independently and in duplicate by two reviewers (MB, DT) and recorded in a predeveloped data extraction sheet.
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	Information will be extracted from each included study on first author's name, publication year, study design, design code, study period, geographical region, percentage of males, mean age, age range, health outcome, definition and ascertainment of economic crisis, categorization of economic crisis, adjusting factors, type of effect estimate and main findings.

In case of cohort studies the cohort size, cases in cohort, follow-up (in years) cohort characteristics and definition/features of CVDs in cohort will be recorded. |

Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	For non-randomized studies (ecological, cohort, register-based, cross-sectional, case-control studies, cohort surveys, surveys) the Newcastle-Ottawa Scale and AHRQ standards will be used.
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	N/A
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2) for each meta-analysis.	N/A
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	N/A
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	N/A
RESULTS			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	

Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	
DISCUSSION			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	
FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	This systematic review has no funding source.

Appendix 2. Characteristics of eligible studies about ischemic heart diseases.

First author (Year)	Design	Cohort size	Cases in cohort	Study period	Region	Males (%)	Mean age	Age range	Cohort characteristics	Definition/features of CVDs	Definition and ascertainment of economic crisis	Categorization (comparison) of economic crisis	Adjusting factors	Main findings regarding Ischemic Heart Diseases
Early 1990s Recession														
Franco (2013)	Ecological study.	Measurements in Cienfuegos: 1,657 (in 1991), 1,351 (1995), 1,667 (2001), and 1,492 (2010). National surveys: 14,304 (1995), 22,851 (2001), and 8,031(2010)	NR	1980-2010	Cuba and the province of Cienfuegos.	NR	NR	15-74 years	Measurements in Cienfuegos included a representative sample of 1657, 1351, 1667, and 1492 adults in 1991, 1995, 2001, and 2010, respectively. National surveys included a representative sample of 14304, 22851, and 8031 participants in 1995, 2001, and 2010, respectively. The age distribution of the population in Cienfuegos is similar to the general Cuban population. The following categories for BMI: underweight (<18.5), normal weight (18.5-<25), overweight (25-<30), and obesity (≥30) were used. Data were obtained from repeated cross-sectional surveys and ecological comparison of secular trends.	ICD-10 codes were used for death from coronary heart disease (I20-I25) and stroke (I60-I69).	Economic crisis of the early 1990s. The largest effect of this economic crisis occurred over a period of about five years (1991-95). Since then, the Cuban economy has shown a modest but constant recovery, especially after the year 2000.	Before, during and after the economic crisis.	Age	From 1980 to 1996, mortality from CHD fell consistently (reduction of 8.8%, 0.5% per year). After the crisis in 1996-2002, CHD mortality decreased sharply by 34.4% (6.5% per year). After 2002, the rate of decline slowed to 7.4% (1.4% per year), similar to the pre-crisis rates.
Finnish Banking Crisis (1991-1993)														
Lammintausta (2012)	Population-based register study	~233,000.	15,374 (acute coronary events)	1988-2002	Finland (4 geographical areas)	NR	NR	35-99 years	The register study aimed to evaluate all suspected MI or CHD events among the 35- to 99-year-old permanent residents of these four areas. The town of Oulu was excluded from these analyses because no data were collected there before 1993.	CHD, AMI fatal or non-fatal. The events were classified based on symptoms, electrocardiography, and biomarker findings and possible autopsy results as suggested in the AHA Scientific Statement of 2003. The event was considered as an incident if there was no indication of a previous, clinically recognized MI in the patient's history. Attack rate was defined as the sum of first and	Economic recession from 1991 to 1995.	1988–1992, 1993–1997, and 1998–2002, which described the time periods before, during, and after the economic recession.	Age	Among men, the incidence rate ratio was 2.5 before the recession and 2.0 after the recession. Among women, the corresponding incidence rate ratios were 2.9 and 3.4 and mortality rate ratios 4.3 and 5.9, respectively.

										recurrent MI events.				
Valko nen (2000)	Ecolog ical Study	NR	1981-1985:4 0,771 1986-1990:4 1,816 1991-1995:3 9,663	1981 to 1995	Finland	NR	35-64 years	NR	Individuals aged 35-64 years and two occupation-based social classes are distinguished: non-manual workers and manual workers.	Mortality due to CVDs and the analysis is based on the ICD-8 in 1981-1986 and the cause of death classification 1987 of statistics Finland in 1987-1995. The latter classification is based on the ICD-9.	In the second half of the 1980s economic growth was exceptionally rapid, but in 1991-1995 Finland suffered a very severe economic recession. Economic output declined for 3 years, reaching its low point in early 1993 at less than 90% of the 1990 level. The bankruptcy rate doubled in 3 years.	Before and during the crisis (1981-1995)	Age	It was assessed that in women the absolute increase in the CVDs was 3 deaths from IHDs, whereas in men the absolute increase was 24 deaths per 100,000 from 1981-1985 to 1986-1990. In addition, in men the absolute decrease in the CVDs deaths from IHDs was -18 deaths and in women -1 death per 100,000 from 1986-1990 to 1991-1995.
Asian Financial Crisis (1997-1999)														
Khang (2005)	Ecolog ical study	Mid-year populatio n in South Korea	NR	1990-2002	South Korea	NR	NR	Four age groups : 1–14, 15–34, 35–64, and 65–79 years	Individuals categorized into four age groups: 1–14, 15–34, 35–64, and 65–79, in both sexes.	Mortality due to hypertensive disease, IHD, cardiomyopathy and cerebrovascular disease.	After enjoying uninterrupted economic growth for decades, South Korea underwent a steep economic decline in the late 1990s.	Before and after the economic crisis.	Age	It was observed an increase in the mortality rate ratios between 1996-2002 among both sexes aged 35-64 in IHD cause of death [RR 1998/1996=1.14, RR 2002/1996=1.28 for males, RR 1998/1996=1.16, RR 1996/2002=1.35 for females] and among both sexes aged 65-79 [RR 1998/1996=1.2, 2002/1996=1.56 for males, RR 1998/1996=1.24, RR 2002/1996=1.65 for females]. The increasing trends in IHD were not limited to the period of the economic crisis.
Kim (2004)	Ecolog ical study	Entire country of South Korea	9,534 (deaths due to CVDs in 1998), 15,108 (deaths due to CVDs in 1999)	1995-1999	South Korea	NR	NR	NR	The number of total deaths and the number of cause-specific deaths that occurred in each month from January 1995 to December1999 (72 months in total) were collected from "The annual report on the cause of death statistics based on vital registration" published by the South Korean National Statistical Office.	Mortality due to CVDs , IHDs and cerebrovascular disease.	On December 3, 1997, South Korea received financial support from the IMF due to a liquidity squeeze. This event marked a national economic crisis unprecedented in South Korean modern history.	Before and after the economic crisis (1995-1999)	NR	The average number of deaths caused by IHD before the crisis was 508 per month and began to increase gradually after the crisis. Excess mortality per 100,000 population was 3.4 in 1998 and 5.8 in 1999. CVD mortality began to increase immediately after the economic crisis.

Russian Financial Crisis (Ruble crisis or Russian Flu) (1998)														
Men (2003)	Ecological study	NR	NR	1991-2001	Russia overall and seven federal regions, five in European Russia (North Western, Central, Privolzhski, Southern, and Uralski) and two in Asian Russia (Siberian and Far Eastern)	NR	NR	All ages (0-70)+	Data obtained from the Russian State statistics committee, including deaths by cause, sex, five year age group, and calendar year together with corresponding population denominators.	Causes of death in Russia were coded with the Soviet system of disease classification up to 1998, with each category corresponding to groups of items in ICD-9. From 1999, a new system based on the ICD-10 was introduced. Diseases of the circulatory system: rheumatic heart disease, hypertensive disease, IHD, cerebrovascular disease.	Russian economic crisis in 1998.	Before, during and after the economic crisis.	Age	The increase in mortality from IHD during 1998-2001 was dramatic, although it was smaller than the 1994-8 decrease. Death rates by IHD at age 35-69 years per 100,000 for men were: 33.2 (in 1991), 688.9 (in 1994), 508.6 (in 1998) and 616.3 (in 2001) and for women: 128.4 (in 1991), 202 (in 1994), 148 (in 1998) and 176 (in 2001).
Argentine Great Depression (1998-2002)														
Gurfinkel (2005)	Cohort study	3,220	2,246 (in crisis period)	1999-2004	Argentine	70	66.1 (crisis), 65 (after crisis)	NR	Study sample contains patients enrolled in centers in Argentine between April 1999 and September of 2004.\n\n3,220 patients were enrolled in Argentine. The number of patients younger than 65 years old was 1,527 (47%), representing the proportion of the population normally expected to be economically active. The remainder 1,693 (53%) were older than 65. A final diagnosis of STEMI was made in 1,179, and 2,041 qualified as unstable angina / non-STEMI.	Individuals who had an admission diagnosis of ACS (STEMI and non-STEMI or unstable angina). Non-fatal MI defined by the presence of at least one positive increment of cardiac biochemical marker of necrosis (in case of those in whom MI was the index diagnosis) plus chest pain prolonged more than 10 minutes, or new ST-segment deviation seen after the index or qualifying electrocardiogram.	The country paid a high toll for this change, with the GDP experiencing a sustained decline from 1998, and unemployment rates reaching approximately 25 percent. By the end of 2001 a rapid cascade of political and economic events opened the road to deep social turmoil and economic unrest that spiraled until December 2001, when the country experienced a virtual halt of vital areas of the economy. The beginning of the negative slope of the gross domestic product curve was considered as the start of the crisis period, which lasted until the domestic product experienced a sustained increase over a full trimester.	The period of time examined was divided into the crisis period, which was delimited from April 1999 to December 2002, and the post crisis period, which encompassed the time from January 2003 to September 2004.	NR	There was a higher incidence of in-hospital complications during the crisis, including MI (OR 2.504, 95%C.I: 1.663-3.773).

Great Recession (2008)													
Bartoll (2019)	Ecolog ical study	Populatio n in Basque country: 2,082,587 (in 2001) 2,179,815 (in 2011), in Barcelona : 1,505,325 (in 2001), 1,620,943 (in 2012)	NR	2001-2012	Basque Country and Barcelona	NR	NR	>25 years	Information on the at-risk population, including age and sex and was obtained from the municipal census. Due to a lack of linkage, 401 IHD deaths for men (4.4%) and 332 for women (4.7%) were excluded.	Deaths were analyzed due to IHD including ICD-10 codes of the underlying cause of death: from angina pectoris (I20) to chronic IHD (I25).	After the mild crisis of 2001, the Spanish economy grew at a constant rate for the next few years until the fourth quarter of 2008 to enter in negative growth rates. Since then, the economic recession has severely affected the Spanish population, with a rapid rise in unemployment, work precariousness and vulnerable population increasing socioeconomic inequalities. The economic recession actually started during the 4th term of 2008.	Before (periods 2001-2004 and 2005-2008) and during the Great Recession (2009-12)	Age	Trends in socioeconomic inequalities in mortality due to IHD were examined and it was found a gradient of increasing standardised death rates of IHD through less educational level. Absolute inequalities' death rates of IHD decreased in the last period 2009-2012, except for women from 50 to 64 years.
Bilal (2014)	Ecolog ical study	NR	NR	1980-2010	Twelve Western European countries were included (Austria, Finland, France, Germany, Greece, Ireland, Netherlan ds, Norway, Spain, Sweden, Switzerla nd and the United Kingdom	NR	NR	NR	Economic (World Bank) and vital statistics data (WHO Mortality Database) gathered for all Western European countries with more than 5 million inhabitants that had complete mortality data for the period 1980-2010.	Ischemic heart disease (IHD)	Economic crisis affecting Europe since 2008 (Great Recession).	Before and after the economic crisis.	Age	Economic recession was associated with a 2-year lagged 1.49% increase in IHD mortality in men (p=0.016) and 1.74% increase in women (p=0.019). Sensitivity analyses using unemployment as a second measure of economic recession showed similar results. Each additional year of recession was associated with a 2-year lagged 1.21% increase in IHD mortality in men (p=0.003) and 1.17% increase in women (p=0.016).
Dapon tas (2019)	Ecolog ical study	NR	NR	1979-2016	Greece	NR	NR	NR	NR	Heart attack accidents. The variable "heart" refers to the number of reported CV and ischemic and stroke per year provided by European Heart Network and Hellenic Society of Cardiology. These incidents there were not only fatal.	The Greek government had practiced successive cut expenditures for health from 2009 to 2013 they set as an alarming issue the number of suicides, the mortality has been stable due to reduction of traffic accidents mortality rate.	Before and after the economic crisis.	NR	Heart attack incidents increase have a positive effect (Robust least squares results: Heart=0.0004). The most important effect has to do with crisis and unemployment. One period lagged crisis is important and positive which means that crisis effects are delayed for one year seem to have significant effect on mortality.

| Fiuzat (2010) | Cohort study | 11,590 | 2,465 (patients with AMI) | January 2006 to July 2009 | United States | 63% | 62 years | 54-71 years | Observational study of data from the 'Duke Databank for Cardiovascular Disease' and includes patients undergoing angiography for evaluation of IHDs from January 2006 to July 2009. | Patients with AMI occurring within 3 days before catheterization were used to calculate AMI rates. MI was identified using the American College of Cardiology/AHA/ESC/WHF universal definition, including evidence of ischemia with clinical signs or symptoms and/or diagnostic electrocardiographic changes and cardiac biomarker increases. Patients with sudden cardiac death and post procedure AMIs were not included in the analysis. | The United States (US) economy had a severe recession in late 2008 that continued into 2009, and with the continued economic decrease, US stocks reached their lowest levels since the 1930s. | Over the entire 3-year period (January 2006 to July 2009). Before and during the economic crisis 2008. | Seasonality | During a period of stock market decrease (September 2008 to March 2009), AMI rates were significantly higher (p=0.01). There was also a strong relation between the period of stock market decrease and increased AMI rates using a 1-month lag period from October 2008 to April 2009 (p=0.003). Comprehensive time series analysis showed no statistically significant correlation between stock market returns and AMI event rates over a 3-year period not taking into account periods of volatility (January 2006 to July2009, p=0.62). |
| Garcia (2015) | Ecological study | NR | NR | 2007-2010 | South Florida | NR | NR | NR | NR | This study calculated the period prevalence of ACS admissions by dividing the number of ACS cases by the total number of monthly admissions to a large safety-net county hospital in South Florida. | American Financial Crisis of 2008-2009. | Before and after economic crisis | NR | The average prevalence of ACS admission diagnosis during the year of the financial crisis (14.61%) was significantly higher as compared to the pre-crisis year period (8.75%) and the post-crisis year period (11.92%) (p<0.01). |

Guojó nsdótti r (2011)	Popula tion-based registe r study	N=140,99 7 (2006), N=145,38 0 (2007) and N=151,53 0 (2008)	NR	10-week period s in 2006, 2007, 2008	Iceland, Reykjaví k	Cardia c ED: 52.3 (2006), 49.3 (2007), 54.8 (2008)	NR	≥18 years	Population information on all adult individuals (≥18 years) living in the larger capital area on 1 July in 2006 (N=140,997), 2007 (N=145,380) and 2008 (N=151,530) obtained.	All discharge diagnoses considered are made by the attending cardiologist and registered according to the Related Health Problems, and ICD-10. Diagnoses of the CV system (I00-I99), IHD (I20-I25), relevant symptom diagnoses of the CV system (R00-R09). The RR of visits with IHD as the discharge diagnosis was calculated by ICD-10 (I20-I25).	The national economic collapse in Iceland in early October 2008.	10-week period, before (weeks 37 & 40) and after (weeks 41 & 46) the economic collapse in Iceland in October 2008.	Gender	Focusing on visits due to IHDs, the corresponding RR (95%CI) for women and men were 1.24 (0.66 to 2.31) and 0.88 (0.55 to 1.40) in 2006 and 1.05 (0.54 to 2.03) and 1.15 (0.71 to 1.87) in 2007, respectively whereas in 2008, the RR was statistically significantly increased among women (RR=1.79; 95%CI: 1.01 to 3.17) but not among men (RR=1.07; 95%CI: 0.71 to 1.62).
Kavira tne (2012)	Registr y-based study	NR	2001:9 35, 2005:1 ,977, 2010:1 ,029 PCI cases	2005-2010	New Hampshir e, Maine, and Vermont.	NR	NR	NR	The PCIs were obtained through 'Dartmouth dynamic registry', which has a catchment area that encompasses New Hampshire, Vermont and Maine. Regional and National unemployment data were obtained through the 'Department of Labor and Statistics'. National and State specific insurance rates were obtained through the US Census data for 2001-2010.	State specific CV prevalence rates and PCI were obtained through individual state specific 'CDC epidemiology department's Behavioral Risk Factor Surveillance System' (BRFS) questionnaire.	Economic crisis in 2008.	Before and after the economic crisis	NR	It observed a steady increase in PCI volume of 935 cases in 2001 to high of 1,477 in 2005 but steadily declined to 1,029 PCIs in 2010. During the same time STEMI cases have steadily increased from 10% to 28% of total volume, while the PCIs due to NSTEMI/UA and stable angina percentage remained between 25%-30% of the total PCI volume but overall numbers declined. Unemployment rate was highly correlated with the STEMI rate (correlation coefficient 0.87, p<0.001).

| Li (2014) | Retrospective cohort study | 1,467 [990 (low-income area group) 477 (high income area grorup)] | 1,467 (AMIs) | 2006-2012 | New Jersey, USA | 53.7% (low-income area group) 26.7% (high income area group) | 69.5 (low-income area group) 70.1 (high-income area group) | NR | The identified cases were separated into two groups based on the average adjusted annual incomes of their residential areas. In total, 990 patients came from the zip code districts where the income ($44,515) was less than the NJ State average ($52,118), while 477 patients were from areas with an average income ($64,138) greater than the State average. Among the 1490 cases, 24 patients resided outside of Raritan Bay region and were not included in the subsequent analysis. | The query criteria used to identify acute MI cases was AMI (the ICD-9 code 410) being the primary discharge diagnosis during the time-period from January 2006 to June 2012. | 2008-2009 economic recession. During the 2008-2009 economic recession, the nadir of the Dow Jones Industrial Stock Average was more than 50% lower than its peak before the recession and the unemployment rate reached a historical high of 10%. | Before and after the 2008-2009 economic crisis. | Annual income of residential neighborhood | The monthly occurrences of acute MI trended up after early 2009 and peaked in March 2011, while the Dow Jones Industrial Stock Index dropped abruptly in October 2008 and the New Jersey monthly unemployment rate rose sharply within the same year. In the low-income neighborhood group, a similar rising trend of monthly occurrences of acute MI was found after the onset of the recession. In the high-income neighborhood group, the trend of monthly acute MI occurrences stayed flat after the onset of the recession and had no correlation with the New Jersey State unemployment rates (-0.016, p-value=0.89). No statistically significant correlation was found between the Dow Jones Index averages and the acute MI occurrences in either group (Low socioeconomic area: 0.137 (p=0.23) and high socioeconomic area: 0.060 (p=0.06). The high state unemployment rate was a contributing factor to the increasing trend of acute MI occurrences in low socioeconomic neighborhoods in Raritan Bay region, New Jersey during the 2008-2009 economic recession (0.0231, p=0.04). |
| Makaris (2013) | Ecological study (retrospective analysis of medical records) | NR | 2,554 (AMI events) | 2003-2012 | Greece | 74.7 | 68.2 | 20-75+ years | All patients admitted to the Cardiology Department of the Messinia General Hospital (300-bed public Hospital located in Kalamata, serving an area of over 170,000 people in Messinia, Southwestern Greece) for incident cases (fatal, non-fatal) of AMI. | Acute myocardial infarction (AMI) | Financial crisis in 2008. The beginning of the financial crisis was based on the change in national GDP and employment rate. Following several years of economic growth, in 2008 GDP began to decrease and the unemployment rate increased, marking the breakout of the Greek financial crisis. | Pre-crisis period (January 2003 to December 2007) financial crisis period (January 2008 to December 2012). | Age | Total number of incident AMI events was 2,554, 1,909 in men (74.7%) and 645 in women (25.3%) (mean age±SD: 68.2±13.8 years [IQR: 58.1–78.9]). Number of incident AMI events increased from 1,046 in the pre-crisis period to 1,508 in the crisis period. Incidence of AMI was higher in the crisis period compared with the pre-crisis period (RR=1.40, 95%CI: 1.29-1.51, p<0.001). Among patients aged 20-44 years incidence was higher in the crisis period (RR=1.35, 0.78-2.34). Comparing the crisis with the pre-crisis period, the rate ratio for patients 45-54 years was 1.20 (0.95-1.52); aged 55-64 years, 1.44 (1.21-1.71); aged 65-74 years, 1.53 (1.31-1.78); and aged 75+ years 1.35 (1.19-1.54). Men had a significantly higher incidence of AMI than women in both periods. In the pre-crisis period the RR was 3.48 (3.00-4.03), and during the crisis it |

														was 3.05 (2.70-3.44) (p<0.001 for both periods). It was found a significant interaction between age and sex in the crisis period (p=0.02), such that the effect of female sex was higher in the older age groups (75+) than in the younger ones.
Nolasco (2018)	Ecological study	NR	2,255,761 total deaths in 2002–2007 and 2,323,380 in 2008–2013.	2002-2013	Spain	NR	NR	0-74 years	Residents in Spain aged 0-74 years. Data obtained from the 'Spanish National Statistics Institute'.	Analysis of amenable mortality. All deaths were considered and grouped into groups: IHD (I20-I25), cerebrovascular disease (I60-I69), hypertensive disease (I10-I13, I15) [coded by ICD-10].	2008 Recession. As a measure of the socioeconomic impact of the crisis, four indices have been considered for each province, based on the percentage evolution of fifteen indicators between 2006 and 2013: Economic Vulnerability Index (evolution of the economic activity and employment, according five indicators: GDP per capita, number of companies, employed population, unemployed population, and foreign trade), Social Vulnerability Index (socio-demographic changes, according five indicators: population and immigration, residential mobility, recipients of unemployment benefits, young people emancipation, and social mobilization), Real-Estate Vulnerability Index (evolution of the real estate market, based on another five indicators: number and value of mortgages, empty completed dwelling, real-estate dwelling transactions, average price of empty dwelling, and mortgage foreclosures), and composite Index of Total Vulnerability (ITV), consisting of an average of the previous three indices, based on a standardised construction process.	Before 2002-2007 and after the 2008-2013 economic Recession.	Age	IHD mortality showed a decrease in age-standardised mortality rates (ASR) with men found to be more affected in the period 2008-2013 compared to 2002-2007 (25.84% in men, 30.69% in women). In 2011, the AMI rate was reduced among men. The results obtained for mortality from IHD were compatible with a procyclical relationship with the vulnerability index, although they were only statistically significant in women.
Osman (2017)	Ecological study	NR	31,060 (IHD deaths)	2001-2014	Northern Ireland	NR	NR	NR	The 'Northern Ireland Statistics and Research Agency-NISRA' provides mortality data in Northern Ireland between 2001 and 2014 inclusive, to the public, on its website. The count of IHD and CVA deaths before and after the year 2008, were contrasted taking into account any possible	Annual CVA and IHD mortality. Mortality data were extracted from the Northern Ireland Statistics and Research Agency database.	Global financial crisis in 2008-2014.	Before vs. after 2008 economic crisis.	Adjustment for population count by including an offset term in the model representing the annual	The average annual IHD deaths were 2,782 deaths per year prior to the economic crisis and 2,084 afterwards. A significant rise in IHD-deaths was observed during the financial crisis years in males and females over the age of 65 (β=49.466, p=0.003; β=57.721, p=0.001, respectively). The rest of the age groups were not significantly

														affected in terms of IHD mortality. Similarly, an overall rise in the males annual AMI rate by 2.96% was noted (95%CI: 0.16%-5.84%), that was significant statistically (p=0.004).
									pre-existing trend of cardiac deaths.				population estimate.	
Regidor (2019)	Ecological study	15,874,723	217,067 (deaths)	2003-2011	Spain	61.9% (9,822,853 men)	NR	25-64 years	Men and women who were between 25 and 64 years of age in each calendar-year of follow-up period and had an occupation at the time of the 2001 census.	CVDs were classified by coding of ICD-10, IHDs, cerebrovascular diseases, all-other heart diseases (I00–I09, I26–I51)	The economic crisis that started in 2008 stimulated the interest of the scientific community in the possible effect of economic recessions on health.	Before, during and after the economic crisis	Age, educational level, employment status, semester of death	The Annual Percentage Changes (APCs) in mortality were negative in the first period (2003-2007) -1.0 (-6.0 to 4.2) and positive in the second (2008-2011) 4.5 (-2.5 to 12.0) in women aged 25-64 years, whereas an opposite effect was observed in men; as the effect sizes (and 95%CI) were 5.6 (-3.1 to 15.2) in women and -1.8 (-4.0 to 0.4).
Samentzas (2014)	Retrospective cohort study	7,307	1,646 (AMIs)	2003-2012	Greece	53.6%	NR	NR	NR	Acute Myocardial Infarction (AMI)	Economic crisis in 2008.	The period from 1.1.2003 until 31.12.2007 was considered the "pre-crisis period", while the period 1.1.2008 until 31.8.12 was defined as "crisis period"	NR	It was observed an increase in the number of admissions in "Elpis General Hospital of Athens" due to AMI in both sexes during the crisis period compared to the pre-crisis period. This increase was statistically significant (p<0.001) in women (14.6% in pre-crisis vs. 22.3% in crisis) but not in men (23.3% in pre-crisis vs. 28.2% in crisis period). In addition, the prevalence of AMI was increased in patients younger than 45 years old during the crisis period, but the increase was statistically significant only for women (17.6% in the pre-crisis period vs. 22.8% in crisis period, p<0.01).
Sanidas (2018)	Retrospective cohort study	3,895	NR	2006-2015	Greece	74.2 %	63.8±11.3	NR	Patients in total were subjected to heart catheterization due to typical or atypical clinical symptoms according to the records of 'Laiko General Hospital of Athens, Greece' and were classified in two groups, the group before the financial crisis (2006-2007, n=1228) and the group during the crisis (2011-2015, n=2667)..	Angiographic evaluation included a mandatory diagnostic coronary angiography according to standard techniques for all incoming patients and, if necessary, a percutaneous coronary intervention (PCI). Before examination, a detailed coronary risk profile for	Financial crisis in 2008.	Before financial crisis (2006-2007) and during the crisis (2011-2015)	NR	More individuals with one vessel disease (20.5% vs. 23%, p<0.001) and less with two (20.2% vs. 18.9%, p<0.001) or three vessels disease (35.6% vs. 23%, p<0.001) were examined during the financial crisis. On the other hand, during the financial crisis, regarding ACS, less patients were presented compared to the pre-crisis period (45.5% vs. 39.9%, p<0.001) as well as the number of patients with Coronary Artery Disease (CAD) was decreased.

										every patient was obtained as well as valid height and weight measurements.				
Savu (2016)	Ecological study	17,935,425 population in 2006	315,011 (AMI events)	2002-2009	Canada (Included all FSAs (forward sortation areas) with non-missing and non-zero population counts in all Canadian provinces, except Quebec;1,155 FSAs were included)	NR	NR	>20 years	Population aged 20 years and over, median household income, home ownership, elderly 65 years and over, being the head of a single-parent family, being without a high-school education, being with university degree, employment and unemployment rate. Hospital admissions of patients aged 20 and over residing within the selected 1,155 FSAs were clustered into hospitalization episodes.	Acute myocardial infarction (AMI). Hospitalizations with a most responsible diagnosis of AMI with a discharge date between Jan 1st, 2002 and Dec 31st, 2009 were selected as indicators of AMI events. AMI as main diagnosis (ICD-9th Revision: 410.xx or 10th Revision: I21.xx).	Economic recession of 2008-2009.	The time frame of the study incorporates two economically distinct periods: (1) an economically-stable period from 2002 to 2007 and (2) the economic recession of 2008–09.	Age, employment and unemployment rates (SES)	AMI rate was, on average, 2.27 per 1,000 person-year. regions in Canada with higher rates of AMI corresponded to those with higher levels of economic and financial stress, as indicated by personal bankruptcy rate, and vice-versa. Specifically, an increase of 100 in bankruptcy count (BKC) was associated with an increase of 1.5 (p=0.02) in the AMI event count in the following year.
Schwartz (2012)	Ecological study	Annual LA Population	Coronary heart disease deaths in: 1985: 19,510 1996: 16,411 2005: 14,365 2008: 12,580	2005-2008	Los Angeles	NR	NR	NR	From 2005 through 2008, we obtained annual LA population estimates (population estimates also obtained for 2004 and 2009), daily stock market data	3 groups of cardiac deaths based on the ICD-10 codes for all circulatory deaths (I00-I99), CHD deaths (I20-I25), and AMI deaths (I21).	Stock market crash in autumn 2008 in Los Angeles County.	Before and during the stock market crash.	NR	The absolute CHD death rates have decreased since 1985 (0.243%) including from 2005 (0.141%) through 2008 (0.121%).

| Tapia Granados (2017) | Ecological study | 27 European countries | NR | 2004-2010, the robustness of the results was checked in two longer periods: 2000–2013 and 1995–2013. | 27 European countries. Countries with mild or no recession: Austria, Belgium, Finland, France, Germany, the Netherlands, Norway, and Switzerland. Countries with mild recession: Bulgaria, Croatia, Czech Republic, Denmark, Hungary, Italy, Poland, Portugal, Slovakia, Sweden, and the UK. Countries with severe recession: Estonia, Greece, Ireland, Latvia, Lithuania, Slovenia, and Spain. | NR | NR | Ages 30-44 and 75 and over, but not ages 0–14 | Individuals aged 30–44 and 75 and over. | CVD and a subset of it, IHD | The Great Recession, a global economic and financial crisis that was particularly severe in many European countries, where there were big increases in unemployment, as well as generalized banking problems, large public and private debts, and austerity policies that have created serious social distress and major financing problems for public services, including health care. 2007 was considered as the last year of the expansion before the recession which openly started in most European countries in 2008. | Three-year period (2007-2010, Recession period) vs. (2004-2007, Pre-Recession or Expansion period) | Age | For IHD mortality rates, the greatest reduction in 2007-2010 occurred in the group of countries in which the recession had been the most severe. It was found to have statistically significant effects consistent with a procyclical oscillation of mortality due to CVDs. A one-percentage point increase in unemployment was associated with reductions of age-standardized mortality from IHD (by 0.3%). Relative changes of age-standardized death rate from IHD per 100,000 population in 27 countries sorted in 3 groups according to the severity of the economic recession in 2007-2010 as A) countries with mild or no economic crisis B) countries with moderate economic crisis C) countries with severe economic crisis: A) % change (2004-2007)= -13.1, % change (2007-2010)= -10.9 B) % change (2004-2007)= -16.5, % change (2007-2010)= -10.3 C) % change (2004-2007)= -10.3, % change (2007-2012)= -14.8 |

| Varda kas (2019) | Ecolog ical study | NR | NR | 2000-2015 | Greece | Mean male popula tion during the crisis (31,28 4/year) before crisis (15,75 5.9/yea r) | NR | 0-85 or older | Individuals in age groups (0–19, 20–39, 40–55, 56–69,and 70 or older), from geographic regions (North and South Greece) for the period 2000–2015. Additional data (1955–1999) were incorporated to evaluate if changes in mortality occurred long before the study period. To calculate mortality rates, the population was divided into 18 age subgroups, i.e., 0–4 years, 5–9 years etc., till 80–84 years and ≥85 years. | All death causes were categorized into 16 groups based on the relevant list provided by the ELSTAT and were among others: heart diseases, cerebrovascular disease | In 2007 Greece experienced its ninth year of recession (2009–2017). Although the financial crisis appeared in late 2008, its effects in the Greek population became evident in 2010, when cuts in salaries and public investments were imposed and unemployment rose above 10%. The years 2010–2015 were selected as the financial crisis period. The indicator used as a measurement of recession (GDP, unemployment, GDP per capita), the duration or the type of the recession (normal fluctuation or severe crisis), the pre-existing levels of vulnerability (public infrastructure, social safety nets, access to effective healthcare, and education), the quality of responses to a crisis (cuts in public spending and health expenditures), and the population(s) under study (developed or developing countries, individual or aggregate relationships). | Prior to (2000-2009) and during (2010-2015) the financial crisis. Reference year: 2001 | Age | Mortality due to MI showing an increase during the crisis. |
| Verso (2014) | Ecolog ical study | NR | 242,00 0 (deaths due to CVDs) | 2002-2012 | Italy and Sicily | NR | NR | 15-69 | The number of residents and migrants, including births and deaths; the number of marriages and separations; and also, data related to the number and percentage of workers in the various sectors were evaluated. data provided by the monitoring system "PASSI" of the National Institute of Health for the period of 2009-2012 | CVDs, MI, unstable angina, heart attack, sudden cardiac death | Economic crisis that started in 2008. | Period before and following 2008, roughly 2002 to 2012 | NR | Among the most frequent cardiac events are nonfatal MI, unstable angina. IHD remains the leading cause of mortality, although mortality from MI has been reduced from 30% to 10% in the first decade of the millennium. The 30% of deaths (about 73,000) are due to MI, in 2009. It was shown that in the North there was an incidence rate of 221.5 per 100,000 males and 93 per 100,000 women, in the center 228 per 100,000 males and 100.2 per 100,000 women and in the South the incidence rate was 238,9 per 100,000 males and 104.2 per 100,000 women. |

Zapata-Moya (2015)	Ecological study.	48,456	NR	2003–2004, 2006–2007, 2009-2010 and 2011–2012	Spain, 17 Spanish autonomous regions	44.76	NR	25-65	A dataset with information from the 2006 and 2011 SNHS and 2009 EHS-S, was used to study MI which has a sample of 21,688 male and 26,768 female respondents, with an accumulated percentage of missing values of 1.87 and 1.01 % respectively. Data were obtained from 3 waves with a cross-sectional design and one more with repeated cross-sectional design.	Myocardial Infarction (MI)	Economic crisis which began in Europe at the end of 2007. The GDP growth rate and low work intensity indicator are used as regional-economic context variables, together with changes in these measurements across the periods at regional level, reflecting the strength of macroeconomic changes.	The situation during the economic crisis (the 2009–2011 period), which began in Europe at the end of 2007 was compared with the situation before the recession (2003–2006).	Age, marital status, household type, work status, period, gender	The prevalence of MIs decreases for men and remains stable for women between 2006 and 2011. From 2003/2006 to 2011 the gender difference is reversed, with men having a higher probability of suffering from MI for each period. There was a greater probability of being diagnosed with MI for women (OR=1.08) but not for men. There is a negative association between the real GDP growth rate and MI for women: in regions where the real GDP has declined less, women are less likely to suffer MI than in regions with a strong decline in the GDP growth rate (OR=0.83). The probability of being diagnosed with a MI decreases for men from 2006 to 2011 (OR=0.88).
Multiple economic crises													
Bunn (1979)	Pooled analysis of data from 18 cohorts	NR	NR	1920-1975	Australia	NR	NR	35-64	In the 50-year period of study the IHD mortality for 18 cohorts was calculated for the period 1920-1975.	IHD; data were bridged over successive revisions of the ICD-7.	Great Depression and 1961 recession. The 1930s were the years of the Great Depression while the early 1960s saw the next recession. Unemployment was measured as the average annual rate and it was used as an indicator of the business cycle.	Three periods are assessed, each of a different socioeconomic experience: before, during, and after the Great Depression.	Age	Mortality increases steeply after 1930 and appears to peak in the late 1950s. After 1961, there was a renewed increase reaching a peak in the mid-1960s and declining after 1968 seemed that IHD mortality triggered in part by the economic stress of the Great Depression and moving over time through the population.

| Noelke (2015) | Multicohort panel survey | 8,837 | 990 (MIs and strokes) | 1992-2010 | United States | NR | 53 years | 45-66 years | All individuals between the ages of 45 and 66 years who were observed in a dependent employment relationship and therefore were at risk of job loss during the observation period (1992–2010). Individuals who reported having had a stroke or MI before the baseline interview were excluded. Jobs that lasted less than 1 year, paid zero earnings, entailed less than 36 weeks of work per year, or required less than 16 hours of work per week were also excluded. Individuals were classified as having experienced a job loss ("treated") if they reported having lost their job because of a layoff or business closure between age 45 years and their cohort-specific full retirement age (~66 years of age). All other individuals were part of the comparison group (controls); this group included workers who remained employed throughout the observation period or had other labor force transitions, such as retirement, transitions to disability, or health-related work exits. Control subjects whose employment spells ended before the individual was 45 years of age or started after the individual's full retirement age were excluded to set a common age range over which treated individuals and controls were observed. | Initial MI or stroke. At each survey, respondents were asked, "Did you have a heart attack or myocardial infarction?" and "Has a doctor ever told you that you had a stroke?" Participants who answered in the affirmative were also asked the year of the event. If respondents were not available, for example, following a fatal MI or stroke, the information was obtained from proxy informants, predominantly spouses. | The recession of the early 1990s ended in March of 1991. Great Recession in 2009 and 2010. Annual country unemployment rates from 1992 to 2010 used to measure fluctuations in economic conditions at a local level and capture both opportunities for reemployment (for unemployed workers) and levels of commercial activity and demand for work hours (for employed workers). | Boom vs. during recession | Place of birth, sex, ethnicity, parental educational level, own educational level, year fixed effects, marital status, household wealth, household income, individual earnings, hours worked, weeks worked, state of residence, inflation differences in household size, health insurance coverage, year of first interview, BMI, smoking, number of alcoholic drinks consumed per day, depression symptoms, self-rated health, self-rated memory, cancer-diabetes diagnosis, high blood pressure, heart problems. | Recessionary labor demand conditions were associated with increased risk of CVD among individuals having experienced a job loss (HR=2.54, 95%CI:1.39-4.65), reflecting positive selection into job loss during recessions compared with booms. In contrast, among controls workers who remained employed recessionary labor market conditions were associated with lower CVD risk (HR=, 95%CI: 0.31-0.78) suggested that recessions might be protective in the absence of job loss but hazardous in the presence of job loss. |

| Wada (2016) | Ecological study | 1980: n=24,250,948, 1985: n=25,896,538, 1990: n=25,961,345, 1995: n=26,059,598, 2000: n=25,935,755, 2005: n=25,621,203, 2010: n=24,077,226 | NR | 1980-2010 | Japan | 100 | NR | 30-59 years | Individual cause of death data obtained from the 'Occupation-specific Vital Statistics' provided by the Japanese MHLW. Data on population size by occupation obtained from the National population census, which is implemented at 5-year intervals on 1 October, to calculate occupation-specific death rates. Data for males aged 30–59 years were also extracted. Individuals aged 20–29 years, including university and other higher education students were excluded, because of the large number of students included in this age band. Those aged 60 years and over, that was the typical retirement age in Japan during the study period were also excluded. | Cause of death data were based on information recorded in official death certificates, including the underlying cause of death, completed by physicians based on the sequence of morbid events leading to death, and coded according to the ICD-9 (1980-1990) and ICD-10 (1995–2010). IHD and cerebrovascular disease were among causes of death. | The Japanese economy faced serious economic stagnation after the 2008 global financial crisis. The GDP growth rate was negative in 2009, and the unemployment rate peaked at 5% in 2009/10, a rate that the Japanese economy has not seen since the period after the Second World War. The three decades up to 2010 studied, a period during which Japan faced its worst stagnation since the Second World War. | Before and after 2000. | Age | The unemployed category showed a non-significant reduction in IHDs with a RR equal to 0.83 (95%CI: 0.66-1.03) after 2000. Mortality for those in professional roles also showed a downward trend after the spike in 2000. |

Appendix 3. Characteristics of eligible studies about cerebrovascular diseases.

First author (Year)	Design	Cohort size	Cases in cohort	Study period	Region	Males (%)	Mean age	Age range	Cohort characteristics	Definition/features of CVDs	Definition and ascertainment of economic crisis	Categorization (comparison) of economic crisis	Adjusting factors	Main findings regarding cerebrovascular diseases
Oil crisis or oil shock (1970s)														
Guberan (1979)	Ecological study	NR	NR	1951-1976	Switzerland	NR	NR	22-85+ years	There were seven age groups for both sexes: 23-34, 35-44, 45-54, 55-64, 65-74, 75-84, 85+ years	The numbers of deaths by sex and five-year age groups are published each year by the 'Federal Bureau of Statistics' (1955-1977) and since 1951 according to the A-list of the ICD. The 3 subcategories of the 6th and 7th revisions of ICD combined together as "non-rheumatic heart disease and hypertension": arteriosclerotic and degenerative heart diseases (A81); other diseases of the heart (A82); hypertension with heart disease (A83); and hypertension without mention of heart (A84) as the subcategories of 8th rev. of ICD: ischaemic heart disease (A83); other forms of heart disease (A84); hypertensive disease (A82)	Economic recession in 1975.	Before, during and after the economic crisis.	Age	The decline in cerebrovascular mortality was constant for both sexes, although a little greater in females than in males reducing by 47% and 36%, respectively from 1951 to 1976. The change in death rates from cerebrovascular diseases between 1951-1976 was -36.2% and -46.6% and the total reduction in deaths due to cerebrovascular diseases was 14.8% and 14.4% for men and women, respectively.

Early 1990s Recession														
Franco (2013)	Ecological study. Data were obtained from repeated cross-sectional surveys and ecological comparison of secular trends.	Measurements in Cienfuegos: 1,657 (in 1991), 1,351 (1995), 1,667 (2001), and 1,492 (2010). National surveys: 14,304 (1995), 22,851 (2001), and 8,031(2010)	NR	1980-2010	Cuba and the province of Cienfuegos	NR	NR	15-74 years	Measurements in Cienfuegos included a representative sample of 1657, 1351, 1667, and 1492 adults in 1991, 1995, 2001, and 2010, respectively. National surveys included a representative sample of 14304, 22851, and 8031 participants in 1995, 2001, and 2010, respectively. The age distribution of the population in Cienfuegos is similar to the general Cuban population. The following categories for body mass index: underweight (<18.5), normal weight (18.5-<25), overweight (25-<30), and obesity (≥30) were used.	ICD-10 codes were used for death from CHD (I20-I25) and stroke (I60-I69).	Economic crisis of the early 1990s. The largest effect of this economic crisis occurred over a period of about five years (1991-1995). Since then, the Cuban economy has shown a modest but constant recovery, especially after the year 2000.	Before, during and after the economic crisis.	Age	The mortality from stroke evolved in three phases. A modest decrease of 6.9% lasting from 1980 to 2000 (0.4% per year) and a sharp fall between 2000 and 2004 of 13.6% (5.3% per year) was observed. From 2004 to 2010, mortality fell by 1.3% (0.01% per year), similar to the pre-crisis rates. Five years after the start of the economic crisis in 1996, an abrupt downward trend was observed in mortality from stroke. The period lasted an additional six years, during which energy intake status gradually recovered and physical activity levels were progressively reduced; in 2002, mortality rates returned to the pre-crisis pattern. From 2002 to 2010, declining rates of stroke slowed to annual decreasing rates similar to those before the crisis.
Finnish Banking Crisis (1991-1993)														
Valkonen (2000)	Ecological Study	NR	1981-1985:40,771 1986-1990:41,816 1991-1995:39,663	1981 to 1995	Finland	NR	35-64 years	NR	Individuals aged 35-64 years and two occupation-based social classes are distinguished: non-manual workers and manual workers.	Mortality due to CVDs and the analysis is based on the ICD-8 in 1981-1986 and the cause of death classification 1987 of statistics Finland in 1987-1995. The latter classification is based on the ICD-9.	In the second half of the 1980s economic growth was exceptionally rapid, but in 1991-1995 Finland suffered a very severe economic recession. Economic output declined for 3 years, reaching its low point in early 1993 at less than 90% of the 1990 level. The bankruptcy rate doubled in 3 years.	Before and during the crisis (1981-1995)	Age	Among women the absolute increase in the CVDs was 2 deaths from cerebrovascular diseases and among men the absolute increase in the CVDs was 7 deaths from cerebrovascular diseases per 100,000 from 1981-1985 to 1986-1990. Age-standardised death rates (per 100,000) (95%CI) by social class, difference in death rates between manual and non-manual workers in 1986-1990 (1) and 1991-1995 (2), and change in the difference in death rates from period 1 to 2 for cerebrovascular diseases: -5 (-11 to 0) for men and -1 (-6 to 3) for women.
Asian Financial Crisis (1997-1999)														
Khang (2005)	Ecological study	Mid-year population in South Korea	NR	1990-2002	South Korea	NR	NR	Four age groups: 1–14, 15–34, 35–64, and 65–79 years	Individuals categorized into four age groups: 1–14, 15–34, 35–64, and 65–79, in both sexes.	Mortality due to hypertensive disease, IHD, cardiomyopathy and cerebrovascular disease.	After enjoying uninterrupted economic growth for decades, South Korea underwent a steep economic decline in the late 1990s.	Before and after the economic crisis.	Age	It was observed a decrease in the mortality rates between 1996-2002 among both sexes aged 35-64 in cerebrovascular disease cause of death [RR 1998/1996=0.90, RR 2002/1996=0.77 for males, RR 1998/1996=0.84, RR 1996/2002=0.63 for females] and among both sexes aged 65-79 years [RR 1998/1996=0.94, RR 1996/2002=0.79 for males, RR

														1998/1996=0.93, RR 1996/2002=0.83 for females].
Kim (2004)	Ecological study	Entire country of South Korea	9,534 (deaths due to CVDs in 1998), 15,108 (deaths due to CVDs in 1999)	1995-1999	South Korea	NR	NR	NR	The number of total deaths and the number of cause-specific deaths that occurred in each month from January 1995 to December 1999 (72 months in total) were collected from "The annual report on the cause of death statistics based on vital registration" published by the 'South Korean National Statistical Office'.	Mortality due to CV, IHDs and cerebrovascular disease.	On December 3, 1997, South Korea received financial support from the IMF due to a liquidity squeeze. This event marked a national economic crisis unprecedented in South Korean modern history	Before and after the economic crisis (1995-1999)	NR	There was an annual increase of 155 deaths after the economic crisis, which was significant in cerebrovascular disease. Furthermore, mortality from cerebrovascular disease per 100,000 population was 4.6 in 1998 and 7.1 in 1999, which showed that the influence of the economic crisis persisted.
Russian Financial Crisis (Ruble crisis or Russian Flu) (1998)														
Men (2003)	Ecological study	NR	NR	1991-2001	Russia overall and seven federal regions, five in European Russia (North Western, Central, Privolzhski, Southern, and Uralski) and two in Asian Russia (Siberian and Far Eastern)	NR	NR	All ages (0-70+)	Data obtained from the 'Russian State statistics committee', including deaths by cause, sex, five-year age group, and calendar year together with corresponding population denominators	Causes of death in Russia were coded with the Soviet system of disease classification up to 1998, with each category corresponding to groups of items in ICD-9. From 1999, a new system based on ICD-10 was introduced. Diseases of circulatory system: rheumatic heart disease, hypertensive disease, IHD, cerebrovascular disease.	Russian economic crisis in 1998.	Before, during and after the economic crisis.	Age	It was found a increase in mortality from cerebrovascular diseases during 1998-2001 as well as a decrease in mortality during 1994-8 among both men and women. Additionally, death rate by cerebrovascular disease at age 35-69 years per 100,000 for men were: 204 (1991), 302.4 (1994), 256.9 (1998) and 300.7 (2001) and for women:123.6 (1991), 167(1994), 145.7(1998), 159.7(2001).
Great Recession (2008)														
Falconi (2016)	Ecological study	NR	7,519,574 (stroke deaths)	2000-2010	California	NR	NR	>50 years	The 'California Department of Public Health, Center for Health Statistics & Informatics', 'Vital Statistics Section' provided the data from all the death certificates registered in California as well as death certificates for California residents who die in other states.	Causes of death were classified according to the ICD-10. As stroke deaths: intracerebral hemorrhages (I61.0-I61.9), cerebral infarctions (I63.0-I63.9), and stroke not specified as hemorrhage or	The Great Recession, which officially began in December 2007.	Before and after May 2008.	Sex, race/ethnicity	Stroke accounted for more deaths among older Californians during the Great Recession. Among white men, the monthly odds of a stroke-attributed death among all deaths increased an average of 5% between May 2008 and December 2010. White men, especially those ages 45 to 64, earn more on average compared to white women, black men and women, and Hispanic men and women, the Great Recession

										infarction (I64.0 - I64.9).			may have disproportionately affected their stroke mortality risk.
Katsanos (2016)	Retrospective registry-based study	734	341 (IS/TIA patients)	2008-2014	Greece	72.7	58.7±12.3	NR	All patients with an acute cerebral ischemic event that were hospitalized in the Department of Neurology, University Hospital of Ioannina, during a 6-year study period (2008-2014) were evaluated. Eligible patients were included if they had available baseline data on whether they did receive treatment with statins and/or antihypertensives prior to stroke onset. Records of 734 patients were screened, 341 IS/TIA patients (mean age=58.7±12.3; 72.7% males) and were identified to satisfy the inclusion criteria. Of these, 180 (52.8%) were admitted before 1/1/ 2011.	After the acute phase of the cerebrovascular event the presence of hypertension was diagnosed according to the corresponding World Health Organization.	Greece's economic crisis has deepened after six consecutive years of economic contraction in 2013, with little or no signs of recovery in 2014. The year 2011 was chosen as the transitional year, because the impact of crisis reached its peak in early 2011 with significantly increased mortality rates being reported in people older than 55 years during the period 2011-2012 for the first time.	Using 2011 as the transitional year patients were dichotomized according to their admission date in two subgroups: the "before economic crisis" subgroup and the "after economic crisis" subgroup.	NR	In 2008, revealed that more patients with a prior history of cerebrovascular events (IS or TIA) admitted after the onset of financial crisis.
Nolasco (2018)	Ecological study	NR	2,255,761 total deaths in 2002–2007 and 2,323,380 in 2008–2013.	2002-2013	Spain	NR	NR	0-74 years	Residents in Spain aged 0-74 years. Data obtained from the 'Spanish National Statistics Institute'.	Analysis of amenable mortality. All deaths were considered and grouped into groups: ischaemic heart disease (I20-I25), cerebrovascular disease (I60-I69), hypertensive disease (I10-I13, I15) [coded by ICD-10].	2008 Recession. As a measure of the socioeconomic impact of the crisis, four indices have been considered for each province, based on the percentage evolution of fifteen indicators between 2006 and 2013: Economic Vulnerability Index (evolution of the economic activity and employment, according five indicators: GDP per capita, number of companies, employed population, unemployed population, and foreign trade), Social Vulnerability Index (socio-demographic changes, according five indicators: population and immigration, residential mobility, recipients of unemployment benefits, young people emancipation, and social mobilization), Real-Estate Vulnerability Index (evolution of the real estate market, based on another five indicators: number and value of mortgages, empty completed dwelling, real-estate dwelling transactions, average price of empty dwelling, and mortgage foreclosures), and composite Index of Total Vulnerability	Before 2002–2007 and after 2008–2013 the economic Recession.	Age	Cerebrovascular disease shows a decrease in mortality (29.07% in men, 28.90% in women). The results obtained for mortality from cerebrovascular disease were compatible with a procyclical relationship with the vulnerability index, although they were only statistically significant in women.

										(ITV), consisting of an average of the previous three indices, based on a standardised construction process.				
Osman (2017)	Ecological study	NR	31,060 (IHD deaths)	2001-2014	Northern Ireland	NR	NR	NR	The 'Northern Ireland Statistics and Research Agency-NISRA' provides mortality data in Northern Ireland between 2001 and 2014 inclusive, to the public, on its website. The count of IHD and CVA deaths were contrasted before and after the year 2008, considering any possible pre-existing trend of cardiac deaths.	Annual CVA and IHD mortality. Mortality data were extracted from the 'Northern Ireland Statistics' and Research Agency' database.	Global financial crisis in 2008-2014.	Before vs. after 2008 economic crisis.	Adjustment for population count by including an offset term in the model representing the annual population estimate.	CVA-mortality in the post-crisis years rose significantly for females who were 65 years or older (β=56,010, p=0.005) but not for males. It was observed an overall, statistically insignificant CVA mortality rate following the 2008 economic recession.
Regidor (2019)	Ecological study	15,874,723	217,067 (deaths)	2003-2011	Spain	61.9% (9,822,853 men)	NR	25-64 years	Men and women who were between 25 and 64 years of age in each calendar-year of follow-up period and had an occupation at the time of the 2001 census.	CVDs were classified by coding of ICD-10, IHDs, cerebrovascular diseases, all-other heart diseases (I00–I09, I26–I51)	The economic crisis that started in 2008 stimulated the interest of the scientific community in the possible effect of economic recessions on health.	Before, during and after the economic crisis.	Age, educational level, employment status, semester of death	The APCs (95%CI) in mortality rate by cerebrovascular diseases in women were negative in the first period (2003-2007) and positive in the second (2008-2011) whereas an opposite effect showed in men. Trend before recession: -4.2(-8.2 to -0.1); during recession: -4.2 (-9.7 to1.6) effect size: 0.0(-7.0 to 7.6) p=0.994 and before recession: 0.8 (-1.5 to 3.1); during recession: -5.7 (-8.7 to -2.7) effect size: -6.5 (-10.1 to -2.8) p<0.001, in women and men, respectively.
Vardakas (2019)	Ecological study	NR	NR	2000-2015	Greece	Mean male population during the crisis (31,284/year) before crisis (15,755.9/year)	NR	0-85 or older	Individuals in age groups (0–19, 20–39, 40–55, 56–69,and 70 or older), from geographic regions (North and South Greece) for the period 2000–2015. Additional data (1955–1999) were incorporated to evaluate if changes in mortality occurred long before the study period. To calculate mortality rates, the population was divided into 18 age subgroups, i.e., 0–4 years, 5–9 years etc., till 80–84 years and ≥85 years.	All death causes were categorized into 16 groups based on the relevant list provided by the ELSTAT and were among others: heart diseases, cerebrovascular disease.	In 2007 Greece experienced its 9th year of recession (2009–2017). Although the financial crisis appeared in late 2008, its effects in the Greek population became evident in 2010, when cuts in salaries and public investments were imposed and unemployment rose above 10%. The years 2010–2015 were selected as the financial crisis period. The indicator used as a measurement of recession (GDP, unemployment, GDP per capita), the duration or the type of the recession (normal fluctuation or severe crisis), the pre-existing levels of vulnerability (public infrastructure, social safety nets, access to effective healthcare, and education), the quality of responses to a crisis (cuts in public spending and	Prior to (2000-2009) and during (2010-2015) the financial crisis. Reference year: 2001	Age	In cerebrovascular disease, the continuous decline in mortality before the crisis (mean 0.03/1,000 per year) was reversed during the crisis (0.02/1,000). Thus, mortality was 1.84/1,000 in 2000, dropped to 1.48/1000 in 2010, and increased to 1.62/1,000 in 2014 and should be mainly attributed to the increase of deaths. The decreasing mortality from cerebrovascular disease was reversed in 2012 and 2013 and affected both genders.

											health expenditures), and the population(s) under study (developed or developing countries, individual or aggregate relationships).			
Voulg ari (2019)	Retros pective cohort study	1000	NR	1995-2018	Greece	48.5 (after crisis) 46.6 (before crisis)	75.2 (after crisis), 77.9 (before crisis)	NR	Patients admitted after the economic crisis outbreak (429 patients, 221 women/208 men, 75.2±9.5years) compared to those hospitalized before the financial crisis (571 patients, 305 women/ 266men, 77.9±8.9years) were found to be younger (p<0.001), more frequent, and heavier tobacco smokers (p=0.002), as well as casual alcohol users (p=0.04).	Atrial fibrillation, arrhythmias, stroke, hypertension.	Economic crisis in 2008. 2008 was used as the transitional year.	Before and after the economic crisis.	NR	Patients after the economic crisis were found to have a higher incidence of a previous stroke (p<0.001). Death was significantly associated with previous stroke (p=0.05.)

Multiple economic crises

Noelke (2015)	Multic ohort panel survey	8,837	990 (MIs and strokes)	1992-2010	United States	NR	53 years	45-66 years	All individuals between the ages of 45 and 66 years who were observed in a dependent employment relationship and therefore were at risk of job loss during the observation period (1992–2010). Individuals who reported having had a stroke or MI before the baseline interview were excluded. Jobs that lasted less than 1 year, paid zero earnings, entailed less than 36 weeks of work per year, or required less than 16 hours of work per week were also excluded. Individuals were classified as having experienced a job loss ("treated") if they reported having lost their job because of a layoff or business closure between age 45 years and their cohort-specific full retirement age (~66 years of age). All other individuals were considered to be part of the comparison group (controls); this group included workers who remained employed throughout the observation period or had other labor force transitions, such as retirement, transitions to disability, or health-related work exits. Control subjects whose employment spells ended before the individual was 45 years of age or started after the individual's full retirement age were excluded to	Initial MI or stroke. At each survey, respondents were asked, "Did you have a heart attack or myocardial infarction?" and "Has a doctor ever told you that you had a stroke?" Participants who answered in the affirmative were also asked the year of the event. If respondents were not available, for example, following a fatal MI or stroke, the information was obtained from proxy informants, predominantly spouses.	The recession of the early 1990s ended in March of 1991. Great Recession in 2009 and 2010. Annual country unemployment rates from 1992 to 2010 used to measure fluctuations in economic conditions at a local level and capture both opportunities for reemployment (for unemployed workers) and levels of commercial activity and demand for work hours (for employed workers).	Boom vs. during recession	Place of birth, sex, ethnicity, parental educational level, own educational level, year fixed effects, marital status, household wealth, household income, individual earnings, hours worked, weeks worked, state of residence, inflation differences in household size, health insurance coverage, year of first interview, BMI,smokin g, number of alcoholic drinks consumed per day, depression	There were observed associations between labor market conditions and stroke risk for individuals who experienced job loss compared with those who did not experience job loss. Recessionary labor demand conditions were associated with an increased risk of stroke among individuals who experienced job loss (HR=2.02, 95%CI: 0.68-5.98). In contrast, among individuals who did not experience job loss, recessionary labor market conditions were associated with lower risk of stroke (HR=0.61, 95%CI: 0.33-1.14).

									set a common age range over which treated individuals and controls were observed.				symptoms, self-rated health, self-rated memory, cancer-diabetes diagnosis, high blood pressure, heart problems.	
Sosa Lipran di (2012)	Ecolog ical study	NR	NR	1995-2005	Argentine	NR	NR	NR	The population estimates used as the denominator were obtained from the 'National Institute of Statistics and Censuses'.	CVMR was calculated using 9th and 10th ICD. The following causes of death were considered: heart failure (HF), acute myocardial infarction (AMI), chronic coronary artery disease (CAD) and stroke (CVA).	Two economic crises were identified: The Southeast Asia crisis (1998-1999) and the end of the convertibility system (2001-2002).	Before and after economic crises	NR	Mortality rates due to stroke decreased by 38.06% between 1995 and 2005.
Wada (2016)	Ecolog ical study	1980: n=24,250, 948, 1985: n=25,896, 538, 1990: n=25,961, 345, 1995: n=26,059, 598, 2000: n= 25,935,75 5, 2005: n=25,621, 203, 2010: n= 24,077, 226	NR	1980-2010	Japan	100	NR	30-59	Individual cause of death data obtained from the 'Occupation-specific Vital Statistics' provided by the Japanese MHLW. Data on population size by occupation also obtained from the 'National population census', which is implemented at 5-year intervals on 1 October, to calculate occupation-specific death rates. Data for males aged 30–59 years were extracted. Individuals aged 20–29 years, including university and other higher education students were excluded, because of the large number of students included in this age band. Those aged 60 years and over, which was the typical retirement age in Japan during the study period were also excluded.	Cause of death data were based on information recorded in official death certificates, including the underlying cause of death, completed by physicians based on the sequence of morbid events leading to death, and coded according to the ICD-9 (1980–1990) and ICD-10 (1995–2010). IHD and cerebrovascular disease were among causes of death.	The Japanese economy again faced serious economic stagnation after the 2008 global financial crisis. The gross domestic product (GDP) growth rate was negative in 2009, and the unemployment rate peaked at 5% in 2009/10, a rate that the Japanese economy has not seen since the period after the Second World War. The three decades are studied up to 2010, a period during which Japan faced its worst stagnation since the Second World War.	Before and after 2000	Age	After 2000, the mortality rate ratio significantly increased for cerebrovascular disease by 2.12 (95%CI: 1.38-3.26)). Management showed a significant impact on mortality after 2000 in cerebrovascular disease (RR=1.83 (95%CI: 1.25-2.69)). The mortality rates for cerebrovascular disease among Japanese men aged 30–59 years appeared stagnant among those in management and production, in contrast to other occupations where mortality decreased.

Appendix 4. Characteristics of eligible studies about hypertensive diseases.

First author (Year)	Design	Cohort size	Cases in cohort	Study period	Region	Males (%)	Mean age	Age range	Cohort characteristics	Definition/features of CVDs	Definition and ascertainment of economic crisis	Categorization (comparison) of economic crisis	Adjusting factors	Main findings regarding Hypertensive Diseases
Oil crisis or oil shock (1970s)														
Guberan (1979)	Ecological study	NR	NR	1951-1976	Switzerland	NR	NR	22-85+ years	There were seven age groups for both sexes: 23-34, 35-44, 45-54, 55-64, 65-74, 75-84, 85+ years	The numbers of deaths by sex and five-year age groups are published each year by the Federal Bureau of Statistics (1955-77) and since 1951 according to the A-list of the ICD. The 3 subcategories of the 6th and 7th revisions of ICD combined as "non-rheumatic heart disease and hypertension": arteriosclerotic and degenerative heart diseases (A81); other diseases of the heart (A82); hypertension with heart disease (A83); and hypertension without mention of heart (A84) as the subcategories of 8th rev. of ICD: ischaemic heart disease (A83); other forms of heart disease (A84); hypertensive disease (A82)	Economic recession in 1975	Before, during and after the economic crisis.	Age	For death rates from hypertension a steady decline of 40% occurred in females; this decrease was of 50% to 60% except in the two oldest age groups of 75-84 and >85 years (-38% and -4%). In males, however, the decline was much more moderate (between -6% and -16%) except in the youngest age group of 23-34 years (-40%).

Asian Financial Crisis (1997-1999)														
Khang (2005)	Ecological study	Mid-year population in South Korea	NR	1990-2002	South Korea	NR	NR	Four age groups: 1–14, 15–34, 35–64, and 65–79	Individuals categorized into four age groups: 1–14, 15–34, 35–64, and 65–79 in both sexes	Mortality due to hypertensive disease, IHD, cardiomyopathy and cerebrovascular disease	After enjoying uninterrupted economic growth for decades, South Korea underwent a steep economic decline in the late 1990s.	Before and after the economic crisis.	Age	It was observed a decrease in the mortality rates between 1996-2002 among both sexes aged 35-64 in hypertensive disease cause of death [RR 1998/1996=0.59, RR 2002/1996=0.35 for males, RR 1998/1996=0.33, RR 1996/2002=0.39 for females] and among males aged 65-79 [RR 1998/1996=0.57 and RR 1996/2002=0.43]
Kim (2003)	Cohort survey	66,357	NR	1995, 1998	Korea	48.4 (1995), 48.9 (1998)	NR	All ages	Data obtained from the survey of 1995 (22,675 people from 6791 households) and from the survey of 1998 (43,682 people from 12,283 households).	CVD, hypertension	On 3 December 1997, the Republic of Korea was obliged to receive financial support from the International Monetary Fund (IMF) because of a foreign currency crisis. This event marked a national economic crisis in the Republic of Korea. After 1995, the economy grew rather sluggishly until the first three quarters of 1997, and this growth rate continued to decline until the fourth quarter of 1998. In 1999 the economy began to show definite signs of a recovery.	Before (1995) and after (1998) the economic crisis	Sex, age, self-evaluated economic status, health insurance type, and maturation effect (potential bias resulting from the phenomenon that the rate of morbidity and utilization increases over time)	The morbidity rates for hypertension had increased significantly after controlling for the maturation effect. The rate for hypertension was found to have significantly decreased by 3.4% after the maturation effect. Hypertension morbidity was 606 (1.16) before the crisis and 1952 (4.47) after the crisis p<0.01.

Great Recession (2008)														
Angrisani (2016)	Ecological study	14	44,074	2004-2010	United States	42.06% for biomarkers analytic sample	~67years	>50 years and <90 years	Longitudinal data obtained from the 'Health and Retirement Study' (HRS). Sample was representative of the U.S. population over the age of 50. The HRS surveys respondents every 2 years on a variety of economic, health, and social outcomes, including employment, income, housing and financial wealth, physical and mental health, and health-insurance status. About 55% of individuals in the selected sample report having been diagnosed with hypertension. Across two consecutive waves, 5.7% were newly diagnosed with hypertension and 7.1% were either newly diagnosed or reported a worsening of their condition. Average age in the sample was about 67 years. Average household size was roughly two and does not change significantly across subsequent waves. The majority of HRS respondents (69%) were in a couple and changes in marital status were relatively rare as only 3.6% moved from being in a couple to being single and less than 1% from being single to being in a couple. The average number of annual doctor visits was about 10.	Self-reported and biomarker measures of hypertension, an important contributor to acute events such as heart attacks and strokes. Individuals are first asked whether a physician ever diagnosed them with hypertension. Individuals who report having been diagnosed in the previous wave state whether their chronic condition has gotten 'better,' 'worse,' or 'stayed the same' since the previous interview. Information on whether diagnosed respondents are taking medication for their condition is also available. For hypertension, compliance with medication is crucial to inhibit disease progression.	Great Recession of 2008-2009 which, according to the NBER's Business Cycle Dating Committee, began in December 2007 and ended in June 2009. The unemployment rate rose to 10% in 2009, double that of 2007. From 2008 to 2010, nearly eight million properties went into foreclosure and house prices decreased by 30% nationwide. Between November 2008 and March 2009, the stock market lost about one-third its value and most U.S. pension funds saw the value of their assets plummet.	The 2004, 2006, 2008, and 2010 waves of the HRS was used to cover the time before, during, and after the Great Recession.	Age, change in household size, change in marital status, and indicators for interview season, year, state of residence, indicators for income and wealth quartiles before the recession and change in the number of doctor visits.	It was mentioned that the likelihood of developing hypertension is negatively related to changes in house prices. A 10% decrease in state-level house prices increases the probability of a new hypertension diagnosis by 0.2% (significant at 5%) with males being the more affected. Among Americans over the age of 50, the likelihood of being newly diagnosed with hypertension increases as local housing market conditions deteriorate.

Birgisdóttir (2017)	Ecological study	9,807	NR	2007 2009, 2012	Iceland	NR	Males 55.08 (2007) 60.08 (2012) Females 52.06 (2007) 57.06 (2012)	18-79	A stratified random sample of 9,807 individuals 18-79 years old was drawn. In 2007, 9,711 individuals received questionnaires with a response rate of 60.9% (5,909 returned questionnaires). The 2009-sample included 5,294 of the original individuals who had agreed to be contacted again. For the 2009 survey the response rate was 69.3% (4,092 individuals). In 2012 the sample of original participants who had agreed to be contacted for follow-up studies consisted of 3,659 individuals. The response rate was 88.5% (3,238 individuals), corresponding to 33.0% of the original sample. Additionally, in 2012 a sample of 3,506 new subjects was added.	Hypertension (main outcome variable); coronary thrombosis; coronary disease; stroke; and CVD, and a binary variable indicating whether participants had CVD i.e., coronary thrombosis, coronary disease, or stroke.	The Icelandic economic collapse that can be pinpointed almost to a specific date; October 6th, 2008 when Iceland's Prime Minister announced the risk of national bankruptcy. Subsequently, the Icelandic economy contracted by 6.6% in 2009 and 4.1% in 2010 and was among the hardest hit in the world. Exposure to certain economic conditions is measured with time indicators.	2007, 2009, 2012 with data from periods of economic boom, bust, and recovery.	Age, age squared, number of children, marital status, residence, education, prescription medication, and short-term crisis coefficient (t2009).	It was observed an increased probability of having hypertension during the economic recovery by 7.39 percentage points compared to pre-crisis for females, but a decrease of 4.69 percentage points for males. In addition, changes in unemployment explain 10.55% of the recovery effect on hypertension in females.
Eiríksdóttir (2015)	Population based cohort study	35,211	NR	2004–2012	Iceland	NR	29.23	NR	Data on pregnancy-induced hypertensive disorders were obtained from the 'Icelandic Medical Birth Register' and use of antihypertensive drugs during pregnancy, including β-blockers and calcium channel blockers, from the 'Icelandic Medicines Register'.	Pregnancy-induced hypertension disorders. Gestational hypertension [ICD-10 code O13] is defined as newly diagnosed hypertension (systolic blood pressure [SBP] ≥140 mmHg; diastolic blood pressure [DBP] ≥90 mmHg) after 20 weeks of gestation. Preeclampsia is defined as pre-existing or gestational hypertension concurring with significant proteinuria (>300 mg protein in 24-hour urine sample). Women were classified as having preeclampsia if they had been diagnosed with pre-existing	Major national economic recession in Iceland, which started abruptly in October 2008. The beginning of the 4th quarter 2008 (28th of September) was used as a marker of the economic collapse.	Pre- and after the collapse period. Pre-collapse period was used as reference.	Demographic and pregnancy characteristics (maternal age, gravidity, time in weeks, sex, diabetes, pre-existing hypertension, relationship status, place of residence, employment status, citizenship, aggregate unemployment rate)	It was suggested a transient increased risk of gestational hypertension among pregnant women in Iceland in the first and most severe year of the national economic recession. More specifically, compared with the pre-collapse period, it was observed an increased prevalence of gestational hypertension in the first year following the economic collapse (2.4% vs. 3.9%; 95%CI: 1.13–1.91) but not in the subsequent years. No changes were observed for preeclampsia between the pre- and post-collapse periods. The overall prevalence of pregnancy-induced hypertensive disorders remained stable during the period 2007-2012.

Author (year)	Study type							Age	Population	Outcome	Recession measure	Time period	Confounders	Results
										hypertensive disorder with superimposed preeclampsia [ICD-10 code O11], preeclampsia [ICD-10 code O14], or eclampsia [ICD-10 code O15].				
Niedzwiedz (2019)	Ecological study	23,078	22,433 patients	2008-2016	16 European countries (Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Hungary, Ireland, Netherlands, Norway, Poland, Portugal, Spain, Sweden and the United Kingdom).	NR	NR	15-64 years	People aged 15–64 years (N = 23,078). Individuals were categorised into those who were workless versus those who were not. Students were included in the workless group.	Self-reported heart or circulation problems, high blood pressure. Participants were coded yes if they reported having the condition over the past 12 months and no if they did not. Poor self-rated health was defined as those reporting their health as bad or very bad, as opposed to very good, good or fair.	Great Recession. The economic downturn which started in late 2007 is popularly referred to as the 'Great Recession' as it has been longer, wider and deeper than any previous economic downturns including the 'Great Depression' of the 1930s. It was characterized by unemployment rates of around 8.5% in the UK and the USA, 10% in France and more than 20% in Spain. National economic wealth (i.e. Gross Domestic Product) has long been considered as a major global determinant of population health. Unemployment rates alone only capture one aspect of recession and local labour market conditions, whereas employment rates also take into account potential increases in those out of work due to sickness, disability and caring responsibilities.	During 2008 represents a time period near the beginning of the Great Recession. During 2013 represents the time at the end of the Great Recession during a period of austerity in some European countries. Between 2008 and 2013.	Individual level confounding factors: age (years), gender, education level (tertiary versus non-tertiary) and marital status (married/cohabiting versus not married/cohabiting).	High blood pressure was highest in Germany (16.4%) and lowest in Ireland (6.0%). Between the 2008 employment rate and high blood pressure, the PRR(95% CI) was 0.979 (0.965, 0.994), p<0.01, and between the average employment rate (2008-2013) PRR was 0.982 (0.966, 0.998), p<0.05. Between differences in employment rates (2008-2013) and high blood pressure problems the PRR(95% CI) was 1.046 (1.0, 1.095), p <0.01 which was non-statistically significant.
Nolasco (2018)	Ecological study	NR	2,255,761 total deaths in 2002–2007 and 2,323,380 in 2008–2013.	2002-2013	Spain	NR	NR	0-74 years	Residents in Spain aged 0-74 years. Data obtained from the Spanish National Statistics Institute.	Analysis of amenable mortality. All deaths were considered and grouped into groups: ischaemic heart disease (I20-I25), cerebrovascular disease (I60-I69), hypertensive disease (I10-I13, I15) [coded by ICD-10].	2008 Recession. As a measure of the socioeconomic impact of the crisis, four indices have been considered for each province, based on the percentage evolution of fifteen indicators between 2006 and 2013: Economic Vulnerability Index (evolution of the economic activity and employment, according five indicators: GDP per capita, number of companies, employed population, unemployed population, and foreign trade), Social Vulnerability Index (socio-	Before 2002–2007 and after 2008–2013 the economic Recession.	Age	There was a countercyclical effect, especially in men. Specifically, different results were obtained for two sexes. Hypertensive disease as a cause of death increased among men (-2.26% percentage decrease) but decreased significantly among women (16.75%).

Author (year)	Study design	n		Study period	Country			Age	Population	Outcome measure	Economic crisis context	Comparison	Adjustments	Findings
											demographic changes, according five indicators: population and immigration, residential mobility, recipients of unemployment benefits, young people emancipation, and social mobilization), Real-Estate Vulnerability Index (evolution of the real estate market, based on another five indicators: number and value of mortgages, empty completed dwelling, real-estate dwelling transactions, average price of empty dwelling, and mortgage foreclosures), and composite Index of Total Vulnerability (ITV), consisting of an average of the previous three indices, based on a standardised construction process.			
Olfson (2018)	Cohort study	79,402	NR	2001-2002 & 2012-2013	United States	NR	NR	≥18 years	Both NESARC surveys oversampled young adults, African Americans, and Hispanics. All people aged ≥18 years. Study participants (n=79,402) included 43,093 in the 2001–2002 cohort and 36,309 in the 2012–2013 cohort. Demographic measures included self-reported age (18–44, 25–44, 45–54, and ≥55 years) sex, race/ethnicity (white, non-Hispanic; black, non-Hispanic; Hispanic; others), and education (high school or less, some college, college graduate).	Cardiac disease included being told by a health-care professional in the past year that the respondent had chest pain or angina, a rapid heartbeat or tachycardia, a heart attack or a myocardial infarction, or any other heart disease. Hypertension was defined with analogous items.	Economic crisis of 2008-2009. Associations are evaluated between changes in common medical, substance abuse, mental health, social, and economic risk factors and trends in SF-6D scores.	Data were analyzed from nationally representative surveys performed in 2001–2002 and 2012–2013, a period spanning the economic crisis of 2008–2009.	Age, sex, race/ethnicity, education	Changes in hypertension were associated with the largest shares of the decrease in SF-6D scores 18.5% (2001-2002) vs.24.8% (2012-2013), p<0.0001. Change in period effect: Unadjusted, %(95%CI) 16.2 (16.1-16.3), adjusted 10.0 (9.9-10.1). According to the NHANES, however, the prevalence of measured hypertension remained hardly changed between 1999-2000 (30.1%) and 2011-2012 (30.8%).
Panagiotakos (2013)	Cohort study	10,141	NR	2006-2012	Greece	47%	39±15 year	18-95	A large-scale, nationwide health survey in Greek population, aged 18-95, between 2006-2012.	A structured, semi-quantitative questionnaire was used to retrieve information about CVD risk. Self-reported medical history of hypertension, CVD and family history of CVD were recorded.The Framingham heart score for the10-year risk of fatal CVD events was calculated	2009 and 2010 were the years where the Greek financial crisis dominates.	Before and after the economic crisis.	Age, sex	No significant change was observed in the prevalence of hypertension (95%CI:−4.1% to 2.1%, p=0.52) after the Greek economic crisis.

| Patel (2019) | Ecological study | 10,500 | NR | 2007-2016 | United States | 49 % | 45 years (NHANES 2007-2010), 46 y (NHANES 2011-2012), 46 y (NHANES 2013-2014), 47y (NHANES 2015-2016) | >20 years | Participants prior to 2007-2008 (pre-recession period) were not included in the study because of significant changes in the measurement and coding of physical activity in NHANES from 2007-2008 onward. Age and sex were self-reported. Self-reported race and ethnicity was categorized into 4 levels: non-Hispanic whites, non-Hispanic blacks, Mexican American, and others. Health insurance status and the total number of health care visits in the past 1 year were also self-reported. The mean age of study participants was 45 years, 51% were females, and ~67% were non-Hispanic whites from 2007-2010 through 2015-2016. The proportion of participants in the different strata of socioeconomic status (a combination of education and income status) remained similar during the study period. There was a modest increase (~6%) in the proportion of individuals with insurance from 2007-2010 to 2015-2016. | classifying the participants as high (N10%) or low-moderate risk (<10%). The CV health metrics were identified using the AHA's Life's Simple 7 behavioral and health factors which are grouped into the ideal health behaviors (i.e., smoking status, BMI, physical activity, and healthy diet score) and ideal health factors (i.e., total cholesterol, blood pressure and fasting plasma glucose). Each CV health metric was categorized into the 'ideal', 'intermediate', and 'poor' categories and given a point score of 2, 1, and 0, respectively. | From the mid-2000s to 2010, there was a significant economic decline with a concomitant deterioration in population-level health. This period was characterized by a staggering rise in unemployment and financial losses and has, therefore, been widely accepted as a period of economic recession (Great Recession). | Between economic recession (2007-2010) and economic recovery (2011-2016). Data sets from 2007 to 2010 NHANES surveys were merged into 1 period to classify these survey years as a period of economic recession; and 2) the data from the NHANES survey years 2011 to 2016 were treated as separate data sets to assess trends in the post-recession or economic recovery period. The poverty income ratio and years of education were used to categorize socioeconomic status. | Age, sex, race, insurance status, and number of health care visits. | In the low socioeconomic stratum, the prevalence of participants with an ideal blood pressure (<120/80 mm Hg) decreased significantly from 50% (95%CI: 44%-56%) in 2007-2010 to 38% (95%CI: 29%-47%) in the period 2015-2016 (Plinear=0.02). |
| Shin (2015) | Ecological study | 41,804 | 2,595 (hypertensive in 2007), 6,440 (hypertensive in 2009) | 2007-2012 | Korea | NR | NR | >30 years | Subjects over 30 years of age who had corrected hypertension data and who had participated in the surveys during KNHANES IV and V (2007–2012). | Hypertension was chosen as an objective health indicator. | 2008 global economic crisis | Before and after the 2008 global economic crisis by 2-year analyses of 2007–2009, 2009–2011, and 2010–2012 | Age, gender, body mass index (BMI), cigarette smoking, drinking, exercise, education, household income, working status, stress | It observed an increase in hypertension prevalence after the 2008 global economic crisis. Specifically, it was demonstrated a significant increase in 2009 compared with 2007 with statistically significant differences regarding stress (P-value of logistic and probit analyses were 0.057 and 0.047, respectively). Factors related to higher hypertension prevalence included older age, male gender, higher BMI, no current tobacco use, recent drinking, lower education levels, and higher stress perception. |

														GDP growth rates, were inversely associated with hypertension prevalence with a 1-year lag and inversely associated with stress perception without lag.
Voulgari (2019)	Retrospective cohort study	1000	NR	1995-2018	Greece	48.5 (after crisis) 46.6 (before crisis)	75.2 (after crisis), 77.9 (before crisis)	NR	Patients admitted after the economic crisis outbreak (429 patients, 221 women/208 men, 75.2±9.5years) compared to those hospitalized before the financial crisis (571 patients, 305 women/ 266men, 77.9±8.9years) were found to be younger (p<0.001), more frequent, and heavier tobacco smokers (p=0.002), as well as casual alcohol users (p=0.04).	Atrial fibrillation, arrhythmias, stroke, hypertension	Economic crisis in 2008. 2008 was used as the transitional year	Before and after the economic crisis.	NR	After the economic crisis there were no differences regarding prevalence of hypertension. Death was significantly associated with hypertension (beta=0.355, p=0.001) compared to patients hospitalized in pre-crisis period.

Appendix 5. Characteristics of eligible studies about heart failure.

First author (Year)	Design	Cohort size	Cases in cohort	Study period	Region	Males (%)	Mean age	Age range	Cohort characteristics	Definition/features of CVDs	Definition and ascertainment of economic crisis	Categorization (comparison) of economic crisis	Adjusting factors	Main findings regarding heart failure
Argentine Great Depression (1998-2002)														
Gurfinkel (2005)	Cohort study	3,220	2,246 (in crisis period)	1999-2004	Argentine	70	66.1 (crisis), 65 (after crisis)	NR	Study sample contains patients enrolled in centers in Argentine between April 1999 and September of 2004. 3,220 patients were enrolled in Argentina. The number of patients younger than 65 years old was 1,527 (47%), representing the proportion of the population normally expected to be economically active. The remainder 1,693 (53%) were older than 65. A final diagnosis of STEMI was made in 1,179, and 2,041 qualified as unstable angina / non-STEMI.	Individuals who had an admission diagnosis of acute coronary syndrome (STEMI and non-STEMI or unstable angina). Non-fatal MI defined by the presence of at least one positive increment of cardiac biochemical marker of necrosis (in case of those in whom MI was the index diagnosis) plus chest pain prolonged more than 10 minutes, or new ST-segment deviation seen after the index or qualifying electrocardiogram.	The country paid a high toll for this change, with the GDP experiencing a sustained decline from 1998, and unemployment rates reaching approximately 25 percent. By the end of 2001 a rapid cascade of political and economic events opened the road to deep social turmoil and economic unrest that spiraled until December 2001, when the country experienced a virtual halt of vital areas of the economy. The beginning of the negative slope of the gross domestic product curve was considered as the start of the crisis period, which lasted until the domestic product experienced a sustained increase over a full trimester.	The period of time examined was divided into the crisis period, which was delimited from April 1999 to December 2002, and the post crisis period, which encompassed the time from January 2003 to September 2004.	NR	It was observed a higher incidence higher incidence of sustained in-hospital complications of congestive heart failure (16% Vs. 11%, p-value<0.01) in the crisis period.

Great Recession (2008)														
Varda kas (2019)	Ecolog ical study	NR	NR	2000-2015	Greece	Mean male popula tion during the crisis (31,28 4/year) before crisis (15,75 5.9/yea r)	NR	0-85 or older	Individuals in age groups (0–19, 20–39, 40–55, 56–69,and 70 or older), from geographic regions (North and South Greece) for the period 2000–2015. Additional data (1955–1999) were incorporated to evaluate if changes in mortality occurred long before the study period. To calculate mortality rates, the population was divided into 18 age subgroups, i.e. 0–4 years, 5–9 years etc., till 80–84 years and ≥85 years.	All death causes were categorized into 16 groups based on the relevant list provided by the ELSTAT and were among others: heart diseases, cerebrovascular disease	In 2007 Greece experienced its ninth year of recession (2009–2017). Although the financial crisis appeared in late 2008, its effects in the Greek population became evident in 2010, when cuts in salaries and public investments were imposed and unemployment rose above 10%. The years 2010–2015 were selected as the financial crisis period. The indicator used as a measurement of recession (GDP, unemployment, GDP per capita), the duration or the type of the recession (normal fluctuation or severe crisis), the pre-existing levels of vulnerability (public infrastructure, social safety nets, access to effective healthcare, and education), the quality of responses to a crisis (cuts in public spending and health expenditures), and the population(s) under study (developed or developing countries, individual or aggregate relationships).	Prior to (2000-2009) and during (2010-2015) the financial crisis. Reference year: 2001	Age	Mortality changes in Greece prior to and during the financial crisis and found that mortality due to heart failure showed an increase during the crisis.
Multiple economic crises														
Sosa Lipran di (2012)	Ecolog ical study	NR	NR	1995-2005	Argentine	NR	NR	NR	The population estimates used as the denominator were obtained from the 'National Institute of Statistics and Censuses'.	CVMR was calculated using 9th and 10th ICD. The following causes of death were considered: heart failure (HF), acute myocardial infarction (AMI), chronic coronary artery disease (CAD) and stroke (CVA).	Two economic crises were identified: the Southeast Asia crisis (1998-1999) and the end of the convertibility system (2001-2002).	Before and after the economic crises.	NR	Mortality rates due to HF decreased by 22.95% from 1995 to 2005.

Appendix 6. Evaluation of the eligible studies with Newcastle-Ottawa scale and AHRQ standards.

Study	SELECTION					COMPARABILITY			OUTCOME				Quality
	Representativeness	Selection of non-exposed	Ascertainment of exposure	Outcome not present at start	Total	Comparability on age	Comparability on other risk factors	Total	Assessment of outcome	Long enough follow-up (median ≥1 year)	Adequacy (completeness) of follow-up (≥85% response rate)	Total	
Angrisani (2016)	*		*		2	*	*	2	*	*		2	Fair
Bartoll (2019)	*		*		2	*		1	*	*		2	Fair
Bilal (2014)	*		*		2	*		1	*	*		2	Fair
Birgisdóttir (2017)	*		*		2	*	*	2	*	*		2	Fair
Bunn (1979)	*		*		2	*		1	*	*		2	Fair
Dapontas (2019)	*		*		2			0	*	*		2	Poor
Eiríksdóttir (2015)	*		*		2	*	*	2	*	*		2	Fair
Falconi (2016)	*		*		2		*	1	*	*		2	Fair
Fiuzat (2010)	*	*	*	*	4		*	1	*	*	*	3	Good
Franco (2013)	*				1	*		1	*	*		2	Poor
Garcia (2015)					0			0	*	*		2	Poor
Guberan (1979)	*		*		2	*		1	*	*		2	Fair

Study													
Guojónsdóttir (2011)			*		1		*	1	*			1	Poor
Gurfinkel (2005)			*		1			0	*	*		2	Poor
Katsanos (2016)					0			0	*	*		2	Poor
Kaviratne (2012)			*		1			0	*	*		2	Poor
Khang (2005)	*		*		2	*		1	*	*		2	Fair
Kim (2003)	*		*		2	*	*	2			*	1	Poor
Kim (2004)	*		*		2			0	*	*		2	Poor
Lammintausta (2012)	*		*		2	*		1	*	*		2	Fair
Li (2014)		*	*		2		*	1	*	*		2	Fair
Makaris (2013)			*		1	*		1	*	*		2	Poor
Men (2003)	*				1	*		1	*	*		2	Poor
Niedzwiedz (2019)	*		*		2	*	*	2			*	1	Poor
Noelke (2015)	*		*	*	3		*	1			*	1	Poor
Nolasco (2018)	*		*		2	*		1	*	*		2	Fair

Study													
Olfson (2018)	*				**1**	*	*	**2**		*		**1**	Poor
Osman (2017)	*		*		**2**		*	**1**	*	*		**2**	Fair
Panagiotakos (2013)		*			**1**	*	*	**2**		*		**1**	Poor
Patel (2019)	*				**1**	*	*	**2**	*	*		**2**	Poor
Regidor (2019), PMID: 31095411	*		*		**2**	*		**1**	*	*		**2**	Fair
Samentzas (2014)					**0**			**0**	*	*		**2**	Poor
Sanidas (2018)					**0**			**0**	*	*		**2**	Poor
Savu (2016)	*		*		**2**	*	*	**2**	*	*		**2**	Fair
Schwartz (2012)	*		*		**2**			**0**	*	*		**2**	Poor
Shin (2015)	*		*		**2**	*	*	**2**	*	*		**2**	Fair
Sosa Liprandi (2012)	*		*		**2**			**0**	*	*		**2**	Poor
Tapia Granados (2017)	*		*		**2**	*	*	**2**	*	*		**2**	Fair
Valkonen (2000)	*		*		**2**	*		**1**	*	*		**2**	Fair

Study												
Vardakas (2019)	*		*		2	*		1	*	*		2	Fair
Verso (2014)	*		*		2			0	*	*		2	Poor
Voulgari (2019)					0			0	*	*		2	Poor
Wada (2016)	*		*		2	*		1	*	*		2	Fair
Zapata-Moya (2015)	*		*		2	*	*	2	*	*		2	Fair

Appendix 7. Studies excluded with their reason for exclusion.

Study	Title	Reason for exclusion
No reference to specific economic crisis		
Albert (2017)	Cumulative psychological stress and cardiovascular disease risk in middle aged and older women: Rationale, design, and baseline characteristics.	This study concerns how cumulative stressors vary by socioeconomic status, how they affect health behavior, how they affect psychological status and social ties and how these factors affect CVD outcomes without reference to specific economic crisis.
Brenner (1982)	Economic change and sex-specific cardiovascular mortality in Britain.	In this study, a multivariate model of the impact of more fundamental changes in the socioeconomic and bio-physical environments has been developed and applied to cardiovascular disease mortality rates, by sex, in England and Wales and Scotland during 1955-1976, without reference to specific economic crisis.
Carvalho (2020)	Mortalidade por Doenças Cardiovasculares Segundo o Sistema de Informação sobre Mortalidade e as Estimativas do Estudo Carga Global de Doenças no Brasil, 2000-2017.	This article aims to compare historical series of CVD mortality based on data in the 2000-2017 period without reference to specific economic crisis or recession.
Dadgar (2020)	Is there a link between cardiovascular mortality and economic fluctuations?	The main aim of this study was to estimate the association between the unemployment rate and mortality from CVD and from coronary heart disease (CHD) without reference to specific economic crisis.
Economou (2008)	Are recessions harmful to health after all? Evidence from the European Union.	The purpose of this paper is to investigate the effects of national unemployment rates on overall age and cause-specific mortality rates in a sample of 13 European Union countries without reference to specific economic crisis.
Fernandes (2020)	A 10-Year Trend Analysis of Heart Failure in the Less Developed Brasil.	This study determines the HF morbidity and mortality in Paraiba and Brazil and its 10-year trends without reference to a specific economic crisis.
Ferrie (2003)	Future uncertainty and socioeconomic inequalities in health: the Whitehall II study.	This study concerns socioeconomic gradients in morbidity and cardiovascular risk factors and examines the contribution of job and financial insecurity with health measures but there is no specific reference to economic crisis or recession.
Gupta (2012)	Regional variations in cardiovascular risk factors in India: India Heart Watch.	This article examines cardiovascular risk factors without reference to a specific economic crisis period.
Hagström (2017)	Psychosocial stress and major cardiovascular events in patients with stable coronary heart disease.	This study concerns psychosocial stress coming from bad economic conditions without reference to a specific economic crisis.

Handberg (2013)	Clinical implications of the women's ischemia syndrome evaluation: interrelationships between symptoms, psychosocial factors and cardiovascular outcomes.	This review focuses on symptom presentation for chest pain, and its relationship to CVD morbidity and mortality, quality of life, healthcare costs, and psychosocial predictor variables without reference to specific economic crisis.
Iversen (2012)	Psychosocial risk factors, weight changes and risk of obesity: the Copenhagen City Heart Study.	This study refers to economic hardship but there is not a specific reference to economic crisis and examines the psychosocial factors such as vital exhaustion, social network, economic hardship, and daily use of sleep medication.
Kopp (2007)	Chronic Stress and Social Changes Socioeconomic Determination of Chronic Stress.	This article refers to economic changes between 1960-2005 in the introduction and includes as an example the results of the "Hungarostudy 2002 survey" which conducted in the years 2002-2006 without data in the period of a specific economic crisis.
Lampropoulos (2016)	Association between anxiety and depression in patients with acute coronary syndromes due to financial crisis	This study investigates the relation between anxiety and depression in patients presenting with ACS due to financial crisis and whether these two entities could predict long-term cardiovascular mortality, without reference to specific economic crisis.
Lauer (2012)	Advancing Cardiovascular Research.	This study refers to economic turmoil in a general way without reference to specific economic crisis or recession.
Mackenbach (2013)	Changing patterns of mortality in 25 European countries and their economic and political correlates, 1955–1989.	This article refers to economic and political changes in mortality following World War II without reference to specific economic crisis.
Mackenbach (2016)	Changes in mortality inequalities over two decades: register based study of European countries.	This study compares changes in mortality between the lowest and highest socioeconomic groups but there is no reference to specific economic crisis.
Moczulska (2015)	Analysis of socioeconomic factors and their influence on the incidence of complications in patients with acute coronary syndrome in Warmia and Mazury province.	This study assesses the effect of certain socioeconomic factors on the incidence of cardiovascular complications of ACS during hospitalization and 3-month follow-up without reference to specific economic crisis.
Mokdad (2014)	The state of health in the Arab world, 1990–2010: an analysis of the burden of diseases, injuries, and risk factors.	There is not any association with crisis/recession conditions.
Moran (2019)	Financial stress and Risk of Coronary Heart Disease in the Jackson Heart Study.	This study examines whether stress because of financial hardship is associated with incident coronary heart disease in African Americans, without reference to specific economic crisis.
Morris (2019)	Who benefits from social investment? The gendered effects of family and employment policies on cardiovascular disease in Europe.	This research refers to social investment policies on health and government expenditures without reference to specific economic crisis.

Murray (1997)	Alternative projections of mortality and disability by cause 1990–2020: Global Burden of Disease Study.	This study refers to the rates and patterns of ill health which are determined by factors such as socioeconomic, development, educational attainment, technological developments, and their dispersion among populations, as well as exposure to hazards, without reference to specific economic crisis.
Ólafsdóttir (2016)	The tax-free year in Iceland: a natural experiment to explore the impact of a short-term increase in labor supply on the risk of heart attacks.	This study merges and analyzes individual-level, registry-based data on earnings and AMIs including all Icelandic men and women during the period 1982–1992 without reference to specific economic crisis/recession.
Ortega (2020)	Cardiovascular disease behavioral risk factors among Latinos by citizenship and documentation status.	This article examines CVD behavioral risk factors by citizenship / documentation statuses, among Latinos and non-Latino in the 2011–2015, without reference to a specific economic crisis period.
Parekh (2020)	Impact of social determinants of health on cardiovascular diseases.	This article addresses the socio-economic factors (food, housing, financial instability, and healthcare access) that promote the development of risk factors for cardiovascular diseases without reference to specific economic crisis.
Sahle (2020)	Association of psychosocial factors with risk of chronic diseases: a nationwide longitudinal study.	This study refers to financial stress due to economic hardship and focuses on psychosocial factors without reference to specific economic crisis.
Stuckler (2008)	Can a bank crisis break your heart?	This study has the purpose to assess whether a banking system crisis increases short-term population cardiovascular mortality rates, without chronological reference to economic crisis.
Tapia Granados (2008)	Macroeconomic fluctuations and mortality in postwar Japan.	This article refers to co-movements between economic fluctuations and mortality changes in postwar Japan without reference to specific economic crisis/recession.
Troxel (2003)	Chronic stress burden, discrimination, and subclinical carotid artery disease in African American and Caucasian Women.	This study examines the association between a composite index of stress without reference to a specific economic crisis/recession.
Vintro (1985)	Coronary Heart Disease Mortality Trends and Related Factors in Spain	This study investigates CHD mortality trends and related factors in Spain without reference to a specific economic crisis/recession.
Williams (2007)	Psychosocial factors related to cardiovascular disease risk in UK South Asian men: a preliminary study.	This article concerns the exposure to psychosocial factors which were associated with cardiovascular risk without any association with a specific economic crisis/recession period.
Analysis of cardiovascular disease in relation to socioeconomic status (SES) / unemployment, without reference to specific economic crisis		
Agyei (2014)	Relationship between psychosocial stress and hypertension among	This article refers to psychosocial stress as an indicator of financial hardship, which was defined as perceived discrimination, depressive symptoms and

		or financial stress whether participants had problems paying their household bills without reference to specific economic crisis.
Ghanaians in Amsterdam, the Netherlands – the GHAIA study.		
Al Hazzouri (2016)	Sustained economic hardship and cognitive function: the Coronary Artery Risk Development in Young Adults Study.	This study concerns low individual income and worse health outcomes. Sustained poverty was defined by the percentage of time participants' household income but there is not any association with specific economic crisis.
Alicandro (2018)	The main causes of death contributing to absolute and relative socio-economic inequality in Italy.	This study aimed at detecting the causes of death with the largest socio-economic inequality in relative and absolute terms in Italy, without comparisons related to the economic crisis.
Alter (2013)	Socioeconomic status, functional recovery, and long-term mortality among patients surviving acute myocardial infarction.	This study concerns the relationship between SES, functional recovery and long-term mortality following acute myocardial infarction (AMI). There is no specific relation to the economic crisis.
Andersen (2014)	Socioeconomic position and incidence of ischemic stroke in Denmark 2003–2012. A Nationwide Hospital-Based Study.	This study refers to the relations between socioeconomic positions, measured as household income and length of education without reference to specific economic crisis.
Brenner (1971)	Economic changes and heart disease mortality.	The present study investigated the relationship between economic change, measured via employment index for nonagricultural industries, and heart disease mortality in New York State and the United States over the period 1900-1967 without reference to specific economic crisis.
Browning (2012)	Effect of job loss due to plant closure on mortality and hospitalization.	This article examines whether job loss due to plant closure causes an increased risk of (cause-specific) mortality and hospitalization for male workers having strong labour market attachment. There is not any specific reference to the economic crisis period.
Chambers (2019)	Relationship between area mortgage foreclosures, homeownership, and cardiovascular disease risk factors: The Hispanic Community Health Study/Study of Latinos.	This study focuses on the individual level and economic factors related to homeownership status.
Conklin (2013)	Socioeconomic status, financial hardship and measured obesity in older adults: a cross-sectional study of the EPIC-Norfolk cohort	This study concerns the SES and the economic hardship after education, social class and home ownership were considered at an individual level.
Di Girolamo (2019)	Progress in reducing inequalities in cardiovascular disease mortality in Europe.	This study focuses on socioeconomic groups and SES without reference to specific economic crisis.
Eliason (2009)	Job loss is bad for your health – Swedish evidence on cause-specific hospitalization following involuntary job loss.	This paper examines the impact of job loss on a number of non-fatal health events and focuses on job loss due only to establishment closures, without any reference to specific economic crisis.

Folyovich (2016)	Higher incidence of stroke on the last day of the month in Hungary—a role for psychosocial factors and financial insecurity?	This article proposes that financial insecurity on the days prior to the receipt of a salary might play a role in the elevation of stroke incidence observed on the last day of the month in Hungary without relation to the economic crisis period.
Gerdtham (2005)	Business cycles and mortality: results from Swedish microdata	This study estimates the relationship between business cycles, measured via unemployment rate, and mortality without reference to specific economic crisis.
Gomez (2020)	Psychological stress, cardiac symptoms, and cardiovascular risk in women with suspected ischemia but no obstructive coronary disease (INOCA).	This article focuses on financial stress which is evaluated according to socioeconomic status without reference to specific economic crisis.
Hackett (2009)	Psychosocial outcomes in StrokE: the POISE observational stroke study protocol.	This study refers to the psychosocial and economic consequences of stroke survivors in relation to the work environment without reference to specific economic crisis.
Halliday (2014)	Unemployment and mortality: Evidence from the PSID	This study uses micro-data to investigate the relationship between unemployment and mortality in the United States without reference to specific economic crisis.
Karlamangla (2005)	Impact of socioeconomic status on longitudinal accumulation of cardiovascular risk in young adults: the CARDIA Study (USA).	This study describes the trajectories of biological risk factors of cardiovascular disease in young adults and studies the association of SES with aggregate risk scores that summarize longitudinal risk accumulation from multiple risk factors without reference to specific economic crisis.
Maniecka-Bryła (2013)	Determinants of premature mortality in a city population: an eight-year observational study concerning subjects aged 18-64.	There is only a reference in the socioeconomic status which may contribute to premature death and there is not any reference to a specific economic crisis period.
Maruthappu (2015)	Unemployment, government healthcare spending, and cerebrovascular mortality, worldwide 1981-2009: an ecological study.	This study determines the effect of changes in unemployment and government healthcare expenditure on cerebrovascular mortality globally without reference to specific economic crisis.
Nolasco (2014)	Trends in socioeconomic inequalities in amenable mortality in urban areas of Spanish cities, 1996–2007.	This study describes inequalities in amenable mortality in relation to socioeconomic status in small urban areas and analyses their evolution over the course of the periods 1996–99, 2000–2003 and 2004–2007 in three major cities without specific relation to the economic crisis.
Svensson (2007)	Do not go breaking your heart: Do economic upturns really increase heart attack mortality?	This study explores the relationship between business cycles and incidence, mortality and lethality in acute myocardial infarction (AMI) in Sweden, without reference to specific economic crisis.

Stuckler (2009)	The public health effect of economic crises and alternative policy responses in Europe: an empirical analysis.	This study investigates how economic changes have affected mortality rates over the past three decades and identified how governments might reduce adverse effects, without reference to specific economic crisis.
Sweet (2013)	The high price of debt: household financial debt and its impact on mental and physical health.	This study investigates the associations of multiple indices of household financial debt with psychological and general health outcomes without reference to specific economic crisis.
Tapia Granados (2005)	Increasing mortality during the expansions of the US economy, 1900–1996.	This study does not include comparisons in times of economic crises.
Healthcare system expenditures / Functionality / Healthcare costs		
Annapureddy (2018)	Association between financial burden, quality of life, and mental health among those with atherosclerotic cardiovascular disease in the United States.	This study concerns the financial burden due to healthcare expenditures and it is not related to the CVDs incidence or mortality.
Baron-Esquivias (2006)	Cost of diagnosis and treatment of syncope in patients admitted to a cardiology unit.	This study focuses on the in-hospital cost of management of syncope patients.
Baugh (2015)	National cost savings from observation unit management of syncope.	This article refers to national cost savings, reduction in inpatient hospitalization for managing selected patients with syncope.
Beech (1996)	Hospital Services for Stroke Care.	This study represents how stroke, impact on mortality and morbidity and its consumption of healthcare resources and costs.
Blomgren (2016)	Over-indebtedness and chronic disease: a linked register-based study of Finnish men and women during 1995–2010.	This study analyses long-term health consequences of severe over-indebtedness.
Davis (2012)	Tilt testing is more cost-effective than implantable loop recorder monitoring as a means of directing pacing therapy in people with recurrent episodes of suspected vasovagal syncope that affect their quality of life or present a high risk of injury.	This study aims to assess the cost-effectiveness of implantable loop recorders (ILRs) and tilt testing (TT) to direct pacing therapy in people with recurrent episodes of transient loss of consciousness.
Davis (2012)	Implantable loop recorders are cost-effective when used to investigate transient loss of consciousness which is either suspected to be arrhythmic or remains unexplained.	A cost-effectiveness study of implantable loop recorders (ILRs) in people with transient loss of consciousness (TLoC), which, after initial assessment and specialist cardiovascular assessment, is either suspected to be arrhythmic in origin or remains unexplained.
Del Rosso (2000)	Social costs of syncope.	This study refers to the costs for the evaluation and treatment of syncope.

Dominguez-Rodriguez (2013)	An appropriate use criterion is very important to reduce overuse for SPECT in coronary heart disease: economic burden in time of crises.	This article refers to Single-Photon Emission Computed Tomography Myocardial Perfusion Images (SPECT) in the after-crisis period.
Fanourgiakis (2013)	Catastrophic healthcare expenditure during economic recession in the field of cardiovascular disease.	This article refers to the effects of health expenditure on national economies and household finances and to the cost-of-illness.
Gheorghe (2018)	The economic burden of cardiovascular disease and hypertension in low- and middle-income countries: a systematic review.	This article synthesizes the available data on the economic burden of CVD and hypertension in LMICs to households, health systems and society.
Hauser (1985)	The cost of tachyarrhythmia management.	This article refers to health economy measures in the United States in relation to physicians' development of more cost-effective approaches to the management of patients who have tachyarrhythmias.
Izon (2015)	Cost inefficiency under financial strain: a stochastic frontier analysis of hospitals in Washington State through the Great Recession.	This study analyzes cost inefficiency of hospitals between 2005 and 2012, with controls for patient burden of illness, hospital process of care quality, and hospital outcome quality.
Jeon (2009)	Economic hardship associated with managing chronic illness: a qualitative inquiry	This study examines the experiences of people affected by chronic diseases and provides a first level, qualitative understanding of the economic impact of chronic illness
Kenny (2013)	Epidemiology of syncope/collapse in younger and older Western patient populations.	This article refers to adult's syncope as a major cause of morbidity and mortality with enormous personal and wider health economic costs. There is not any association with economic crisis or recession.
Keskimaki (2003)	How did Finland's economic recession in the early 1990s affect socio-economic equity in the use of hospital care?	This study evaluates the changes in socio-economic equity in the use of general hospital care but with no specific references to CVDs.
Kontos (2017)	The effect of financial crisis on the profile of the patients examined at the surgical emergencies of an academic institution in Greece.	This article refers to the crisis impact on the provision of services in public and university hospital units and the reductions in health expenditure followed by lack of appropriate equipment for surgical interventions, resulting in problematic provision of surgical healthcare services and thus deterioration of surgical patients' health.
Krahn (1999)	The high cost of syncope: cost implications of a new insertable loop recorder in the investigation of recurrent syncope.	This study refers to the relative cost-effective profile of the investigative tools used in patients with syncope.
Kyriopoulos (2014)	Barriers in access to healthcare services for chronic patients in times	This study investigates the magnitude of barriers in access to health services for chronic patients and the

	of austerity: an empirical approach in Greece.	socioeconomic and demographic characteristics that affect them.
Le Roux (2010)	Outcome and cost of aneurysmal subarachnoid hemorrhage.	This study examines the cost impact factor of aneurysmal subarachnoid hemorrhage as from a financial perspective as well as from a patient perspective.
Logan (2013)	The burden of chronic diseases in a rural North Florida sample.	This article refers to patients' access to quality health care systems and the burden of disease.
Mattei (2015)	Occupational health physicians and the impact of the Great Recession on the health of workers: a qualitative study.	This article concerns the impact on workers' health of the economic recession in the industrial district of Sassuolo and the psychological and social needs of workers.
Maynou (2016)	Economic crisis and health inequalities: evidence from the European Union.	The main objective in this paper was to show the impact of the economic crisis on convergence. The aim was to observe whether the economic crisis (from 2008 onwards) has in fact had an effect on health inequalities within the EU.
Merry (2012)	More for less: best patient outcomes in a time of financial restraint.	This article refers to the ability to continue providing cardiac surgery in the face of constrained economic times and concerns health care costs and expenditures.
Pearlman (2014)	The economic burden of preventable chronic diseases in Rhode Island.	This report examines the prevalence of arthritis, current asthma, diabetes, and cardiovascular disease, with and without current obesity and current depression, to estimate the public health burden of preventable chronic diseases. It also explores the economic impact of these chronic conditions on Rhode Island's health care system.
Pinilla (2019)	Trends in horizontal inequity in access to public health care services by immigrant condition in Spain (2006–2017).	The objective of this research is to analyze trends in horizontal inequity in access to public health services by immigration condition in Spain throughout the period 2006–2017.
Sacco (2017)	Racial-ethnic disparities in acute stroke care in the Florida-Puerto Rico collaboration to reduce stroke disparities study.	This study examines race ethnic disparities in acute stroke performance metrics in a voluntary stroke registry and focuses on social disparities and health system problems.
Schillinger (2000)	Admission for syncope: evaluation, cost and prognosis.	This study determines the application and cost of diagnostic tests, cost of hospital stay, success of evaluation and prognosis of patients admitted via the emergency department after syncope.
Shin (2013)	Standardized approaches to syncope evaluation for reducing hospital admissions and costs in overcrowded emergency departments.	This study examines the financial impact of syncope on health care which imposes a significant socioeconomic burden.
Simpson (1999)	A cost-effective approach to the investigation of syncope: relative merit of different diagnostic strategies.	This study compares the cost effectiveness of a conventional diagnostic work-up with that of several different diagnostic cascades for the investigation of undifferentiated syncope.

Steinberg (2005)	Syncope in children: diagnostic tests have a high cost and low yield.	This study aims to assess the use, yield, and cost-effectiveness of diagnostic tests used in the evaluation of syncope in children.
Swanson (2015)	Primary care in Cuba: a public health approach.	This article presents an update on Cuba's primary health care delivery system.
Viqar-Syed (2013)	Syncope units: impact on patient care and health-related costs.	This study refers to health-related costs and not to CVDs incidence/mortality in times of economic crisis.
Zilidis (2020)	Use of amenable mortality indicators to evaluate the impact of financial crisis on health system performance in Greece.	This study sought to identify changes in health system performance during a period of austerity in Greece.
Conference/symposium/consensus reports / posters' abstracts / Oral Presentations that did not present relevant original data		
Florou (2017)	The impact of the economic crisis on hypertension in children.	The purpose of the study is to determine the existence of an inverse relationship between childhood obesity, and by extension of childhood hypertension, and the economic crisis plaguing Greek households.
Foskolou (2017)	Financial crisis and health of older Mediterranean adults: the multinational MEDIS study (2005-2015).	This study investigates how the financial crisis has affected the behaviors and the health status of older people living in the Mediterranean islands according to clinical, lifestyle, socio-demographic characteristics, presence or absence of smoking, physical activity, MedDietScore and Geriatric Depression Scale.
Gikas (2017)	Cardiovascular diseases in times of economic crisis: New challenges for medical and community research	This article refers to CVDs in times of economic crises, without reported data in this time-period.
Korantzopoulos (2018)	Contemporary diagnostic yield of implantable loop recorders in patients from Northwestern Greece in the setting of economic crisis.	The aim of this study was to investigate the utility and diagnostic yield of ILRs in an adult population in the setting of the Greek economic crisis.
Wright (2019)	What moderates the scarring effect of youth unemployment on later life mental health?	This presentation focuses on mental health and unemployment rates which followed the global financial crisis but not to CVDs.
No specific report of CVDs or incidence/mortality		
Borowy (2011)	Similar but different: Health and economic crisis in 1990s Cuba and Russia.	This study refers to fundamental social, political and cultural differences in two countries and the respective specificities of the crisis, including different long-term health trajectories and different traditions of health-related agenda setting without specific reference to CVDs.

Bourdon (2015)	The impact of economic recession on the use of treatment technology for peripheral arterial disease.	This study investigates whether economic changes may have affected the treatment of one of the major diseases in Germany, peripheral arterial disease (PAD), using femoropopliteal stent angioplasty.
Cutler (2002)	Financial crisis, health outcomes and ageing: Mexico in the 1980s and 1990s.	This article analyzes the effects of the economic crisis on mortality rates in Mexico, in 1995. It is noted at the outset that mortality is only one measure of health status and not likely to be the most responsive or easily observable indicator of the effect of economic crisis.
Cutler (2019)	Do economic crises harm mental health? Effects of the Great Recession on older Americans.	This study focuses on mental health effects and not on CVDs.
Finch (2019)	The Great Recession and adverse birth outcomes: evidence from California, USA.	This study examines the spatially and temporally heterogeneous effects of the Great Recession on adverse birth outcomes without reference to specific CVDs.
Hiyoshi (2013)	Inequalities in self-rated health in Japan 1986–2007 according to household income and a novel occupational classification: national sampling survey series.	This article examines whether health inequalities increased over the period of economic stagnation and substantial social change without references to CVDs.
Kyriopoulos (2019)	Does economic recession impact newborn health? Evidence from Greece.	This article refers to the economic crisis, but there is no specific reference to CVDs.
Mazeikaite (2019)	The Great Recession, financial strain and self-assessed health in Ireland.	This study examines the effects of the 2008 economic crisis on general health in Ireland, the relationship between compositional changes in demographic and socio-economic factors, and changes in the prevalence of poor self-assessed health over a 5-year period (2008-2013) without specific reference to CVDs.
Mitonas (2016)	COPD patients' medical care and support in Greece during financial crisis.	This study attempts to investigate the profile of patients with COPD in specific community settings in Greece. There is only a simple reference in heart disease as a comorbidity.
Nena (2014)	Greek financial crisis: From loss of money to loss of sleep?	This study refers to Greek economic recession and analyzed how job insecurity is associated with poor self-rated health and minor psychiatric morbidity, without reference to CVDs.
Regidor (2019)	Reversal of upward trends in mortality during the Great Recession by employment status at baseline in a national longitudinal study.	This study focuses on employment status during the Great Recession without any association with CVDs.
Seeman (2018)	The Great Recession worsened blood pressure and blood glucose levels in American adults.	This study examines the association of Great Recession with increases in blood pressure and glucose, without further information on CVDs.

Tapia Granados (2009)	Life and death during the Great Depression.	This article analyzes causes of death during the Great Depression but examines CVDs with renal diseases or with respiratory diseases. There were not presented results for CVDs.
Wang (2020)	The impact of the great economic crisis on mental health care in Italy.	This paper investigates the impact of the economic crisis on hospital admissions for severe mental disorders in Italy and assesses whether there are heterogeneous effects across areas with distinct levels of income without reference to CVDs.
Yumar (2019)	Economic crisis and obesity in the Canary Islands: an exploratory study through the relationship between body mass index and educational level.	This research examines the education-related inequalities in adult obesity in the Canary Islands and their evolution in recent years, considering the possible impact of the economic recession without association with CVDs.
Commentaries/Letters to the editor /Editorials that did not present relevant original data		
Catalano (2005)	If economic expansion threatens public health, should epidemiologists recommend recession?	This commentary provides general information based on bibliographic data but does not present relevant original data.
Davlouros (2013)	DES thrombosis related to antiplatelet therapy noncompliance: a consequence of the Greek financial crisis.	This letter concerns a case report which is excluded from review as described in the protocol.
Grubb (2013)	Economical selection of syncope patients for permanent cardiac pacing: a tilted view.	This is an editorial about patients who might potentially benefit from therapies in the most economical manner without relation to CVDs and economic crises.
Kim (2003)	Regarding "Changes in mortality after the recent economic crisis in South Korea" (multiple letters)	These letters refer to the article "Changes in mortality after the recent economic crisis in south Korea" by Kim et. al. which was included in our review.
Murthy (2014)	Decompressive craniectomy--the price is right?	Comment on "Economic evaluation of decompressive craniectomy versus barbiturate coma for refractory intracranial hypertension following traumatic brain injury" which was evaluated for selection.
Panagiotakos (2019)	Cardiovascular disease risk status during the years of the financial crisis: the Greek case.	This article refers to findings from the 10-year follow-up (2002-2012) of the ATTICA epidemiological study without any statistical data.
Panayiotou (2015)	Financial crisis, drug compliance and cardiovascular health-the GREECS case?	This is a supplementary comment on study by *Notara et. al.* with the results from the 10-year follow-up (2004-2014) of a nationally representative study in Greece on Acute Coronary Syndrome (ACS) incidence and all-cause mortality in cardiac patients (the GREECs study) which is included in our review.
Popovic (2019)	The effects of Economic crisis on health of the Serbian population: What do we know so far?	This letter refers to trends in socioeconomic and health status indicators and identifies a possible association between economic recession and health

		of the Serbian population without specific reference to CVDs before the crisis.
Stefanadis (2013)	Economic crisis: the role of cardiovascular medicine.	This is an editor's page with not reported statistics. There is a discussion of the connection of the economic crisis with CV medicine.
Stolinsky (1984)	Recessions and increased mortality.	This article was based on a review of drugs without any statistical data.
Tapia Granados (2006)	Mortality effects of the economic crisis in South Korea.	The paper tries to establish mortality effects of the strong depression affecting the South Korean economy in the late 1990s without statistical data.
Tosoulis (2017)	Socioeconomic status and cardiac disease in Europe: a modern-day problem in the era of economic crisis	This is a letter to the review article by *Psaltopoulou et. al.* about the association of socioeconomic status with dietary habits and how dietary patterns change from unhealthy to healthy over the range of educational and income status without any statistical data.
Studies not presenting comparisons pre vs. during/post crisis		
Andrikopoulos (2015)	Impact of income status on prognosis of acute coronary syndrome patients during Greek financial crisis.	This article classified patients as "low" or "high" income status during the period of economic crisis in Greece, without any comparison with the previous economic state.
Andrikopoulos (2015)	Impact of income status on prognosis of acute coronary syndrome patients during a period of financial crisis-insights from a Greek prospective multicenter observational study.	In this paper patients were classified as low- or high-income based on the reported net annual household income using as a cut-off point the relative poverty threshold for Greece without comparisons pre vs. post crisis.
Avendano (2016)	Are some populations resilient to recessions? Economic fluctuations and mortality during a period of economic decline and recovery in Finland.	This study examines the health effects of economic fluctuations during a period of economic decline (1989–1996) and recovery (1997–2007) in Finland without data of comparison among pre/post crisis periods.
Birgisdóttir (2020)	The effect of the economic collapse in Iceland on the probability of cardiovascular events.	This study explores whether the economic collapse in 2008 and subsequent economic crisis affected the probability of ischemic heart disease (IHD) events, independent of regular cyclical effects that can be attributed to typical economic conditions without a report of pre- post-crisis data.
Edwards (2008)	Who is hurt by procyclical mortality?	This article examines mortality by individual characteristic during the 1980s and 1990s and focuses on the procyclical effect without comparisons in pre- or post-crisis periods.
Hanchate (2010)	Identifying socioeconomic gradients and racial/ethnic disparities in outcomes from ischemic stroke hospitalizations.	This article does not contain any comparisons among pre- and post-crisis periods.
Hone (2019)	Effect of economic recession and impact of health and social	This article estimates the association between economic recession and adult mortality in Brazil and

	protection expenditures on adult mortality: a longitudinal analysis of 5565 Brazilian municipalities	whether health and social welfare programs in the country had a protective effect against the negative impact of this recession, without comparison among pre- and post-crisis periods.
Ketilsdottir (2019)	Self-reported health and quality of life outcomes of heart failure patients in the aftermath of a national economic crisis: a cross-sectional study.	This study describes characteristics, health status, and SES of HF patients several years after a national economic crisis but no measures were available on the patient population's profile before the crisis.
Ketilsdottir (2018)	Self-reported health and quality of life outcomes of heart failure patients in the aftermath of a national economic crisis: a cross-sectional study.	This study was conducted in 2014 and describes data from this year without any comparison in the state before the economic crisis in 2008.
Ketilsdottir (2016)	Icelandic heart failure patients at time of economic crisis: patient reported outcomes.	This poster abstract refers to health status of HF Icelandic patients with data after 2008 economic crisis without comparisons with pre-crisis period and overlaps with the main article's data of *Ketilsdottir et. al. (2019)*
Khatana (2019)	Trends in cardiovascular mortality and economic distress in communities.	This article assesses whether economic distress was associated with trends in cardiovascular mortality rates from 2010 to 2015, without any comparison in time-period before crisis.
Kollia (2016)	Exploring the association between low socioeconomic status and cardiovascular disease risk in healthy Greeks, in the years of financial crisis (2002–2012): The ATTICA study	This study explores the effect of low socioeconomic status (SES) on a 10-year cardiovascular disease (CVD) incidence, in the years of financial crisis without comparison between pre- and post-crisis period.
Kollia (2018)	Trends of Cardiovascular Disease Mortality in Relation to Population Aging in Greece (1956 - 2015).	The purpose of this study was to examine the association between cardiovascular disease (CVD) mortality and demographic indicators, in Greece the past 60 years (1956-2015) without comparisons among the periods of the economic crisis.
Magriplis (2019)	Aims, design and preliminary findings of the Hellenic National Nutrition and Health Survey (HNNHS).	The aim of this study was to assess nutritional intake, health status and various behaviors in a representative sample of the Greek population, in 2013-2015 an after-crisis time-period without comparisons with the previous economic situation.
Marmot (2013)	The Role of Social Determinants in Tackling Health Objectives in a Context of Economic Crisis.	This article examines the impact of the economic crisis on health through its social determinants without comparisons with the pre-crisis conditions.
Modrek (2013)	Health consequences of the 'Great Recession' on the employed: Evidence from an industrial cohort in aluminum manufacturing.	This study explores the health consequences of downsizing on the remaining workforce and focuses on the "recession period" without comparison with the previous / post situation.
Munoz (2015)	The health of adults undergoing an eviction process.	This article analyzes the perceived health status and other health-related indicators in the adult

		population in Granada undergoing an eviction process from their homes, whether rented or owned, in comparison with health indicators in the general adult population without comparisons in pre- or post-crisis periods.
Ruhm (2000)	Are recessions good for your health?	This study investigates the relationship between economic conditions measured via unemployment rate and health without comparisons in pre- or post-crisis periods.
Ruhm (2015)	Health effects of economic crises.	This analysis summarizes prior research and uses national, state and county level data from the US from 1976-2013 to examine whether the mortality effects of economic crises differ in kind from those of the more typical fluctuations without reference to pre- and post-crisis periods.
Seon (2017)	Cardiovascular health status between standard and nonstandard workers in Korea.	This article evaluates if the effect of employment insecurity on employee health is an important public health issue due to the recent effects of neoliberalism and the global financial crisis (2007–2008) on labor markets without a clear comparison between pre- and post-crisis periods.
Strumpf (2017)	Did the Great Recession affect mortality rates in the metropolitan United States? Effects on mortality by age, gender and cause of death.	This study estimates the impacts of increases in unemployment rates on both all-cause and cause-specific mortality across U.S. metropolitan regions during the Great Recession without comparison among pre- and post-crisis periods.
Tapia Granados (2005)	Recessions and mortality in Spain, 1980–1997.	This article refers to the relationship between economic fluctuations and mortality as assessed with data from Spain during the years 1980–1997 without comparisons in pre- or post-crisis periods.
Torbica (2015)	The economic crisis and acute myocardial infarction: new evidence using hospital level data.	The aim of the present analysis was to investigate the relation between the unemployment rate and the incidence of hospital level AMI in the Italian NHS during the period of economic crisis, without comparisons between pre- and post-crisis periods.
Vagero (2016)	Does unemployment cause long-term mortality? Selection and causation after the 1992–96 deep Swedish recession	In this study, mortality events were studied in the post-recession period only.
Vagero (2005)	Self-reported heart symptoms are strongly linked to past and present poverty in Russia: evidence from the 1998 Taganrog interview survey.	The aim of this study was to relate poverty to the presence of self-reported heart symptoms without reference to pre- or post- recession periods.
Walberg (1998)	Economic change, crime, and mortality crisis in Russia: regional analysis.	This study identifies which aspects of socioeconomic change were associated with the steep decline in life expectancy in Russia between 1990 and 1994 a period following the 1990's Recession.

Williams (2012)	The Social Context of Cardiovascular Disease: Challenges and Opportunities for the Jackson Heart Study.	This paper outlines critical research opportunities for the Jackson Heart Study to advance the science base for understanding and effectively addressing racial disparities in CVD without comparison with pre- and post-crises conditions.
Zagożdżon (2014)	Effect of unemployment on cardiovascular risk factors and mental health.	Data were collected between 2009 and 2010 in a period of economic crisis but there is not any comparison in the state before the economic crisis period.
Studies reporting only on risk factors (and not cardiovascular disease, as defined in the study protocol)		
Baumbach (2014)	Impact of financial crisis on selected health outcomes in Europe.	The aim of this study was to analyze the effects of the financial crisis on selected health outcomes at population level in Europe. Study refers to cardiovascular risk factors but without specific cardiovascular outcomes.
Bobak (1997)	Political changes and trends in cardiovascular risk factors in the Czech Republic, 1985-92.	This paper examines the trends in cardiovascular risk factors in Czech population over the decade in which a major and sudden change of the political and social system occurred in 1989, and whether the trends differed in relation to age and educational group.
Filippidis (2014)	Trends in cardiovascular risk factors in Greece before and during the financial crisis: the impact of social disparities.	The objective of this study was to assess trends in health-related behaviors and cardiovascular risk factors within Greece before, at the beginning and during the current financial crisis.
Inthachai (2019)	Effects of physical activity and smoking on cardio-ankle vascular index, respiratory muscle strength, and exercise performance in early normal weight adulthood: a cross-sectional study.	This article focuses on risk factors that contribute to CVDs.
Jofre-Bonet (2018)	The impact of the Great Recession on health-related risk factors, behaviour and outcomes in England.	This study examines the impact that the Great Recession had on individuals' health behaviors and risk factors (e.g. diet choices, smoking, alcohol consumption, Body Mass Index), as well as on intermediate health outcomes in England without specific reference to CVDs.
Karaslavova (2011)	Psychosomatic correlates of coronary heart disease during the socio-economic crisis of post-communist Bulgaria.	This study examines the role of psychological factors correlating with Acute Myocardial Infarction (AMI) during the transition period in post-communist Bulgaria and focuses on anxiety and depressive disorders.
Karaslavova (2011)	Risk factors for acute myocardial infarction during the transition period in Bulgaria.	The aim of this study was the analysis of the impact of several socio-economic factors over the development of coronary heart disease during the transition period.

Kastorini (2015)	Defining the path between social and economic factors, clinical and lifestyle determinants, and cardiovascular disease.	The aim of this study was to evaluate how social and economic factors influence modifiable cardiovascular disease risk factors and thus, acute coronary syndrome or ischemic stroke presence.
Marcotte-Chénard (2019)	Prevalence of the metabolic syndrome between 1999 and 2014 in the U.S. adult population and the impact of the 2007-2008 recession: a NHANES study.	The aim of this study was to document changes in prevalence of the metabolic syndrome (MetS) in the U.S. adult population between 1999 and 2014 and to explore how variations in the dietary intakes explain changes in MetS prevalence and its components over time.
Miller (2017)	Metabolic syndrome risks following the Great Recession in rural black young adults.	This study examines metabolic syndrome (MetS) in rural black young adults as a function of their family's economic conditions before and after the Great Recession.
Panagiotakos (2014)	Financial crisis, beliefs and attitudes regarding cardiovascular disease risk factors: a health survey in 10,141 Greek men and women (2006-2012).	This study evaluates beliefs and knowledge about CVD risk factors of the Greek population, before and after the financial crisis.
Pitsavos (2003)	Epidemiology of cardiovascular risk factors in Greece: aims, design and baseline characteristics of the ATTICA study.	This article refers to a population-based health and nutrition survey, the "ATTICA study" to evaluate the levels of several cardiovascular risk factors in Greece.
Psaltopoulou (2017)	Socioeconomic status and risk factors for cardiovascular disease: impact of dietary mediators.	This study examines several risk factors such as family history, diabetes, hypertension, obesity, diabetes, smoking and physical inactivity in relation to the overall cardiovascular risk.
Rodgers (2019)	County-level housing affordability in relation to risk factors for cardiovascular disease among middle-aged adults: The National Longitudinal Survey of Youths 1979.	This survey estimated the associations between the change in median country-level percentage of household income spent on housing (rent/mortgage) between 2000 and 2008 and individual-level risks of risk factors for CVDs from 2008 to 2014.
Samentzas (2016)	The incidence of diabetes mellitus type II in patients with acute coronary syndromes in an urban population during the last decade.	This article examines the importance of DMtII as a major risk factor for ACS and evaluates the incidence of DMtII in men and women with ACS during the period of financial crisis (2008-2012) and didn't refer exclusively to CVDs and their relation to periods of economic crisis.
Tapia-Granados (2018)	Cardiovascular risk factors, depression, and alcohol consumption during joblessness and during recessions in CARDIA young adults.	This article refers to CVD risk factors not to specific disease.
Westerlund (2004)	Organizational instability and cardiovascular risk factors in white-collar employees.	The aim of this study was to determine the effects of organizational instability, on the components of the demand–control model and on the cardiovascular risk factors; fibrinogen, cholesterol, triglycerides, and blood pressure in white-collar employees.

Studies reporting different times of economic crisis and CVDs assessment		
Alessie (2019)	Economic Conditions at Birth and Cardiovascular Disease Risk in Adulthood: Evidence From post-1950 Cohorts	Crisis referring to time of birth and not to time of CVD assessment.
Van den Berg (2011)	Being born under adverse economic conditions leads to a higher cardiovascular mortality rate later in life: evidence based on individuals born at different stages of the business cycle.	This article connects the recent medical and economic literature on the long-run effects of early-life conditions by analyzing the effects of economic conditions in general, on the individual CV mortality rate later in life, using individual data records. Crisis referring to time of birth and not to time of CVD assessment.