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Advocating for Early Cardiovascular Disease Screening in Canada

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Tribute

Dedicated to Fouad Mikhail Moujalli, the love of my life since the day we met at 17 and 19, my eternal love, and my forever guide and a rock with a steel spine to our entire family and heart of pure gold, who passed from a Silent Heart Attack without warning on Nov. 18th. 2024. Fouad means poetic heart in Arabic.

- Shanaz Joan Parsan

Contents

Executive Summary: Heart Diseases

Canada has a population of approximately 41 million and spans an area of 10 million square kilometers[1]. It is a high-income country that provides universal health care, primarily financed through taxation. Cardiovascular care and health outcomes are comparable to those observed in other economically developed nations. However, access to health care services can be significantly limited in remote and rural regions. Additionally, Indigenous populations often encounter systemic barriers that further hinder equitable access to health care.

Canada allocates approximately 11.5% of its gross domestic product (GDP) to health care[2]. Over 70% of health care services are publicly funded through a tax-based system, which primarily covers essential medical services, such as hospitalizations. Health care delivery is administered by 13 provincial and territorial jurisdictions, each responsible for the management and organization of services within its region. The federal government provides funding for specific populations, including Indigenous communities. Health Canada is responsible for the regulation and approval of pharmaceuticals and medical devices. While drug coverage is managed at the provincial level, most seniors receive financial assistance for prescription medications. Other individuals may rely on private insurance or out-of-pocket payments for drug costs. Recent federal legislation aims to establish a national pharmacare program to standardize access to prescription medications across the country. Canada's health costs are lower than in the U.S. Drug prices are managed by federal rules. Provinces work together to negotiate prices. They also use drug lists to control costs. Health care delivery costs are managed through set fees and budgets.

Canadians access publicly funded health care services through a government-issued health card, which also facilitates the collection of data on health care utilization and outcomes through national and provincial databases. Despite the availability of such data, Canada invests relatively less in health research compared to other high-income countries. The Canadian Institutes of Health Research (CIHR) serves as the primary federal agency supporting cardiovascular and other biomedical research. However, CIHR grants typically do not cover researchers' salaries, requiring investigators to secure additional funding sources to support their own compensation.

[1] Government of Canada, Statistics Canada. (2024, June 19). *The Daily — Canada's population estimates, first quarter 2024*. https://www150.statcan.gc.ca/n1/daily-quotidien/240619/dq240619a-eng.htm

[2] Clement, F. (2023). Value-Based healthcare: Is it just another buzzword? *Healthcare Policy*, *18*(4), 18–25. https://doi.org/10.12927/hcpol.2023.27096

Supply of Doctors

In 2023, Canada had a total of 97,384 physicians, corresponding to a national ratio of 243 physicians per 100,000 population[3]. The overall physician supply increased by 1.4% compared to 2022; however, this growth was solely attributable to a 2.9% increase in the number of specialist physicians. In contrast, the number of family medicine physicians experienced a slight decline, with a negative growth rate of 0.1%.

Dollars and Utilization

In the 2022–2023 fiscal year, total clinical payments to physicians in Canada reached $32.4 billion, reflecting a 5.3% increase compared to the previous year. The average gross clinical payment per physician rose by 3.5%, reaching $369,000. This figure varied across provinces, ranging from $302,000 in Nova Scotia to $410,000 in Alberta. During the same period, physicians delivered over 278 million services, representing an increase of nearly 3% from the previous year.

Demographics

The representation of female physicians in Canada's medical workforce continues to increase. As of 2023, women accounted for 50.4% of family medicine physicians and 40.7% of specialist physicians. The average age of physicians was 49.3 years, with male physicians averaging 51.7 years and female physicians averaging 46.4 years. The distribution of specialists tends to be concentrated in more affluent regions, reflecting disparities in access to specialized care. The majority of physicians are remunerated on a fee-for-service basis through provincial health insurance plans. Cardiologists typically undergo six years of postgraduate medical training before certification, which is granted by a national professional body. Licensure to practice is issued by individual provincial regulatory authorities. The Canadian Cardiovascular Society plays a key role in advancing cardiovascular care by publishing national clinical practice guidelines.

CVD Care (Cardiovascular Disease Care) and Outcome

Canada's shortage of family physicians limits access to cardiovascular care[4], affecting prevention, screening, and treatment efforts. Despite these challenges in primary care, hospital-based treatment for heart disease remains comparable to that in other high-income countries. The 30-day mortality rate

[3] *Physicians | CIHI*. (n.d.). https://www.cihi.ca/en/physicians

[4] Li, K., Frumkin, A., Bi, W. G., Magrill, J., & Newton, C. (2023). Biopsy of Canada's family physician shortage. *Family Medicine and Community Health*, *11*(2), e002236. https://doi.org/10.1136/fmch-2023-002236

following a heart attack is 6.3% in Canada, within the OECD range of 3.2% to 17.0%. In 2023, wait times for coronary bypass surgery varied across provinces, with a national median wait time of eight days.

Canadians also have a relatively high life expectancy compared to other Organization for Economic Co-operation and Development (OECD) countries[5]. According to a 2023 report by OECD, the life expectancy in Canada is 81.6 years, 1.3 years higher than the average of 80.3 yrs.

How does Canadian Health Care Fall Short? [6]

Although Canada is one of the highest spenders on health care among OECD countries, this expenditure does not always translate into better health outcomes. Canada allocates 11.5% of its GDP to health care, significantly higher than the OECD average of 9.2%.

Access to primary care has become increasingly difficult for Canadians. In 2016, 93% of Canadians aged 18 and older reported having access to a primary care physician, but by 2023, this figure had dropped to 86%-the lowest proportion among the 10 countries surveyed in the Commonwealth Fund's 2023 International Health Policy Survey.

Canadians' access to same-day or next-day doctor's appointments has significantly declined. In 2016, 46% of Canadians were able to secure an appointment within one or two days, but by 2023, this proportion had fallen to just 26%. This remains the lowest among the 10 countries surveyed in the Commonwealth Fund's 2023 International Health Policy Survey.

Burden of CVD

Geography and money affect access to care. Poorer provinces have less access to heart care. For instance, many hospitals lack on-site echocardiography. Specialist services are centered in a few places. Only a small number of facilities offer procedures such as bypass surgery.

[5] *How does Canada rank in health care?* (n.d.). Health Care for Real. https://www.cma.ca/healthcare-for-real/how-does-canada-rank-health-care#:~:text=In%20Canada%2C%20life%20expectancy%20is,OECD%20average%20of%2080.3%20years.

[6] *How does Canada rank in health care?* (n.d.). Health Care for Real. https://www.cma.ca/healthcare-for-real/how-does-canada-rank-health-care#:~:text=In%20Canada%2C%20life%20expectancy%20is,OECD%20average%20of%2080.3%20years.

Cardiovascular diseases (CVD), principally ischemic heart disease and stroke, remain the leading cause of mortality worldwide and a major contributor to disability and rising healthcare costs [7,8,9,10].

It is expected to reach US$863 billion in direct healthcare costs and productivity losses worldwide [11]. In fact, these costs are projected to reach US$20 trillion by the year 2030

In Canada, heart disease poses a significant health threat. Only cancer causes more deaths. Cancer and heart issues were the main death causes in 2023. They made up 43.7% of all deaths, rising from 42.4% in 2022. The top 10 causes led to 221,147 deaths in 2023. This is over two-thirds (67.8%) of all deaths. Ischemic heart disease, also known as coronary heart disease, is included. This condition arises from plaque accumulation in heart arteries. Heart attack, stroke, or heart failure may result. Heart disease ranks as the most prevalent heart ailment in Canada. Industrialized countries also see it often. Almost half the deaths related to heart disease stem from this specific type. Chronic stress harms the heart by increasing inflammation, raising blood pressure, promoting unhealthy habits, and contributing to heart disease and heart failure. Managing stress through healthy lifestyle choices is essential to reduce cardiovascular risk.

Key Findings

Cardiovascular diseases (CVDs) are a group of disorders of the heart and blood vessels. [12]

They include:

- coronary heart disease – a disease of the blood vessels supplying the heart muscle;
- cerebrovascular disease – a disease of the blood vessels supplying the brain;
- peripheral arterial disease – a disease of blood vessels supplying the arms and legs;
- rheumatic heart disease – damage to the heart muscle and heart valves from rheumatic fever, caused by streptococcal bacteria;

[7] Lozano R, Naghavi M, Foreman K, et al. Global and regional mortality from 235 causes of death for 20 age groups in 1990 and 2010: a systematic analysis for the Global Burden of Disease Study 2010. Lancet 2012;380:2095–128.
[8] Murray CJ, Vos T, Lozano R, et al. Disability-adjusted life years (DALYs) for 291 diseases and injuries in 21 regions, 1990e2010: a systematic analysis for the Global Burden of Disease Study 2010. Lancet 2012; 380:2197–223.
[9] Leeder S, Raymond S, Greenberg H, Liu H, Esson K. A Race Against Time: The Challenge of Cardiovascular Disease in Developing Coun- tries. New York, NY: Trustees of Columbia University, 2004.
[10] Tarride JE, Lim M, DesMeules M, et al. A review of the cost of cardiovascular disease. Can J Cardiol 2009;25:e195–202.
[11] Bloom DE, Cafiero ET, Jane-Llopis E, et al. The Global Economic Burden of Noncommunicable Diseases. Geneva, Switzerland: World Economic Forum, 2013.
[12] World Health Organization: WHO. (2021, June 11). *Cardiovascular diseases (CVDs)*. https://www.who.int/news-room/fact-sheets/detail/cardiovascular-diseases-(cvds)

- congenital heart disease – birth defects that affect the normal development and functioning of the heart caused by malformations of the heart structure from birth; and
- deep vein thrombosis and pulmonary embolism – blood clots in the leg veins, which can dislodge and move to the heart and lungs.

Heart attacks and strokes are usually acute events and are mainly caused by a blockage that prevents blood from flowing to the heart or brain. The most common reason for this is a build-up of fatty deposits on the inner walls of the blood vessels that supply the heart or brain. Strokes can be caused by bleeding from a blood vessel in the brain or from blood clots.

Key Facts

Cardiovascular diseases (CVDs) are the leading cause of death globally. An estimated 17.9 million people died from CVDs in 2019, representing 32% of all global deaths. Of these deaths, 85% were due to heart attack and stroke. Over three-quarters of CVD deaths take place in low- and middle-income countries. Out of the 17 million premature deaths (under the age of 70) due to noncommunicable diseases in 2019, 38% were caused by CVDs.

Most cardiovascular diseases can be prevented by addressing behavioural and environmental risk factors such as tobacco use, unhealthy diet and obesity, physical inactivity, harmful use of alcohol and air pollution. It is important to detect cardiovascular disease as early as possible so that management with counselling and medicines can begin.

According to 2017–2018 data provided by Canadian Chronic Disease Surveillance System (CCDSS):

- About 1 in 12 (or 2.6 million) Canadian adults age 20 and over live with diagnosed heart disease
- Every hour, about 14 Canadian adults age 20 and over with diagnosed heart disease die

The death rate is:

- 2.9 times higher among adults age 20 and over with diagnosed heart disease versus those without
- 4.6 times higher among adults age 20 and over who have had a heart attack versus those who have not
- 6.3 times higher among adults age 40 and over with diagnosed heart failure versus those without

Heart disease affects men and women differently.

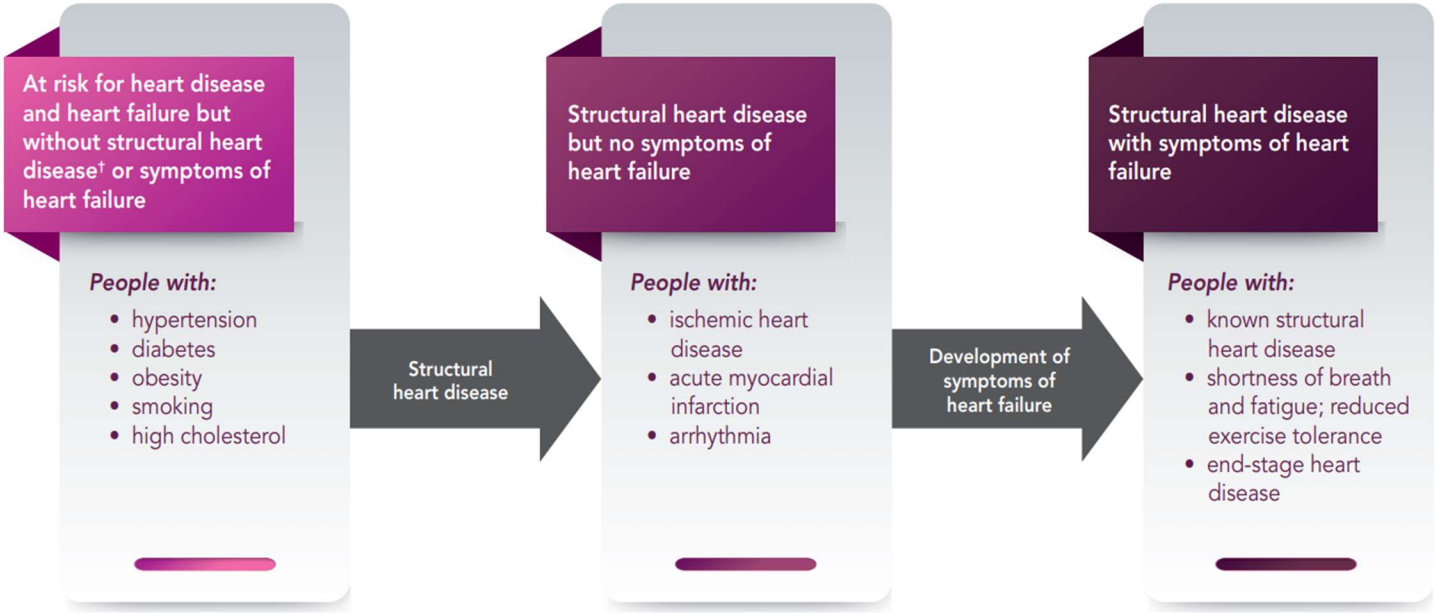
- Men are 2 times more likely to suffer a heart attack than women
- Men are newly diagnosed with heart disease about 10 years younger than women (55–64 vs 65–74 years of age)

The good news is that from 2000–2001 to 2017–2018:

- the number of Canadian adults newly diagnosed with heart disease declined from 217,600 to 162,730

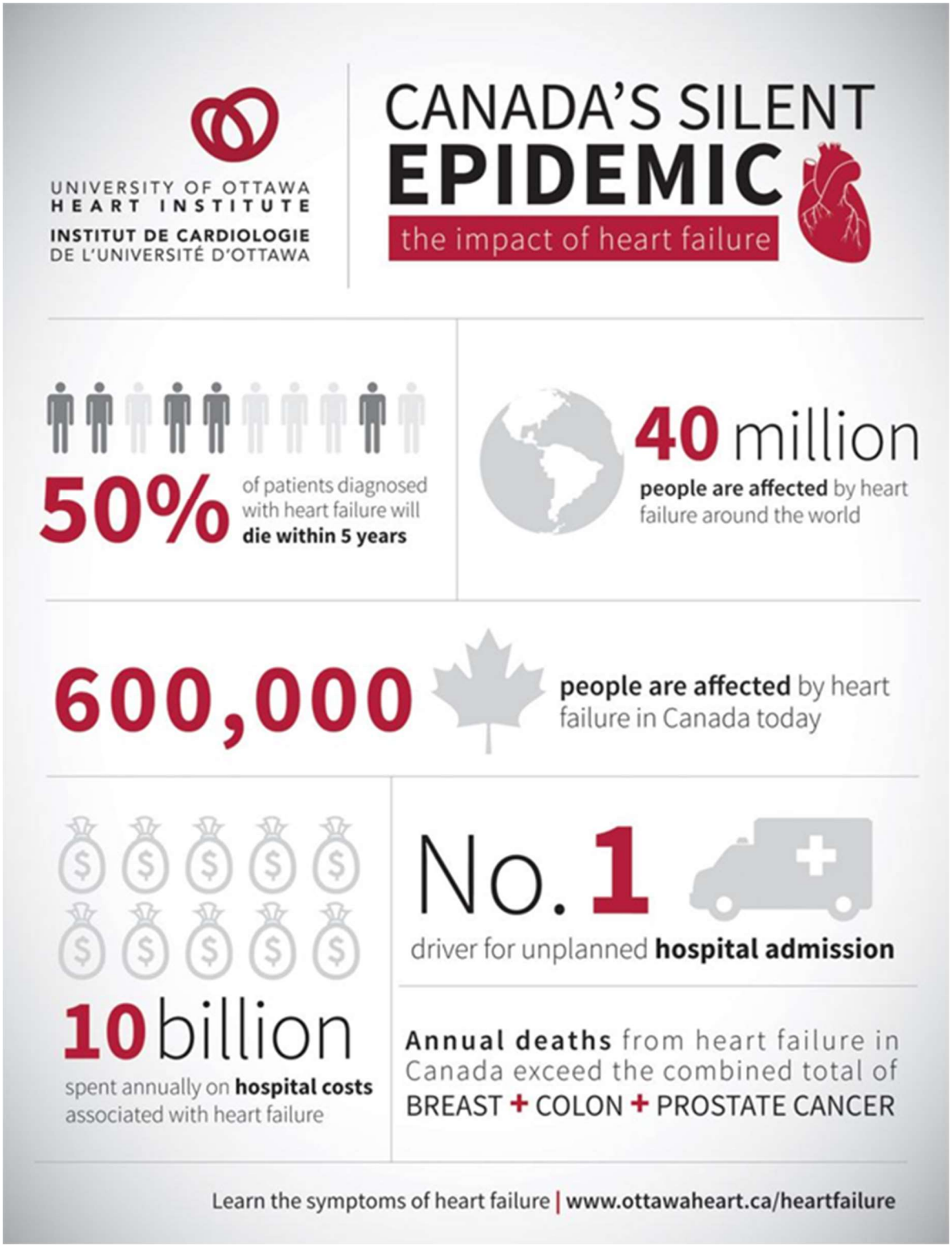
Also see *Appendix A. 10 Shocking Statistics about Heart Disease* and *Appendix B. British Heart Foundation Global Heart & Circulatory Disease Fact Sheet*.

Exhibit 1. Events Leading to Heart Disease Progression



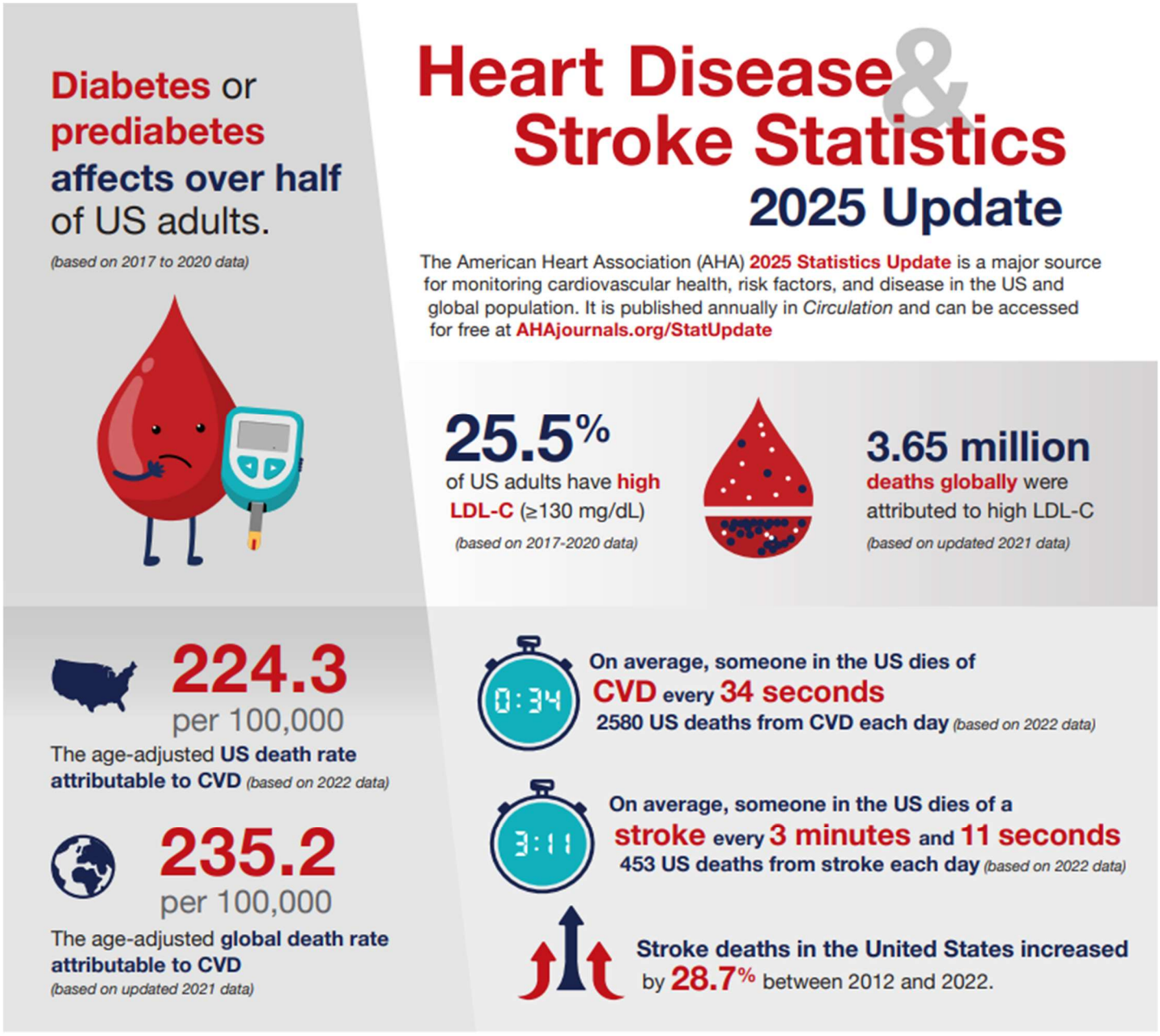
Source: Jessup M. et al

Exhibit 2. Canada's Silent Epidemic: The Impact of Heart Failure



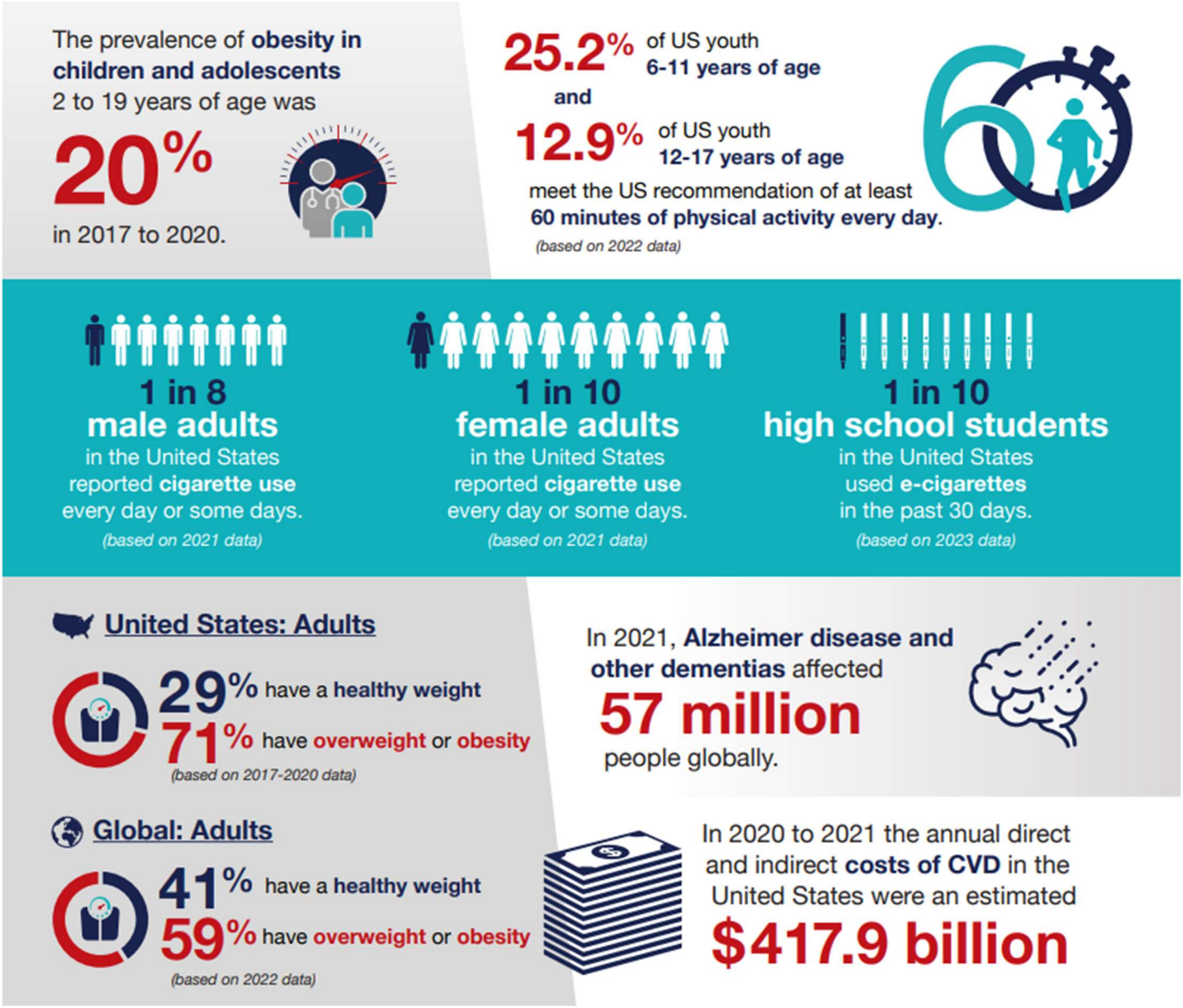
Source: Dzau VJ et al.

Exhibit 3. Heart Disease & Stroke Statistics 2024 Update



Source: American Heart Association Journals

Exhibit 3. Heart Disease & Stroke Statistics 2024 Update (cont'd)



Source: American Heart Association Journals

Heart conditions, stroke, and vascular cognitive impairment pose a major threat in Canada[13].

- Nine in ten Canadians have at least one risk factor for these conditions.
- Every five minutes, one Canadian dies from them.
- These diseases claim more lives than all cancers combined, exceeding them by 13%.
- In 2016, 91,524 Canadians died from these illnesses.
- Hospital data from 2007 to 2017 shows the burden.
- There were 2.6 million hospitalizations involving these conditions.
- Over one in ten hospitalizations were due to heart conditions, stroke, or vascular cognitive impairment.
- Among 1,515,256 people hospitalized for these conditions, 40% were readmitted. This could be for a similar or new event. Over 30% of those with heart valve disease returned to the hospital for atrial fibrillation.
- One-third of people with heart valve disease had prior hospitalizations for heart failure.
- 21% of people with vascular cognitive impairment were previously hospitalized for stroke.
- One in five patients had two hospital admissions for new heart or stroke issues.
- Another one in five had three or more admissions.
- Hospitalizations for these conditions are rising, especially for structural heart disease (50%), vascular cognitive impairment (35%), and heart failure (25%). The aging population contributes to this increase.
- These conditions appear at younger ages, impacting people in their 30s, 40s, and 50s.

[13] *Connected by the numbers*. (n.d.). Heart and Stroke Foundation of Canada. https://www.heartandstroke.ca/articles/connected-by-the-numbers#:~:text=One%20person%20dies%20in%20Canada,die%20from%20all%20cancers%20combined.

Vascular cognitive impairment has serious consequences. It increases the risk of fatal stroke by up to 68%.

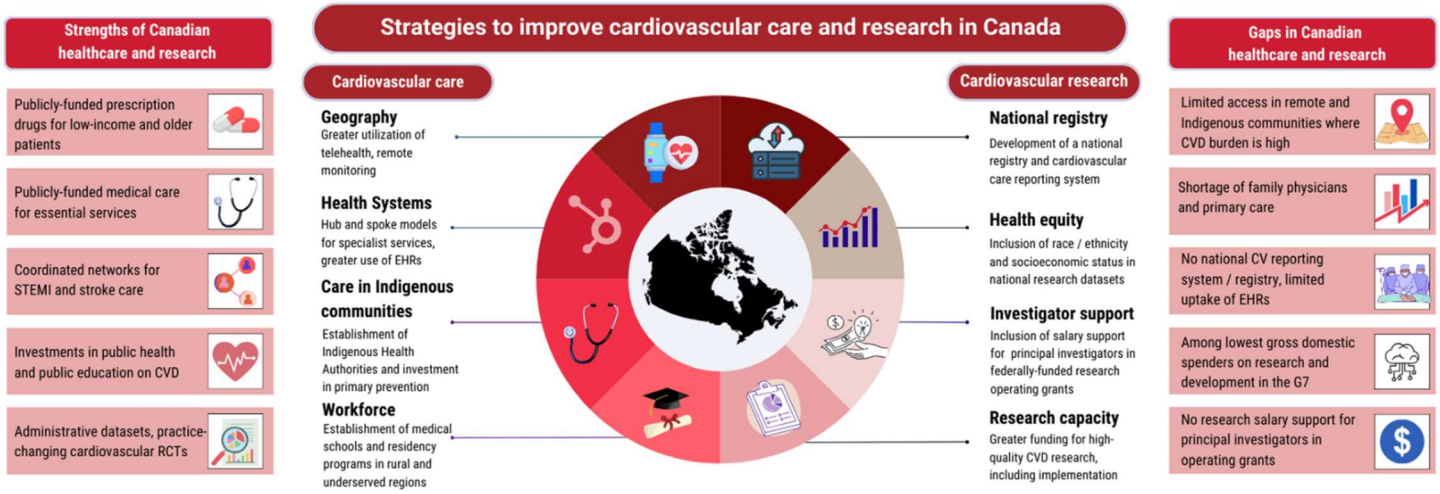
- Stroke patients are 2.2 times more likely to develop vascular cognitive impairment.
- Heart failure patients face a 2.6 times higher risk of cognitive impairment.
- Atrial fibrillation raises the risk of vascular cognitive impairment by 1.4 times.
- Valve disease increases the risk by 25%.
- Congenital heart disease may triple the risk of early-onset vascular cognitive impairment.
- It also raises the risk of late-onset vascular cognitive impairment by 30%.

Women face unique challenges.

- Women with heart failure have a six-times increased risk of atrial fibrillation.
- This is 25% higher than for men.
- Stroke affects women disproportionately.
- 45% more women die of stroke than men.
- More women live with the effects of stroke because they live longer.

- Women with heart valve disease have a three-times increased risk of Afib. This is a 50% higher risk than men.
- In 2016, 12% more women died of heart conditions, stroke, or vascular cognitive impairment than men.
- Twice as many women died from causes tied to vascular cognitive impairment.

Exhibit 4. Cardiovascular health care and research: strengths, limitations, and strategies for improvement[14].



Cost

Heart disease is the most expensive in Canada. It costs $21.2 billion for medical care and lost work[15]. Strokes cost Canada $3.6 billion yearly. This includes doctor visits, hospital stays, and lost pay. Dementia's expenses are $33 billion each year. This could rise to $293 billion by 2040. The link between heart problems, stroke, and cognitive decline raises costs. For instance, stroke care with atrial fibrillation (Afib) is more costly. It is more than stroke care without Afib.

[14] Averbuch, T., Stelkia, K., & Van Spall, H. G. (2024). Cardiovascular Care in Canada: Strengths, Challenges, and Opportunities For Improvement. *Circulation*, *150*(19), 1490-1492.

[15] Moubarac, J.-C., Nilson, E., Rezende, L., Hamel, V., Wahrhaftig, J., Polsky, J. Y., & Rimouche, S. (2025). How much of the burden of cardiovascular disease in Canada is attributable to ultra-processed foods? In Heart & Stroke & Statistics Canada, https://www.heartandstroke.ca/-/media/pdf-files/what-we-do/news/nilson_moubarac_upf_2025_en.pdf?rev=62e596a8210146a081305b6a838ffb5e#:~:text=Data%20from%20the%20Canadian%20Chronic,survived%20a%20stroke%20(2).

Purpose of This Report

This report provides a comprehensive overview of heart disease, focusing on silent heart attacks, and presents both national and global data. The information is sourced from organizations such as the Canadian Chronic Disease Surveillance System, the Canadian and American Heart and Stroke Foundations, and other cited references. It covers ischemic heart disease, heart attacks, and heart failure, with the primary aim of raising awareness and advocating for increased funding for heart attack screening—similar to the funding allocated for colon cancer screening, which results in fewer fatalities.

The report focuses on Canadian adults, with ischemic heart disease and heart attacks covering individuals aged 20 and older, while heart failure is examined in those aged 40 and older. Although advancements in prevention and treatment have been made, there is still significant work to be done. Preventing risk factors and ensuring early detection are critical to improving outcomes. Additionally, it is essential to address the differences in how heart disease affects men and women, as these disparities can influence diagnosis, treatment, and outcomes. With a growing number of individuals living with heart conditions, the need for ongoing treatment and care remains high.

Heart disease results in significantly higher mortality rates. Canadian adults with ischemic heart disease face a death risk three times higher than those without the condition. Among younger adults aged 20 to 39, those with ischemic heart disease experience the most severe outcomes, with men being 11 times more likely to die and women 18 times more likely. Individuals with a history of heart attacks face a fourfold increased risk of death, while those with heart failure have a sixfold increased risk.

Heart disease affects men and women differently. It tends to manifest approximately 10 years later in women, who generally experience lower rates of ischemic heart disease and heart failure but higher rates of heart attacks. While men have higher overall death rates from heart disease, women aged 45 to 74 are more likely to die from a heart attack, with a 30% higher chance of death compared to men.

While improvements have been made in the prevention and treatment of heart disease, further progress is needed. Addressing risk factors, ensuring early detection, and targeting gender differences in heart disease are vital steps toward improving outcomes. As more individuals live with heart conditions, the need for effective treatment and care remains a pressing concern.

Policy Recommendations and Implementation Considerations

We urgently need a national heart care registry. This system must track race and other social factors. This tracking will reveal unfair differences in care. Statistics Canada needs to gather more detailed data. Sharing health data across regions could ensure fair resource allocation. Canada aims to boost heart care quality, yet lacks a key tool. A national registry is vital to track and improve care nationwide.

Despite progress in heart failure care, a national registry is missing. The CAN-HF Registry collects data, but is not a full national system. We must do more. An HF Action Plan for Canada is being developed to close gaps. But a national registry is still essential.

A national registry is key to better heart care. It would show if treatments work. It would pinpoint areas needing fixes. It ensures all patients get the best care. Groups like the Heart and Stroke Foundation are working to help. A national registry would greatly aid their efforts.

Canada's health system is divided by region. This split leads to scattered data. This makes it hard to see national trends. A national registry would solve this issue. It would enable focused improvements for all.A national digital health plan could improve access to care. It could also boost the use of electronic health records. These records should integrate across systems and update in real time. Providers should create and access them easily. Patients should have access too. Digital health tech has gaps in integration and data sharing. Doctors get paid for virtual visits, a good step. Remote monitoring lacks payment. Options include public-private groups to improve data sharing. Regulated AI solutions and payment for tech use are other solutions.

Heart disease prevention must reach underserved groups, like Indigenous people. This requires real partnerships and public health work. Care must be culturally safe. Some medical schools prioritize regional applicants. The First Nations Health Authority shows culturally sensitive care.

Consistent funding is vital for heart research. Grants should support clinician researchers' salaries. This is important for women and underrepresented researchers. They often face unequal opportunities and pay.

Silent Heart attacks are on the rise and screening must take place as soon as does breast cancer and colon cancer.

Based on the evidence presented throughout this report, we recommend comprehensive policy changes to address the critical gap in SMI detection in Canada. These recommendations aim to align the approach to SMIs with other asymptomatic conditions that currently benefit from systematic screening efforts.

Expanding Cardiac Screening Programs

Targeted Screening for High-Risk Populations

We propose a tiered implementation approach that prioritizes populations at highest risk for SMIs while optimizing resource allocation:

- Pending formal guidelines from the Canadian Cardiovascular Society, provincial health authorities should immediately implement targeted screening programs for individuals with diabetes mellitus, particularly those over age 50. The established link between diabetes and SMIs provides strong justification for this population-specific approach. Implementation could begin within existing diabetes management programs, requiring minimal additional infrastructure while generating significant health benefits.

- Meanwhile, the Canadian Cardiovascular Society should develop and publish specific clinical practice guidelines for SMI screening. These guidelines should stratify populations by risk factors and recommend appropriate screening intervals, similar to existing guidelines for other cardiovascular conditions.

- Where resources allow, healthcare providers should incorporate baseline ECGs into standard preventive care for all Canadians aged 50 and older, with repeat screenings at appropriate intervals based on risk stratification.

- High blood pressure should not be overlooked and screening for those over 50 should be mandatory with stress tests and ECGs that are inexpensive.

- CRP tests while non specific for where inflammation is should be mandatory for those over 50

Existing Healthcare Infrastructure

- We recommend incorporating SMI screening into Canada's existing chronic disease management programs as an initial step. Provincial health authorities can leverage existing infrastructure while ensuring early detection among high-risk patients. Future expansions should aim to reach broader at-risk populations beyond those already diagnosed with chronic conditions (hypertension, diabetes, or other cardiovascular risk factors).

- Primary care networks across provinces should receive funding specifically designated for implementing SMI screening within their patient populations.
- Electronic medical record systems should be updated to include automated reminders for SMI screening based on patient risk profiles.

Public Awareness and Education Initiatives

- Health Canada, in partnership with the Heart and Stroke Foundation, should launch a national public awareness campaign specifically addressing SMIs. This campaign should emphasize risk factors, subtle symptoms, and the importance of screening, particularly among high-risk populations, also prevention methodologies. The successful model used for hypertension awareness provides an effective template.

- Educational materials about SMIs should be developed and distributed to healthcare providers across specialties, not limited to cardiologists.

- Patient advocacy groups should be engaged to develop culturally appropriate educational resources for diverse Canadian populations, with particular attention to communities demonstrating higher prevalence of SMIs. This effort can involve partnerships with cultural organizations and community leaders to ensure effective outreach and adoption of the **materials.**

Healthcare Coverage and Funding Recommendations

Provincial Health Coverage

We strongly recommend that all provincial and territorial health plans expand coverage to include preventive cardiac screening for high-risk populations. Specifically:

- Resting ECGs for individuals with diabetes, hypertension, or multiple cardiovascular risk factors should be covered regardless of symptom presentation. This coverage should extend to asymptomatic individuals who meet established risk criteria, similar to current coverage for asymptomatic diabetes screening.

- Provincial drug plans should evaluate coverage criteria for cardiovascular medications to ensure appropriate access for individuals with detected SMIs. Current criteria often require symptomatic presentation or hospital admission, potentially excluding those with SMIs.

- Telehealth services related to cardiovascular screening and follow-up should receive coverage parity with in-person services to improve access for rural and remote populations.

Federal Funding Initiatives

We recommend that the Public Health Agency of Canada establish a dedicated funding stream for SMI screening implementation, similar to existing funding for cancer screening programs.

- The Canadian Institutes of Health Research should create a targeted research funding opportunity specifically addressing SMI detection and management. This research initiative would address current knowledge gaps while generating Canadian-specific data to support ongoing program refinement, with a clear focus on translating research findings into tangible improvements.

- Federal health transfer payments to provinces should include performance metrics related to cardiovascular screening, including SMI detection rates. Metrics should be designed to encourage improvements in healthcare outcomes, while allowing for flexibility based on the unique healthcare infrastructure and needs of each province.

Challenges in Policy Implementation

Possible Implementation Barriers

- Budget constraints across provincial healthcare systems present significant implementation challenges. The strong cost-effectiveness data presented in this report provide a compelling economic argument, but competing priorities may still limit available resources.

- The fragmented nature of Canadian healthcare delivery across provinces necessitates coordination to ensure consistent implementation. While national guidelines can provide a framework, provincial variations in implementation may create geographic disparities in access.

- Physician resistance to expanded screening recommendations may occur, particularly related to concerns about false positives, incidental findings, and liability. Clear clinical guidelines with decision support tools can mitigate these concerns while providing implementation confidence.

- The absence of standardized treatment protocols specifically for SMIs may create uncertainty in clinical management following detection. Unlike cancer screening programs with established treatment pathways, SMI management requires individualized approaches based on multiple factors.

- Workflow integration presents practical challenges in busy clinical settings. Implementation strategies must minimize administrative burden while providing clear guidance for screening appropriate patients.

Overcoming Implementation Barriers

- Phased implementation, beginning with the highest-risk populations, allows for program refinement before broader rollout.

- Development of clear clinical decision support tools embedded within electronic medical records can address provider uncertainty and streamline workflow integration. These tools should guide both screening decisions and post-detection management. Pilot testing and user feedback will be essential to ensure the tools are intuitive and seamlessly integrated into existing systems, encouraging widespread provider adoption.

- Engagement of physician leadership organizations in program development ensures clinical credibility and facilitates provider adoption. Early involvement of these stakeholders converts potential resistance into implementation support.

- Regular program evaluation with transparent reporting creates accountability while facilitating continuous improvement.

The policy recommendations presented provide a framework for addressing the critical gap in SMI detection and management in Canada. Implementation would align the approach to this significant cardiovascular condition with established practices for other asymptomatic conditions that currently

receive systematic screening attention. The evidence presented throughout this report demonstrates that the current approach to SMIs represents a significant missed opportunity to improve cardiovascular outcomes for Canadians. The prevalence, impact, and economic burden of undetected SMIs clearly justify policy intervention, particularly given the favorable cost-effectiveness projections for screening implementation. We call upon federal and provincial health authorities, professional societies, and healthcare organizations to prioritize this issue and implement the recommendations outlined in this report.

Further, there needs to be recognition of the impact of stress on the heart that affects physiology beyond diet, exercise, and blood pressure, as important as all these are. Stress is a major factor in silent heart attacks

Exhibit 5. Heat Map of Associations between Heart Conditions, Stroke and Vascular Cognitive Impairment.

Review along the horizontal rows to understand the strength of the associated risk of each condition on the left to all other conditions listed across the top columns.

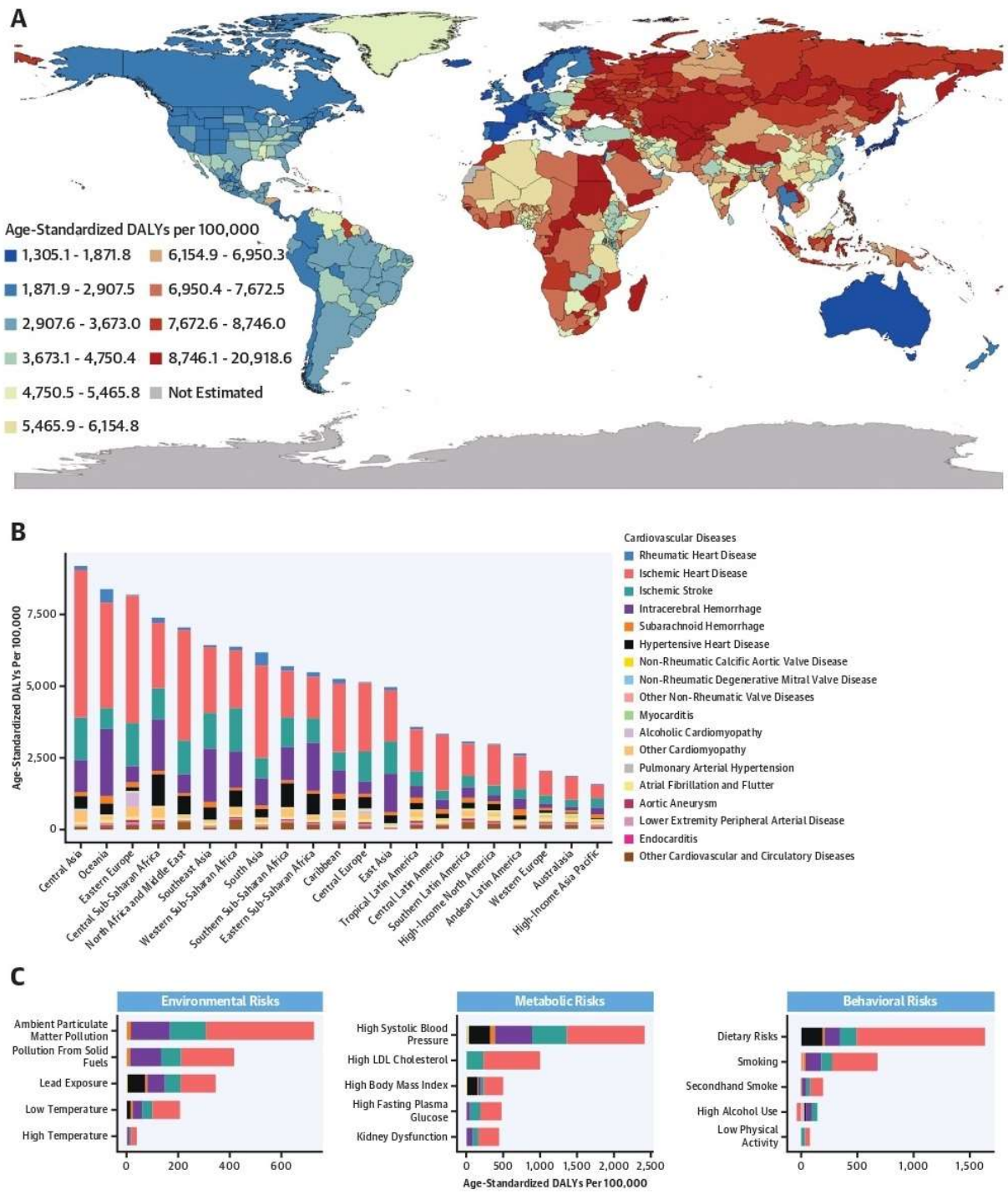
Strength of Association: No Known Association · Weak · Moderate · Strong

CONDITIONS (Read across rows)	Atrial Fibrillation	Heart Failure	Stroke	Vascular Cognitive Impairment	Congenital Heart Disease	Heart Valve Disease	Myocardial Infarction (Heart Attack)	Coronary Artery & Vascular Disease	Cardiac Arrest
	POSSIBLE ASSOCIATIONS								
Atrial Fibrillation		Strong	Strong	Moderate		Weak	Weak	Moderate	Moderate
Heart Failure	Strong		Strong	Strong		Strong	Moderate	No Known Association	Strong
Stroke	No Known Association	No Known Association		Strong		No Known Association	Weak	Strong	No Known Association
Vascular Cognitive Impairment	No Known Association	No Known Association	Moderate			No Known Association	No Known Association	No Known Association	No Known Association
Congenital Heart Disease	Strong	Weak	Strong	Strong		Weak	Strong	Weak	Strong
Heart Valve Disease	Strong	Moderate	Moderate	Weak			Weak	Strong	Weak
Myocardial Infarction (Heart Attack)	Strong	Moderate	Strong	Moderate		Weak		No Known Association	Moderate
Coronary Artery & Vascular Disease	Weak	Moderate	Weak	Strong		Moderate	Strong		Strong
Cardiac Arrest	No Known Association	No Known Association	No Known Association	Moderate		No Known Association	No Known Association	No Known Association	

Source: Heart and Stroke.ca

Part I. The Global Burdern of Cardiovascular Disease

Exhibit 6. Central Illustration: Global Burden of Cardiovascular Diseases and Risks

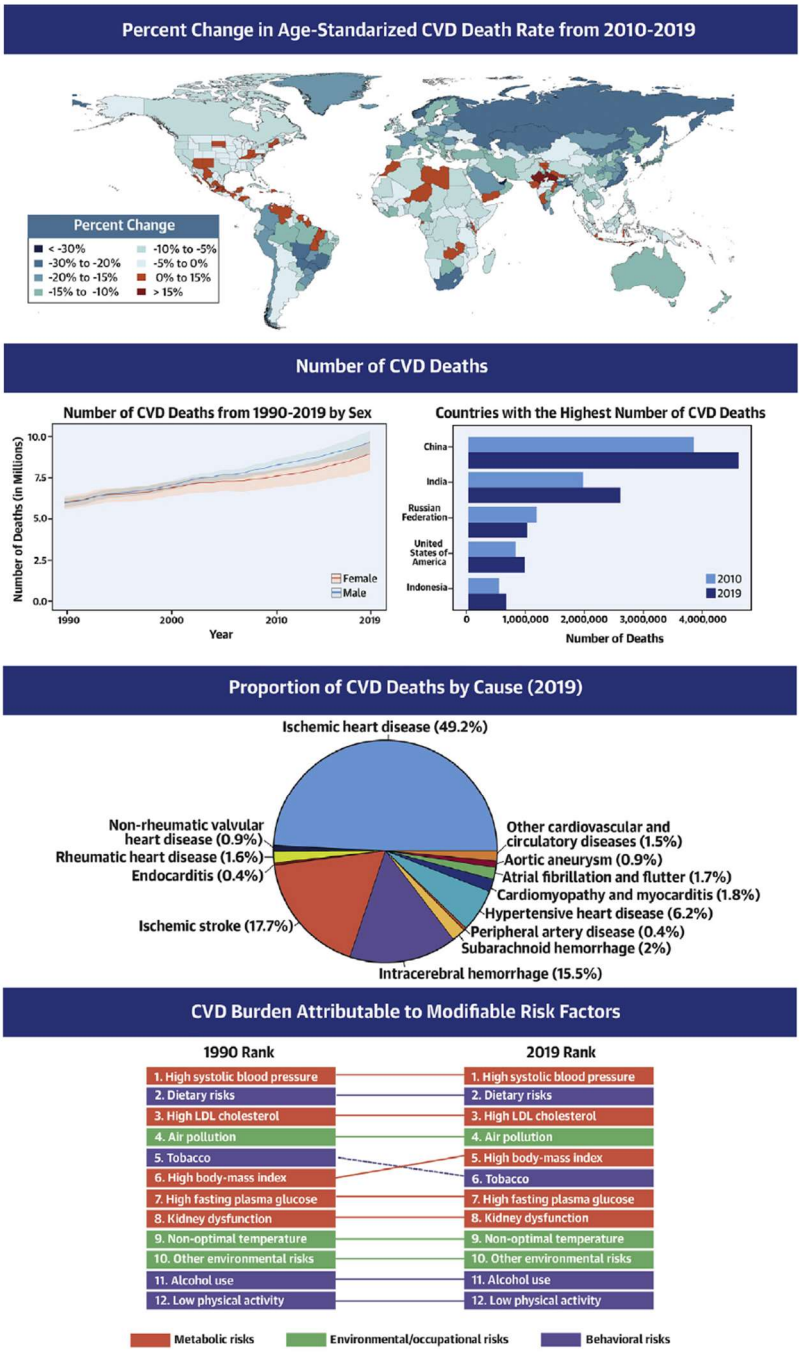


Vaduganathan M, et al. J Am Coll Cardiol. 2022;80(25):2361-2371.

Age-standardized disability-adjusted life years (DALYs) per 100,000 for **(A)** cardiovascular diseases globally, **(B)** specific cardiovascular diseases by region, and **(C)** global burden attributable to selected risk factors compared to the theoretical minimum risk level.

Source: The Global Burden of Cardiovascular Diseases and Risk: A Compass for Future Health

Exhibit 6. Central Illustration: Global Burden of Cardiovascular Diseases and Risks (cont'd)



Roth, G.A. et al. J Am Coll Cardiol. 2020;76(25):2982-3021.

Percent Change in Age-Standardized CVD Death Rate from 2010-2019. Map of the percent change in age-standardized CVD mortality rate from 2010 to 2019.**Number of CVD Deaths.** Total number of deaths due to CVD by sex, 1990 to 2019; total number of deaths due to CVD in 2010 and 2019 among the countries with the highest number of CVD deaths in 2019. **Proportion of CVD Deaths by Cause (2019).** Proportion of total CVD deaths in 2019 by underlying causes. **CVD Burden Attributable to Modifiable Risk Factors.** Comparison of the rankings of CVD DALYs attributable to modifiable risk factors in 1990 and 2019. CVD = cardiovascular disease; DALYs = disability-adjusted life years; LDL = low-density lipoprotein.

Source: Global Burden of Cardiovascular Diseases and Risk Factors, 1990–2019: Update From the GBD 2019 Study

Table 1. Global Ranking of Cardiovascular Deaths by Cause

TABLE 1 Global Ranking of Cardiovascular Deaths by Cause

Rank	Cause of Death	Number of Deaths in 2021 (95% UI)	Number of DALYs (95% UI)
1	Ischemic heart disease	9,440,000 (8,820,000-9,960,000)	185,000,000 (175,000,000-196,000,000)
2	Ischemic stroke	3,870,000 (3,550,000-4,170,000)	70,200,000 (64,500,000-76,800,000)
3	Intracerebral hemorrhage	3,460,000 (3,210,000-3,750,000)	78,600,000 (73,300,000-84,600,000)
4	Hypertensive heart disease	1,410,000 (1,170,000-1,560,000)	24,900,000 (20,900,000-27,200,000)
5	Rheumatic heart disease	391,000 (340,000-454,000)	13,400,000 (11,600,000-15,400,000)
6	Atrial fibrillation and flutter	366,000 (313,000-396,000)	8,200,000 (6,830,000-9,940,000)
7	Subarachnoid hemorrhage	365,000 (329,000-411,000)	10,400,000 (9,370,000-11,800,000)
8	Other cardiomyopathy	320,000 (289,000-348,000)	8,450,000 (7,800,000-9,170,000)
9	Other cardiovascular diseases	232,000 (212,000-252,000)	10,100,000 (8,500,000-11,900,000)
10	Aortic aneurysm	160,000 (144,000-170,000)	3,040,000 (2,820,000-3,210,000)
11	Nonrheumatic calcific aortic valve disease	151,000 (127,000-164,000)	2,140,000 (1,950,000-2,370,000)
12	Endocarditis	81,100 (74,400-90,400)	2,040,000 (1,880,000-2,270,000)
13	Lower extremity peripheral arterial disease	71,200 (61,400-76,300)	1,520,000 (1,230,000-2,010,000)
14	Alcoholic cardiomyopathy	66,000 (55,600-74,200)	2,190,000 (1,850,000-2,460,000)
15	Nonrheumatic degenerative mitral valve disease	38,600 (33,900-43,100)	924,000 (827,000-1,070,000)
16	Myocarditis	33,600 (27,100-38,000)	962,000 (810,000-1,090,000)
17	Pulmonary arterial hypertension	23,300 (20,000-26,000)	640,000 (565,000-726,000)
18	Other nonrheumatic valve diseases	2,120 (1,580-2,690)	51,500 (37,100-66,200)

DALY = disability-adjusted life year; UI = uncertainty interval.

Table 2. Global Ranking of Attributable Burden of Cardiovascular Diseases Due to Selected Modifiable Risk Factors

TABLE 2 Global Ranking of Attributable Burden of Cardiovascular Diseases Due to Selected Modifiable Risk Factors

Rank	Cause of Death	Number of Deaths in 2021 (95% UI)	Number of DALYs (95% UI)
1	High systolic blood pressure	10,800,000 (9,150,000-12,100,000)	209,000,000 (172,000,000-236,000,000)
2	Dietary risks	6,580,000 (2,270,000-9,520,000)	142,000,000 (45,300,000-200,000,000)
3	High low-density lipoprotein cholesterol	3,810,000 (2,170,000-5,420,000)	86,300,000 (54,100,000-115,000,000)
4	Ambient particulate matter pollution	3,130,000 (2,310,000-3,930,000)	62,500,000 (45,700,000-78,400,000)
5	Smoking	2,370,000 (498,000-4,410,000)	59,600,000 (13,100,000-107,000,000)
6	High fasting plasma glucose	2,300,000 (2,030,000-2,650,000)	41,200,000 (36,600,000-47,600,000)
7	High body mass index	1,950,000 (1,120,000-2,910,000)	43,900,000 (23,800,000-65,400,000)
8	Kidney dysfunction	1,870,000 (1,440,000-2,340,000)	38,200,000 (30,700,000-45,900,000)
9	Household air pollution from solid fuels	1,610,000 (904,000-2,820,000)	36,200,000 (21,200,000-61,100,000)
10	Lead exposure	1,570,000 (-139,000-3,170,000)	29,700,000 (-2,780,000-61,200,000)
11	Low temperature	1,020,000 (915,000-1,100,000)	17,700,000 (15,900,000-19,200,000)
12	Secondhand smoke	743,000 (297,000-1,070,000)	16,700,000 (6,870,000-24,300,000)
13	High alcohol use	407,000 (179,000-708,000)	9,260,000 (3,830,000-16,300,000)
14	Low physical activity	397,000 (122,000-684,000)	7,220,000 (2,870,000-11,500,000)
15	High temperature	164,000 (114,000-205,000)	3,440,000 (2,370,000-4,300,000)

Abbreviations as in Table 1.

Part II. Different Types of Heart Disease, Causes, Symptoms, and Treatments

1. Cardiovascular Diseases (CVDs)

Key facts

- Cardiovascular diseases (CVDs) are the leading cause of death globally.
- An estimated 17.9 million people died from CVDs in 2019, representing 32% of all global deaths. Of these deaths, 85% were due to heart attack and stroke.
- Over three quarters of CVD deaths take place in low- and middle-income countries.
- Out of the 17 million premature deaths (under the age of 70) due to noncommunicable diseases in 2019, 38% were caused by CVDs.
- Most cardiovascular diseases can be prevented by addressing behavioral and environmental risk factors such as tobacco use, unhealthy diet and obesity, physical inactivity, harmful use of alcohol and air pollution.
- It is important to detect cardiovascular disease as early as possible so that management with counselling and medicines can begin.

Overview

Cardiovascular diseases (CVDs) are a group of disorders of heart and blood vessels. They include:

- coronary heart disease – a disease of the blood vessels supplying the heart muscle.
- cerebrovascular disease – a disease of the blood vessels supplying the brain.
- peripheral arterial disease – a disease of blood vessels supplying the arms and legs.
- rheumatic heart disease – damage to the heart muscle and heart valves from rheumatic fever, caused by streptococcal bacteria.
- congenital heart disease – birth defects that affect the normal development and functioning of the heart caused by malformations of the heart structure from birth; and
- deep vein thrombosis and pulmonary embolism – blood clots in the leg veins, which can dislodge and move to the heart and lungs.

Heart attacks and strokes often happen suddenly. They are usually caused by blockages. These blockages stop blood from getting to the heart or brain. Fatty deposits building up in blood vessels is a common cause. Strokes can also occur from bleeding in the brain. Blood clots can also cause strokes.

What are the risk factors for heart disease?

Key behavioral risks include unhealthy eating and lack of exercise. Tobacco and too much alcohol are also risks. Air pollution is a major environmental risk. These factors can lead to high blood pressure and blood sugar. They can also cause high blood lipids, being overweight, and obesity. Doctors can measure these "intermediate risks." These indicate a higher chance of heart attack and stroke. They also increase the risk of heart failure.

Quitting tobacco helps lower risks. Reducing salt and eating more fruits and vegetables is important. Regular exercise and avoiding too much alcohol are also beneficial. Health policies can help people make healthy choices. Making healthy options affordable and available is crucial. Improving air quality and reducing pollution is also essential.

There are also underlying causes of heart disease. These reflect major changes like globalization and urbanization. Population aging is another factor. Poverty, stress, and family history also play a role.

Medications for high blood pressure and diabetes are important. Drugs for high blood lipids are also needed. These treatments lower heart risks. They help prevent heart attacks and strokes.

What are common symptoms of cardiovascular diseases? [16]

Often, there are no symptoms of the underlying disease of the blood vessels. A heart attack or stroke may be the first sign of underlying disease. Symptoms of a heart attack include:

- pain or discomfort in the centre of the chest; and/or
- pain or discomfort in the arms, the left shoulder, elbows, jaw, or back.

In addition the person may experience:

- difficulty in breathing or shortness of breath;
- nausea or vomiting;
- light-headedness or faintness;
- a cold sweat; and turning pale.

[16] *Heart disease - Symptoms and causes*. (n.d.). Mayo Clinic. https://www.mayoclinic.org/diseases-conditions/heart-disease/symptoms-causes/syc-20353118

Women are more likely than men to have shortness of breath, nausea, vomiting, and back or jaw pain.

The most common symptom of a stroke is sudden weakness of the face, arm, or leg, most often on one side of the body. Other symptoms include sudden onset of:

- numbness of the face, arm, or leg, especially on one side of the body;
- confusion, difficulty speaking or understanding speech;
- difficulty seeing with one or both eyes;
- difficulty walking, dizziness and/or loss of balance or coordination;
- severe headache with no known cause; and/or
- fainting or unconsciousness.

People experiencing these symptoms should seek medical care immediately.

2. Rheumatic Heart Disease? [17]

What is rheumatic heart disease? It results from rheumatic fever, which damages heart valves and muscle. Rheumatic fever is an abnormal reaction to streptococcal bacteria. This infection often starts as a sore throat in children.

This disease mainly affects children in developing nations. Poverty increases the risk. Globally, it causes about 2% of cardiovascular deaths.

Symptoms include shortness of breath and fatigue. Irregular heartbeats, chest pain, and fainting can also occur. Rheumatic fever symptoms are fever and joint pain. Nausea, stomach cramps, and vomiting may also be present.

Why are heart diseases a problem in poorer countries? Most heart disease deaths happen in these nations. They often lack early detection and treatment programs. Access to care is limited for people with heart issues. Detection happens late, and people die younger. This impacts those in their most productive years. The poorest are most affected. Heart diseases can lead to poverty due to health costs. These diseases also strain the economies of poorer nations.

How Can We Reduce Heart Disease?

Include heart disease care in universal health coverage. Many countries need better health systems. Hypertension programs can be effective and cheap at primary care. This lowers the risk of heart disease and stroke. Patients need access to proper technology and drugs.

Basic medicines should include aspirin and beta-blockers. Angiotensin-converting enzyme inhibitors and statins are also important. Quick treatment is needed for heart attacks and strokes. Sometimes, surgery is needed.

[17] *Rheumatic fever - Symptoms and causes*. (n.d.). Mayo Clinic. https://www.mayoclinic.org/diseases-conditions/rheumatic-fever/symptoms-causes/syc-20354588

Symptoms of rheumatic heart disease

Symptoms of rheumatic heart disease include: shortness of breath, fatigue, irregular heartbeats, chest pain and fainting. Symptoms of rheumatic fever include: fever, pain and swelling of the joints, nausea, stomach cramps and vomiting.

Why are Cardiovascular Diseases a Development Issue in Low- and Middle-Income Countries?

In low- and middle-income nations, CVDs cause most deaths worldwide. These countries often lack health programs. Early detection and treatment of CVD risk factors are uncommon. People in these nations have poor access to health care. This affects those with CVDs and other diseases. Detection often happens late. People die young from CVDs and other diseases. This often occurs during their best working years.

The poorest people are harmed the most. CVDs and other diseases worsen poverty. This happens due to large health costs. Families pay much out-of-pocket. CVDs also hurt the economies. They create a large burden for these nations.

How Can the Burden of Cardiovascular Diseases be Reduced?

The key to cardiovascular disease reduction lies in the inclusion of cardiovascular disease management interventions in universal health coverage packages, although in a high number of countries health systems require significant investment and reorientation to effectively manage CVDs.

Evidence from 18 countries has shown that hypertension programs can be implemented efficiently and cost-effectively at the primary care level which will ultimately result in reduced coronary heart disease and stroke. Patients with cardiovascular disease should have access to appropriate technology and medication. Basic medicines that should be available include:

- aspirin;
- beta-blockers;
- angiotensin-converting enzyme inhibitors; and
- statins.

An acute event such as a heart attack or stroke should be promptly managed.

Sometimes, surgical operations are required to treat CVDs. They include:

- coronary artery bypass;
- balloon angioplasty (where a small balloon-like device is threaded through an artery to open the blockage);
- valve repair and replacement;
- heart transplantation; and
- artificial heart operations.

Medical devices are required to treat some CVDs. Such devices include pacemakers, prosthetic valves, and patches for closing holes in the heart.

WHO response [18]

In 2013, WHO members agreed to cut the NCD burden. The "Global Action Plan for 2013-2020" was created. This plan seeks a 25% drop in early deaths from NCDs by 2025. Nine global targets will help reach this goal. Two targets directly address CVD prevention.

Target 6 aims to lower high blood pressure by 25% by 2025. This uses 2010 levels as a starting point. Heart attack and stroke prevention is crucial. Target 8 states at least 50% of those at risk should get therapy and advice. This includes blood sugar control by 2025. Medicines must be available.

Target 9 seeks 80% access to affordable tech and drugs. This includes generics for major NCDs in public and private sectors. Reaching these goals needs better health systems. Investment and strength are vital. WHO is boosting guidance for treating heart issues and strokes. This will aid progress in these areas.

[18] The "Global Action Plan for 2013-2020" was a World Health Organization (WHO) roadmap focusing on preventing and controlling non-communicable diseases (NCDs), aiming for a 25% reduction in premature mortality from NCDs by 2025.

3. Coronary Artery Disease (CAD): Symptoms & Treatment[19]

Coronary Artery Disease

Don't let coronary artery disease (CAD) slow you down. CAD happens when plaque narrows arteries. These arteries feed your heart muscle blood. The most common sign of CAD is chest pain. CAD can cause a heart attack. It may also lead to heart failure. You could also have irregular heartbeats. Get treated and protect your heart. There are many options to improve your health!

What is coronary artery disease?

Coronary artery disease, or CAD, occurs when your heart's arteries narrow. These arteries carry vital, oxygen-rich blood to your heart. Over time, plaque builds up inside these arteries. This buildup limits how much blood flows to your heart.

Think of it like a road closing lanes. Less traffic can get through. With CAD, you may feel fine at first. But the plaque can cause a dangerous blood clot. This clot is like a wall blocking the road. Blood can't reach your heart, leading to a heart attack.

CAD can be present for years with no signs. This is why CAD is often called a "silent killer." Coronary heart disease (CHD) and ischemic heart disease are other names for CAD. It is also the main thing people mean by “heart disease”. Protect your heart; understand CAD.

Coronary artery disease types

There are two main forms of coronary artery disease:

- Stable ischemic heart disease
  This is the chronic form. Your coronary arteries gradually narrow over many, many years. T does not happen overnight. Over time, your heart receives less oxygen-rich blood. You may feel some symptoms (or you may not), but you’re able to live with the condition day to day.
- Acute coronary syndrome**:**

[19] *Coronary artery disease*. (2025, April 2). Cleveland Clinic. https://my.clevelandclinic.org/health/diseases/16898-coronary-artery-disease

This is the sudden form that's a medical emergency and far too often happens when it is too late. The plaque in your coronary artery suddenly ruptures and forms a blood clot that blocks blood flow to your heart. This abrupt blockage causes a heart attack.

How common is coronary artery disease?

Coronary artery disease is a widespread threat. It affects over 18 million U.S. adults. That equals the populations of New York, Los Angeles, Chicago, and Houston combined. This disease caused 375,500 U.S. deaths in 2021. Coronary artery disease is the top killer in the U.S. and globally. Take it seriously and protect your heart health.

Symptoms and Causes

You may have no symptoms of coronary artery disease for a long time. Plaque buildup takes many years, even decades. But as your arteries narrow, you may notice mild symptoms. These symptoms mean your heart is pumping harder to deliver oxygen-rich blood to your body.

- Stable angina
  This is the most common symptom. Stable angina is temporary chest pain or discomfort that comes and goes in a predictable pattern. You'll usually notice it during physical activity or emotional distress. It goes away when you rest or take nitroglycerin (medicine that treats angina).
- Shortness of breath (dyspnea)
  Some people feel short of breath during light physical activity.
- Sometimes, the first coronary artery disease symptom is a heart attack.

What causes coronary artery disease?

Atherosclerosis causes coronary artery disease. Atherosclerosis is the gradual buildup of plaque in arteries throughout your body. When the plaque affects blood flow in your coronary arteries, you have coronary artery disease.

Plaque consists of cholesterol, waste products, calcium and fibrin (a substance that helps your blood clot). As plaque collects along your artery walls, your arteries become narrow and stiff.

Plaque can clog or damage your arteries, which limits or stops blood flow to a certain part of your body. When plaque builds up in your coronary arteries, your heart muscle can't receive enough blood. So, your heart can't get the oxygen and nutrients it needs to work properly (myocardial ischemia). It leads to chest discomfort (angina) and puts you at risk of a heart attack.

People who have plaque buildup in their coronary arteries often have buildup elsewhere in their body, too. This can lead to conditions like carotid artery disease and peripheral artery disease (PAD).

Is it genetic?

Partly. Family history affects your risk of coronary artery disease, but many other risk factors have nothing to do with your genetics. The choices you make every day add up to a big impact on your risk of CAD.

What are the risk factors for coronary artery disease?

There are many risk factors for coronary artery disease. You can't change all of them, but you can manage some of them by making lifestyle changes or taking medications. Talk with your provider about what you can do about these risk factors:

- Being older than 45 if you're male or over 55 if you're female.
- Having a biological family member with heart disease, especially a father or brother with a diagnosis before age 55 or mother or sister before age 65.
- Eating a lot of saturated fat or refined carbohydrates.
- Not exercising enough.
- Not getting enough sleep.
- Smoking, vaping or other tobacco use.
- Having atherosclerosis.
- High blood pressure. [20]
- High LDL ("bad") cholesterol.

[20] Razo, C., Welgan, C. A., Johnson, C. O., McLaughlin, S. A., Iannucci, V., Rodgers, A., Wang, N., LeGrand, K. E., Sorensen, R. J. D., He, J., Zheng, P., Aravkin, A. Y., Hay, S. I., Murray, C. J. L., & Roth, G. A. (2022). Effects of elevated systolic blood pressure on ischemic heart disease: a Burden of Proof study. *Nature Medicine*, *28*(10), 2056–2065. https://doi.org/10.1038/s41591-022-01974-1

- Low HDL ("good") cholesterol.
- High triglycerides (hypertriglyceridemia).
- Anemia.
- Autoimmune diseases, including lupus and rheumatoid arthritis.
- Chronic kidney disease.
- Diabetes.
- HIV/AIDS.
- Metabolic syndrome.
- A body mass index (BMI) higher than 25.
- Sleep disorders like sleep apnea.
- Early menopause (before age 40).
- Endometriosis.
- History of gestational diabetes, eclampsia or preeclampsia.
- Use of hormonal birth control.

What are the complications of coronary artery disease? [21]

The main complication of coronary artery disease is a heart attack. This is a medical emergency that can be fatal. Your heart muscle starts to die because it's not receiving enough blood. You need prompt medical attention to restore blood flow to your heart and save your life.

Over the years, CAD can also weaken your heart and lead to complications, including:

- Arrhythmias (abnormal heart rhythms like atrial fibrillation).
- Cardiac arrest.
- Cardiogenic shock.
- Heart failure.

[21] *Coronary artery disease - Symptoms and causes*. (n.d.). Mayo Clinic. https://www.mayoclinic.org/diseases-conditions/coronary-artery-disease/symptoms-causes/syc-20350613

Diagnosis and Tests

Healthcare providers diagnose coronary artery disease through a physical exam and testing.

During your physical exam, your provider will:

- Measure your blood pressure.
- Listen to your heart with a stethoscope.
- Ask what symptoms you're experiencing and how long you've had them.
- Ask you about your medical history.
- Ask you about your lifestyle.
- Ask you about your family history. They'll want to know about heart disease among your biological parents and siblings.

All of this information will help your provider determine your risk for heart disease.

What tests will be done?

Your provider may also recommend one or more tests to assess your heart function and diagnose CAD. These include:

- Blood tests.
- Cardiac catheterization.
- Computed tomography (CT) coronary angiogram.
- Heart MRI (magnetic resonance imaging).
- Coronary calcium scan.
- Echocardiogram (echo).
- Electrocardiogram (EKG/ECG).
- Exercise stress test.
- Chest X-ray.

Management and Treatment

Coronary artery disease treatment often includes lifestyle changes, risk factor management and medications. Some people may also need a procedure or surgery.

Your healthcare provider will talk with you about the best treatment plan for you. It's important to follow your treatment plan so you can lower your risk of serious complications from CAD.

Lifestyle changes

Lifestyle changes play a big role in treating coronary artery disease. Such changes include:

- Don't smoke, vape or use any tobacco products.
- Eat heart-healthy foods low in sodium, saturated fat, trans fat and sugar. The Mediterranean diet is a proven way to lower your risk of a heart attack or stroke.
- Exercise: Aim for 30 minutes of walking (or other activities) five days a week.
- Limit alcohol.

Be sure to talk with your provider before starting any new exercise program. Your provider can also offer guidance on lifestyle changes tailored to your needs. They may recommend smoking cessation options or meeting with a dietitian to discuss healthy eating plans.

Risk factor management

Managing your risk factors for CAD can help slow down the progression of your disease. Work with your provider to manage the following conditions:

- Diabetes.
- High blood pressure.
- High cholesterol.
- High triglycerides (hypertriglyceridemia).
- Having a BMI higher than 25.

Medications

Medications can help you manage your risk factors and treat symptoms of coronary artery disease. Your provider may prescribe one or more medications that:

1. Lower your blood pressure.
2. Lower your cholesterol.
3. Manage stable angina, like nitroglycerin and ranolazine.
4. Reduce your risk of blood clots.

Procedures and surgeries

Some people need a procedure or surgery to manage coronary artery disease, including:

- **Percutaneous coronary intervention (PCI)**: This minimally invasive procedure has another name — coronary angioplasty. Your provider reopens your blocked artery to help blood flow through it better. They may also insert a stent to help your artery stay open.
- **Coronary artery bypass grafting (CABG)**: This surgery creates a new path for your blood to flow around blockages. This "detour" restores blood flow to your heart. CABG helps people who have severe blockages in several coronary arteries.

Complications/side effects of the treatment

Complications or side effects of coronary artery disease treatments may include:

1. Bleeding.
2. Diarrhea.
3. Dizziness.
4. Cough.
5. Blood clot.
6. Coronary artery puncture.
7. Infection.
8. Abnormal heart rhythms.

9. Cardiac tamponade.

How long does it take to recover from this treatment?

After PCI (angioplasty), you can usually get back to normal activities within a week. After CABG (bypass surgery), you'll be in the hospital for more than a week. After that, it'll take six to 12 weeks for a full recovery.

Prevention

Can coronary artery disease be prevented? [22]

While some coronary artery disease risk factors are unavoidable, you can still reduce your risk. You can also keep it from getting worse.

Avoid smoking or starting smoking. Smoking is a major heart attack risk. Stay away from secondhand smoke too. If someone in your home smokes, help them quit. Call your state's quit line for help. The number is 800-QUIT-NOW.

Eat less food that harms your heart. Eat more food that helps it. Choose a diet low in saturated and trans fats. Increase monounsaturated and polyunsaturated fats found in olive oil and fish. Also, increase fiber from plant foods. Lower salt and sugar intake.

Increase your activity level throughout your life. Aim for at least 150 minutes of moderate exercise weekly. You could also do 75 minutes of vigorous exercise each week. Aim for 30 minutes of daily activity, most days. If you're new to exercise, check with your doctor first.

Maintain a weight within the normal range on a BMI chart. Losing just 5% to 10% of your weight can lower your risk if you're overweight.

Find healthy ways to deal with stress. Stress is part of life. It can lead to bad habits, like overeating. Healthy habits, like exercise, help. Meditation or relaxing with friends can help too. A stress management program might also be useful.

[22] *Coronary Artery Disease: Prevention, treatment and research*. (2023, October 30). Johns Hopkins Medicine. https://www.hopkinsmedicine.org/health/conditions-and-diseases/coronary-artery-disease-prevention-treatment-and-research

Outlook / Prognosis

What can I expect if I have coronary artery disease?

Your provider is the best person to ask about your prognosis. Outcomes vary based on the person. Your provider will look at the big picture, including your age, medical conditions, risk factors and symptoms. Lifestyle changes and other treatments can improve your chances of a good prognosis.

Can coronary artery disease be reversed?

You can't reverse coronary artery disease. But you can manage your condition and prevent it from getting worse. Work with your healthcare provider and follow your treatment plan. Doing so will give you the strongest possible chance of living a long and healthy life.

Living With

How do I take care of myself?

The most important thing you can do is keep up with your treatment plan. This may include lifestyle changes and medications. It may also involve a procedure or surgery and the necessary recovery afterward.

Along with treatment, your provider may recommend cardiac rehab. A cardiac rehab program is especially helpful for people recovering from a heart attack or living with heart failure. Cardiac rehab can help you with exercise, dietary changes and stress management.

Coronary artery disease and mental health [23]

A CAD diagnosis may make you think about your heart and arteries more than ever before. This can be exhausting and overwhelming. You may worry a lot about your symptoms or what might happen to you. Many people with coronary artery disease experience depression and anxiety. It's normal to worry when you're living in a condition that can be life-threatening.

But worry shouldn't consume your daily life. You can still live an active, fulfilling life while having heart disease. If your diagnosis is affecting your mental health, talk with a counselor. Find a support group where you can meet people who share your concerns. Don't feel you need to keep it all inside or be strong for others. CAD is a life-changing diagnosis. It's OK to devote time to processing it all and figuring out how to feel better, both physically and emotionally.

[23] *Coronary artery disease*. (2025b, April 2). Cleveland Clinic. https://my.clevelandclinic.org/health/diseases/16898-coronary-artery-disease

When should I see my healthcare provider?

Your provider will tell you how often you need to come in for testing or follow-ups. You may have appointments with specialists (like a cardiologist) in addition to your primary care visits. Call your provider if you:

- Experience new or changing symptoms.
- Have side effects from your medication.
- Have questions or concerns about your condition or your treatment plan.

Call 911 or your local emergency number immediately if you experience symptoms of a heart attack or stroke—these are life-threatening emergencies that require urgent medical attention. Consider printing out a list of the symptoms and keeping it in a visible place. It's also a good idea to share this information with family and friends so they can act quickly and call 911 on your behalf if necessary.

What questions should I ask my doctor?

If your provider hasn't diagnosed you with coronary artery disease, consider asking:

- What are my risk factors for coronary artery disease?
- What can I do to lower my risk?
- What lifestyle changes are most important for me?
- What medications would lower my risk, and what are the side effects? How long do I need to stay on these medications?

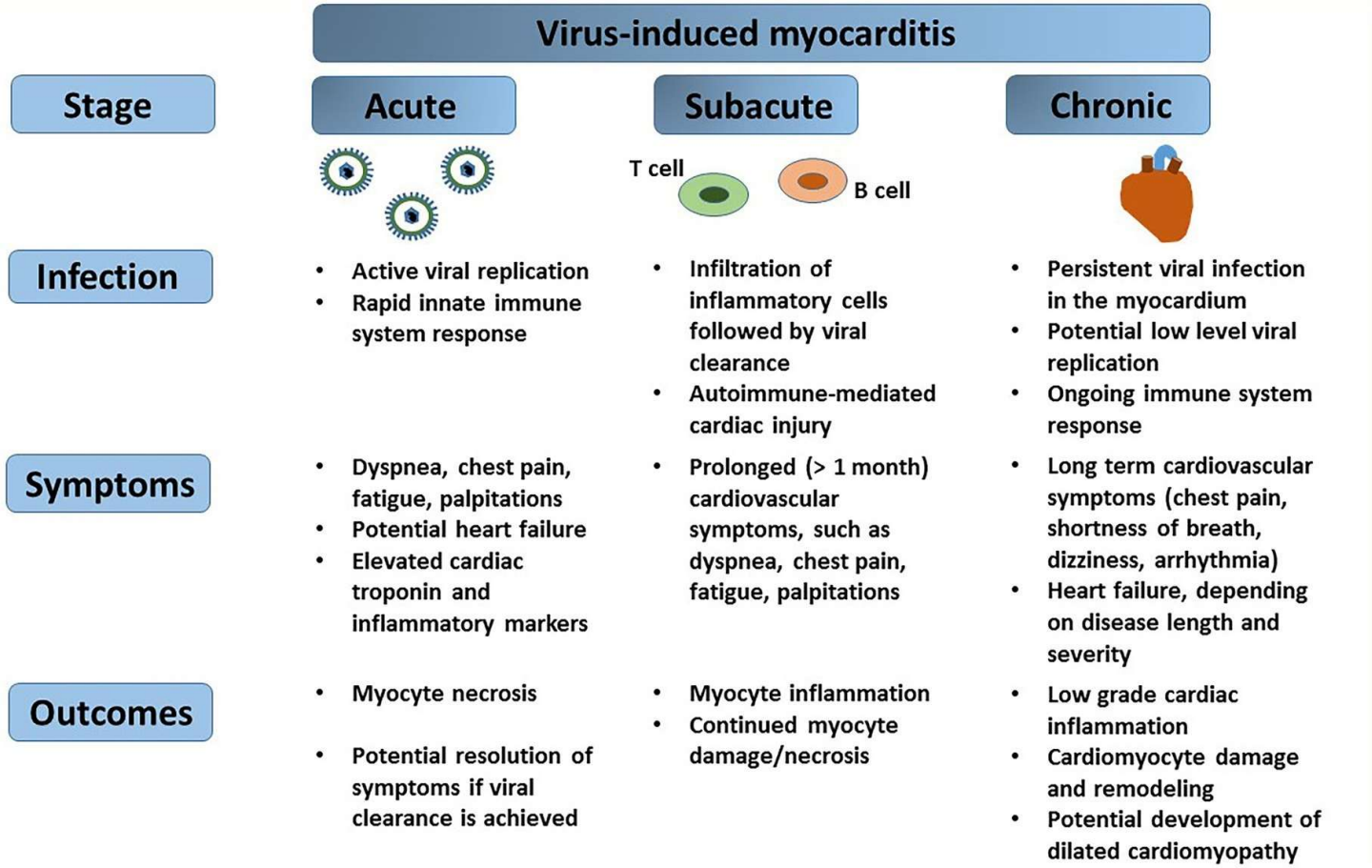
If you have coronary artery disease, some helpful questions include:

- What can I do to slow down disease progression?
- What's the best treatment plan for me?
- What lifestyle changes should I make?
- What medications do I need, and what are the side effects?
- Will I need a procedure or surgery? What does recovery look like?
- Are there support groups or resources you can recommend?

4. Virus Induced Myocarditis [24]

A viral infection of the heart can progress from the acute stage, manifested by rapid viral replication, to a chronic stage, which may involve periods of viral reactivation followed by silent infection. Each of the stages of viral infection of the cardiac muscle may present specific symptoms, and result in outcomes that impact cardiovascular health.

Exhibit 7. Virus-induced myocarditis[25].



Viruses cause many diseases. Myocarditis, or heart muscle inflammation, is one example. Some viruses directly cause this heart problem. Parvovirus B19 and coxsackievirus B3 can trigger it. SARS-CoV-2 is a

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more recent cause. Untreated myocarditis can lead to dilated cardiomyopathy. This condition hurts the heart for good and shortens life. Some viruses may stay in the heart after the first infection. They could reactivate later when conditions are right. Experts are studying if these chronic infections harm the heart over time. This research matters for how doctors treat patients. Studies show that certain viruses are common in heart biopsies. These viruses include parvovirus B19, coxsackievirus, and adenovirus. Human herpesvirus 6, cytomegalovirus, and Epstein–Barr virus also appear. SARS-CoV-2 can also impact the heart. This review looks at how viruses that stay in the heart affect inflammation and disease. It also explores what this means for patient outcomes.

The heart muscle, called myocardium, pumps blood. Cardiomyopathy is a disease of this muscle. It changes the muscle and hurts how it works. Common types include dilated, hypertrophic, and restrictive. Also, there is arrhythmogenic and Takotsubo cardiomyopathy. Myocarditis is when the heart muscle gets inflamed. Viruses often cause it. But, bacteria, fungi, parasites, or autoimmune responses can, too. Toxins or drugs might cause it. Sometimes, the cause is unknown. The AHA says myocarditis is heart muscle inflammation. They estimate 22 in 100,000 people have it, about 0.022%. The disease has stages, with different severity levels. Doctors diagnose acute or chronic myocarditis. Acute myocarditis often follows a virus. Symptoms like shortness of breath, chest pain, and fatigue last weeks to months. Fulminant myocarditis is a fast, severe type of acute myocarditis. It has quick onset and much inflammation. The immune system fights the virus in subacute myocarditis. But, the virus can stay in the heart a long time. It may harm heart cells directly. Or, it can cause damage through ongoing inflammation. The virus might reactivate sometimes. Other times, it's silent, with no activity. It may also keep copying itself. Both things can affect heart health for a long time.

Doctors use the Dallas criteria to classify myocarditis. A biopsy can confirm heart damage from a virus. The test shows immune cells and dead heart cells. This means the heart is hurt. Viruses directly harm heart cells. The body's response can also cause harm. For instance, CD8+ T cells kill infected heart cells in mice. This helps clear the virus. But, too much response can worsen damage. If acute myocarditis doesn't heal, the virus causes ongoing inflammation. This hurts heart cells and changes the heart.

Unresolved myocarditis can lead to DCM. About 20% of myocarditis cases turn into DCM. DCM causes the heart's pump ability to go down and the chambers to get bigger. People with DCM often get heart failure. This limits their lives. Without a transplant, over half die within 5 years of diagnosis.

To diagnose myocarditis, doctors check symptoms. People may have chest pain, shortness of breath, or irregular heartbeats. An EKG is often abnormal. Blood tests may show high heart enzymes like troponin. Antibody levels were also checked in the past. Today, a biopsy is the best tool. It confirms the virus in the heart. It can link the virus to heart inflammation. The risk of problems is low. Biopsies are not for routine checks. They are also not for new heart issues. This may make viral myocarditis seem rare.

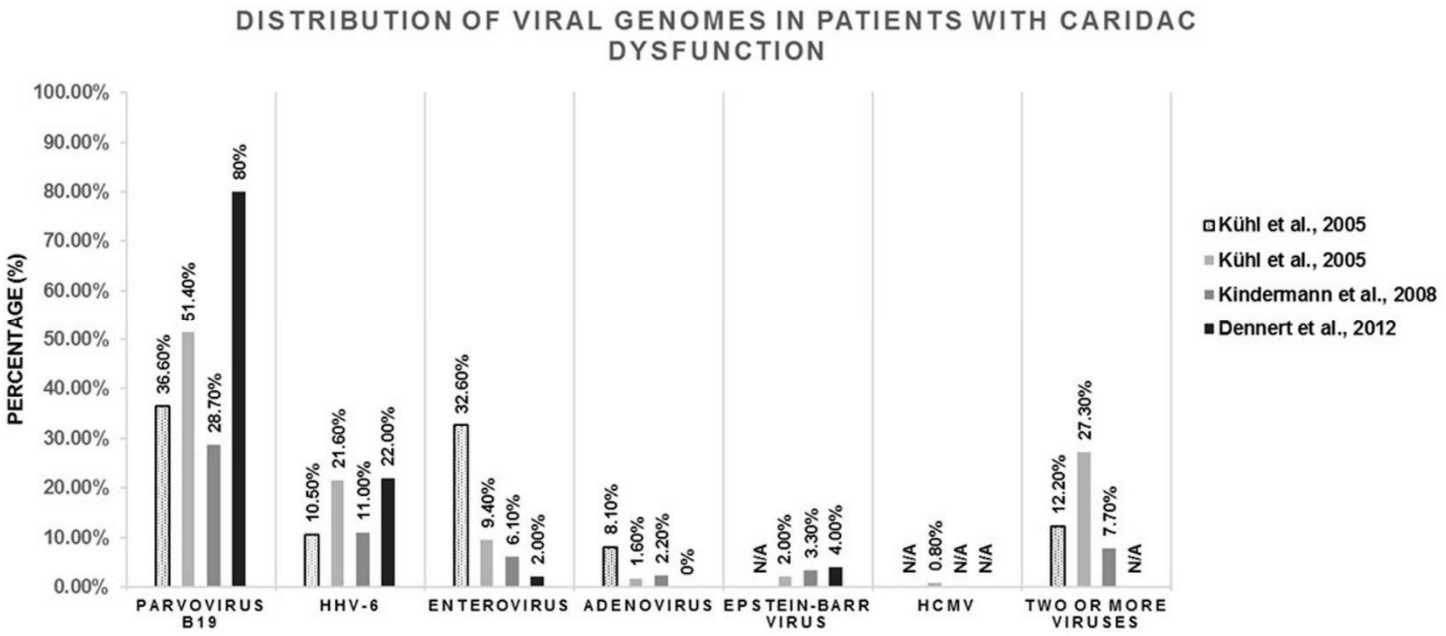
Cardiac inflammation can be linked to many viruses. Parvovirus B19 and CVB3 are common examples. They often cause mild sickness, yet can lead to heart issues. Less common viruses like Ebola and Hantavirus may also cause inflammation, but rarely. SARS-CoV-2, which appeared in 2019, is linked to heart problems too. Heart issues from virus flare-ups can happen after treatments like chemo. This can be due to a weakened immune system.

Table 3. Viruses previously reported to cause myocarditis.

Viral genome type	Virus	References
ssDNA	Parvovirus B19 (B19V)	Schowengerdt et al. (1997); Jain et al. (2013); Ackermann et al. (2020)
dsDNA	Adenovirus	Martin et al. (1994); Treacy et al. (2010)
	Cytomegalovirus (HHV-5, CMV)	Vanstechelman and Vandekerckhove (2012); Saraca et al. (2018)
	Epstein-Barr virus (HHV-4)	Ishikawa et al. (2005); Mutlu et al. (2011)
	Herpesvirus 1 & 2	Kuchynka et al. (2010); Yamamoto et al. (2018); Colombo et al. (2022)
	Hepatitis B	Mahapatra and Ellis (1985)
	Human herpesvirus 6 (HHV-6)	Fukae et al. (2000); Leveque et al. (2011)
	Trichodysplasia spinulosa-associated polyomavirus (TSV)	Tsuzuki et al. (2014)
	Varicella-Zosten virus	Tsintsof et al. (1993); Donoiu and Isrătoaie (2013)
(+) ssRNA	Coxsackievirus	Chapman et al. (2008); Wu et al. (2013); Diarra et al. (2021)
	Chikungunya virus	Alvarez et al., 2017; Farias et al. (2019)
	Dengue virus	Li et al. (2016); Farias et al. (2019)
	Echovirus	Maller et al. (1967)
	Hepatitis A	Allen et al. (2018)
	Hepatitic C	Matsumori and Hepatitis (2005)
	Hepatitis E	Premkumar et al. (2015)
	Human immunodeficiency virus 1&2 (HIV)	Ntusi et al. (2016); Ntusi, 2017
	Human rhinovirus	Wiyatno et al. (2018); Cebeci et al. (2022)
	Poliovirus	Galpine and Wilson (1959)
	Rubella virus	Ainger et al. (1966); Thanopoulos et al. (1989)
	SARS-CoV-2	Fox et al. (2020); Halushka and Vander Heide (2021); Jumah et al. (2022)
	Yellow fever virus	Paixão et al. (2019)
	Zika virus	Aletti et al. (2016)
(−) ssRNA	Crimean-Congo hemorrphagic fever virus	Gülhan et al. (2015)
	Ebola virus	Chertow et al. (2017)
	Hantavirus	Saggioro et al. (2007)
	Human parainfluenza virus (HPIV)	Kalimuddin et al. (2013); Formisano et al. (2021)
	Influenza A & B	Ukimura et al. (2012); Roto et al. (2018)
	Mumps virus	Özkutlu et al. (1989)
	Respiratory syncytial virus (RSV)	Milas et al. (2017); Obrien et al. (2021)

Viral heart infections can persist when the immune system fails to clear them. Persistent infections fall into two groups: latent and chronic. Latent infections last a lifetime. They feature quiet periods and reactivated virus replication. Chronic infections involve constant viral presence. They may eventually be cleared. Studies of heart patients show several viruses are common. These include parvovirus B19, adenovirus, CVB3, Epstein-Barr virus, cytomegalovirus, and herpesvirus 6. Bowles et al. studied myocarditis patients in the US. They found adenovirus, enterovirus, parvovirus B19, and other viruses. Viral DNA was in 38% of patients. Ninety-three percent had prior viral infections. Only a few control samples tested positive. Viral RNA was also found in heart failure patients in Canada. About 20% of DCM patients had viral genomes in their hearts. Seven percent had prior viral infections. This suggests incomplete viral clearance can cause problems. These include inflammation, immune activation, or disease. Viruses are also found in heart tissue of people without heart issues. It is unclear if these viruses are harmful. They may not cause or worsen heart problems. It is also possible they play a role in heart disease.

Exhibit 8. Distribution of Viral Genomes in Patients with Caridac Dysfunction



Analysis of viral genome presence in human endomyocardial samples obtained from patients with cardiomyopathy (dilated cardiomyopathy or myocarditis), as described by Kühl et al. (2005a,b), Kindermann et al. (2008), and Dennert et al. (2012). The amount of parvovirus B19, HHV-6, Enterovirus, Adenovirus, Epstein-Barr virus, HCMV or multi-viral presence (two of more viruses present in one endomyocardial sample) found in each individual study is shown as a percentage (%) in the respective population.

Parvovirus B19 (B19V) is a small virus with single-stranded DNA. It is often found in heart tissue, no matter the person's health. This virus causes fifth disease, a common rash in kids. Most cases are mild. However, anemia can occur, especially in those with weak immune systems. Studies show most people have B19V antibodies by age 50. This confirms the virus is common. B19V can cause acute myocarditis, or heart inflammation. It infects vessel cells in the heart, not heart muscle cells. This leads to inflammation and damages the heart muscle. Some patients with myocarditis show heart muscle changes. Others have lymphocyte infiltration and heart fibrosis from B19V. Besides acute myocarditis, B19V appears in patients with heart failure, even without prior heart issues. It is unclear if B19V is harmful or just present.

Many studies have looked at B19V's impact on heart disease. A study found 84% of heart failure patients with diastolic dysfunction had B19V. Only 21% of those without this dysfunction had the virus. This suggests B19V may harm vessel function and cause disease. B19V can stay in the body after infection. This has been linked to a certain type of chest pain. B19V targets heart lining cells and causes them to die. This process releases particles that hurt blood vessel health. Myocarditis patients with B19V in their hearts had more of these particles. A mouse study showed the same result. This supports the idea that B19V damages vessel linings.

B19V genomes are common in heart tissues with disease. Yet, B19V can stay in healthy people too. A Dutch study found the virus in 80% of DCM patients. It also found it in 75% of healthy controls [26]. Similarly, another study found B19V in 15% of women with heart issues. It also found it in 15% of healthy controls [27]. Viral loads were similar in both groups (Schenk et al., 2009). This suggests the virus amount cannot predict heart disease.

Myocardium B19V persistence does not relate to lymphocyte infiltration. But, heart tissue with the virus showed mitochondrial issues [28]. This hints at another way B19V hurts the heart. Inflammation after the virus can also harm tissue. The B19V NS1 protein can kill endothelial cells. It also boosts pro-inflammatory cytokines [29]. NS1 protein in cells boosts cytokines like IL-6 and TNF-α [30]. Viral proteins in heart tissue might cause lasting inflammation. This could then hurt heart function.

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Checking viral activity is key for understanding B19V findings. A German study found B19V in 70% of people with heart failure. Viral mRNA was in 26.9% of those samples [31]. It would help to check heart damage and inflammation in people with viral activity. This could reveal the link between virus and heart disease. Future work should see if B19V affects heart remodeling by changing genes. Also, it should check how viral proteins damage heart muscle.

Coxsackieviruses

Coxsackie B viruses (CBVs) often cause heart inflammation. This common infection has flu-like symptoms. These include fever, rash, joint pain, and stomach issues. If untreated, CBV infection harms the heart muscle. CBVs cause 25 to 40% of myocarditis cases in young people. Like other heart viruses, CBVs inflame the heart in two ways. They cause direct damage or trigger immune damage.

CBVs use CAR and DAF proteins to enter cells. Scientists have studied CVB3 myocarditis in mice for years. CAR deficiency prevents CVB3 infection and myocarditis. Once inside, the virus's RNA makes a long protein. Viral enzymes cut it into smaller proteins. These proteins help the virus copy itself and exit cells. The enzymes also hurt host cells.

CBVs stop the immune system and release more viruses. They cut host proteins and stop interferon. They also disrupt calcium and ER function. This hurts heart function. Immune damage starts when the body detects viral RNA. This triggers the release of cytokines like IL-1α and TNF-α. The cytokine storm damages infected and healthy heart cells. It also creates heart autoantibodies.

The infection can either clear up or become chronic. This leads to ongoing heart inflammation. This is driven by cytokines and autoimmune reactions. Acute myocarditis from enterovirus is known. One case reported CVB3 heart infection with heart failure. The patient also had lung issues. Heart tissue showed immune cells and dead heart cells. Prior infections can also cause heart issues. One patient developed pericarditis after a CVB3 infection. This suggests that long-term CVB3 infections threaten the heart. Coxsackie B viruses (CBVs) often cause heart inflammation. This common infection has flu-like symptoms. These include fever, rash, joint pain, and stomach issues. If untreated, CBV infection harms the heart muscle. CBVs cause 25 to 40% of myocarditis cases in young people. Like other heart viruses, CBVs inflame the heart in two ways. They cause direct damage or trigger immune damage.

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Herpesviruses

Several viruses in the herpes family may be linked to myocarditis. These include Epstein-Barr virus (EBV), human herpesvirus 6 (HHV-6), and human cytomegalovirus (HCMV). Many people are infected with these DNA viruses. Over 90% of people worldwide have had EBV. More than half have been infected with HHV-6 and HCMV. These viruses stay in the body after the first infection. They don't make more virus because of limited activity.

However, certain conditions can reactivate the virus. These include a weak immune system or illness. This reactivation leads to virus production. Though rare, EBV can cause myocarditis. One case showed heart inflammation with immune cells. The disease varies in severity and outcome. Some people recover on their own. In others, the heart is damaged, possibly causing death. Reactivation has been reported with EBV RNA in the pericardium. Similarly, HCMV-induced heart inflammation has been described. EBV and HCMV cannot infect heart muscle cells directly. Instead, they are found in cardiac immune cells. This suggests the immune system may indirectly cause heart damage.

HHV-6 is the most common herpes virus in heart samples. Many HHV-6 myocarditis cases occur in people with normal immune systems. HHV-6 can also be a co-infection agent. It is thought to play a role in pediatric myocarditis and heart problems. HHV-6 infection, also known as roseola, is common in kids. One case of pediatric myocarditis after HHV-6 showed immune cells in the heart. There was also damage to heart muscle cells. Another study found high levels of heart damage and inflammation markers after HHV-6 infection. HHV-6 may cause problems with blood vessels and heart function. This may happen through direct infection of blood vessel cells.

The exact way herpesviruses affect the heart long-term isn't clear. However, research suggests it harms heart function. EBV and HHV-6 were found in heart samples from people with heart issues or transplants. Kindermann et al's German study found EBV in 3.3% of myocarditis patients' heart samples. HHV-6 was in 11% of those patients. Dennert et al in the Netherlands found EBV in 4% and HHV-6 in 22% of DCM patients. Control group heart samples had no detectable viruses. Kühl et al found HHV-6 in 9.4% of DCM patients' hearts. EBV was in 2%, and HCMV in 0.8%. Elsanhoury et al's German study found HHV-6 DNA in 10.4% of heart failure patients. It was also in 8% of healthy patients. About 62% of heart failure patients had heart inflammation. This suggests HHV-6 isn't always linked to inflammation. Mahrholdt et al's German study linked HHV-6 to heart damage. The virus was in 18.3% of myocarditis patients. Half also had heart failure. Patients with both B19V and HHV-6 had worse heart failure. Multiple viruses may worsen heart function. Escher et al found HHV-6B persistence linked to heart problems. Resolved infections improved heart function. They checked heart function in HHV-6 positive patients over time.

Herpesvirus persistence has been linked to viral protein presence. Scientists used special tools to find EBV in hearts of those with heart issues. EBNA-1 protein, needed for EBV to stay around, was found in the center of some heart cells from these patients. It's possible that EBV protein in the heart could harm cells, affecting heart muscle. It will be useful to see if other EBV proteins also go to heart cells. Most people have EBV. It would be helpful to know if the resting virus in B cells can affect heart disease if it wakes up.

Adenovirus often causes cold symptoms, like issues with breathing. But it can sometimes cause heart inflammation in adults and kids. Like CVB3, adenovirus can infect heart cells directly. It sticks to CAR, causing cell damage and messing up cell structure. Adenovirus type 8 was found in almost 18% of patients with severe heart issues needing a transplant. A study in Canada showed adenovirus in over 27% of heart failure patients. A US study showed adenovirus in 23% of myocarditis patients and 12% of DCM patients' hearts. About 13% of patients with weak hearts had adenovirus in heart samples. But no virus was found in healthy people. These patients did not have active heart inflammation. This suggests the virus might stay in heart tissue after the first infection. Earlier studies showed heart cell death from long-term adenovirus infection. Two adenovirus proteins, E1A and E1, can cause cell death. Future studies may explain how adenovirus harms heart cells.

SARS-CoV-2

SARS-CoV-2 causes COVID-19 and mainly attacks the lungs, leading to breathing problems [32]. However, the virus also damages the heart and blood vessels. Some COVID-19 patients have an irregular heartbeat or heart cell damage. Others develop myocardial fibrosis or myocarditis [33]. Myocarditis can affect up to 30%

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of hospitalized patients, worsening their long-term health [34]. SARS-CoV-2 may infect the heart directly [35]. The Ace2 receptor acts as its entry point into heart cells. After infection, cells internalize the Ace2 receptor, lowering its levels in the heart [36]. This increases the risk of heart disease because Ace2 loss can cause heart failure [37]. The virus can also infect vascular endothelial cells, causing damage.

Autopsies of COVID-19 patients with myocarditis show heart cell death [38]. SARS-CoV-2 proteins have also been found in the heart cells of infected people [39]. Cardiac damage from COVID-19 has unique features like non-myocarditic inflammation or fibrosis [40]. Cytokine storms may also trigger heart injury [41]. This hyper-inflammatory state from the body's immune response releases cytokines. COVID-19 patients often have high levels of troponin, myoglobin, and IL-6. High IL-6 and TNF-α levels during COVID-19 are linked to more severe disease [42].

Some COVID-19 patients experience lingering symptoms, a condition called Long COVID-19 [43]. Vibholm et al found that 12% of people still had SARS-CoV-2 genetic material 23 days after recovery. Over 5% had it 90 days after recovery [44]. The risk of heart problems continues after the initial infection. Xie et al reported

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more myocarditis, pericarditis, and ischemic cardiomyopathy a year after COVID-19 [45]. The exact reasons for long-term heart issues after COVID-19 are unclear. However, the immune system may play a role. Some COVID-19 patients have lower levels of dendritic cells, and this may last for months [46]. Dendritic cells are important for immunity, so their reduced levels may affect the body's response to viruses. More research will help understand the long-term effects of COVID-19.

Discussion

Heart disease is a major killer around the world. Genes, surroundings, and germs can cause heart issues. A viral infection, then heart muscle swelling, hurts the heart. Doctors find viruses, check heart tissue, and see symptoms to link the acute disease to a virus. It is unclear if viruses in the heart long-term have the same effect. This is key since viruses are often in healthy hearts without symptoms.

Evidence shows that viruses or their proteins might cause swelling. This could mess up heart cell jobs. Studies show that clearing the virus improves heart function after heart muscle swelling. This is true for any virus. But, viruses that stay in the heart make things worse. Figuring out how viruses stick around could help make treatments for virus-caused swelling.

Virus proteins may also play a role in heart problems. Mice with a viral gene had weak hearts. This killed them. The gene was also in their hearts. It took months for heart failure to show up. There were no early signs. This means the virus does not need to be active to harm the heart. Another study showed a virus enzyme boosts swelling and helps cells stick together. This enzyme might damage blood vessels and worsen heart disease.

The immune system is key to fighting viruses. A good immune system can stop or limit disease, even if the virus sticks around. But, a weak immune system fails. Also, one virus can help others wake up in the heart by hurting the immune system. Recent reports say the COVID-19 virus can reactivate another virus. Other viruses were also reactivated in people with COVID-19. Scientists think COVID-19 messes up the body's virus defense. The role of shared molecular actions in waking up quiet viruses in the heart needs more study. Still, heart issues may stem from many viruses. Think about both old and new infections as possible causes of cardiac arrest when looking at heart swelling.

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5. Left Sided Heart Failure[47]

Left-sided heart failure occurs when the heart loses its ability to pump blood. This prevents organs from receiving enough oxygen. The condition can lead to complications that include right-sided heart failure and organ damage.

Overview

What is left-sided heart failure? It occurs when the left side of the heart fails to work properly.

There are two main types.

Systolic: The first is systolic heart failure, where the left ventricle is too weak to push blood out to the body. It is also called heart failure with reduced ejection fraction.

Diastolic: The second type is diastolic heart failure, where the left ventricle becomes stiff and cannot relax enough to fill with blood. This is known as heart failure with preserved ejection fraction.

The heart's two sides serve different roles.

Left side:

The left side takes oxygen-rich blood from the lungs and sends it to the body. This oxygen fuels the organs, muscles, and tissues.

Right side

The right side collects oxygen-poor blood from the body and sends it to the lungs. In the lungs, carbon dioxide is released, and fresh oxygen is absorbed.

Symptoms and Causes

Left-sided heart failure may occur in people with:

- Coronary artery disease.
- Heart attack.

[47] *Left-Sided heart failure*. (2025, March 19). Cleveland Clinic. https://my.clevelandclinic.org/health/diseases/22181-left-sided-heart-failure

- High blood pressure.
- Valvular heart disease.
- Abnormal heart rhythms.
- Infiltrative diseases such as amyloid and sarcoid.

Other risk factors for left-sided heart failure include:

- Certain chemotherapy treatments for cancer that cause cardiotoxicity.
- Diabetes.
- Obesity.
- Sleep apnea.
- Older age.
- Smoking.
- Toxins to your heart, such as certain drugs and energy drinks.
- Less commonly, certain medications are used to treat different disease processes, like autoimmune diseases and attention-deficit/hyperactivity disorder.

What are the symptoms of left-sided heart failure?

Symptoms may be mild at first or you may think it's a cold or allergy. You might not even notice them. But as heart function worsens, you may experience:

- Constant coughing.
- Shortness of breath with walking or bending over.
- Waking up short of breath or unable to lie flat at night.
- Weight gain.
- Swelling (edema) in your ankles, legs or abdomen.

Over time, the heart works harder to do its job. This causes complications that may include:

- Cardiogenic shock.
- Enlarged heart.

- Abnormal heart rates and rhythms (arrhythmia).

Diagnosis and Tests

How is left-sided heart failure diagnosed?

Healthcare providers can diagnose this through history and performing a physical examination along with ordering laboratory tests and imaging studies.

Laboratory tests

Lab tests for left-sided heart failure use a sample of blood. They detect signs of heart disease and rule out other causes of your symptoms. You may need:

A **BNP blood test** measures hormones that change when pressure increases inside the heart.

A **metabolic panel** checks how well your kidneys and liver are working. It also looks at electrolytes like sodium and potassium.

Heart imaging tests you may need include:

- An electrocardiogram (EKG) records the heart's electrical signals to check its rhythm.
- An echocardiogram (ECHO) shows how the heart moves and how blood flows through it.
- Coronary angiography uses special dye and X-rays to view the heart's blood vessels.
- A cardiac MRI provides a detailed, high-quality image of the heart's structure and function.

Management and Treatment

What does left-sided heart failure treatment involve?

There are many treatment choices available. The best options depend on whether you have diastolic or systolic heart failure.

Medications are often used to improve how the heart works:

• ACE inhibitors, ARBs, or ARNIs relax blood vessels and help reshape the heart.

• Aldosterone blockers manage stress hormones and stop symptoms from getting worse; they also act as mild water pills.

• Beta blockers slow your heart rate and reduce the effort your heart needs to make.

• Digoxin can help you feel better and keep your heart rate steady.

• Diuretics remove extra fluid from your body.

• SGLT2 inhibitors help lower fluid buildup in those with or without diabetes.

What procedures are necessary for left-sided heart failure treatment?

A procedure may be necessary if:

- symptoms don't improve.
- testing or labs show signs of worsening heart failure.

Care may include:

- **Cardiac resynchronization therapy (CRT)** involves implanting a device that sends small electrical signals to help your heart beat better. It is also called a biventricular pacemaker.
- **Electrical cardioversion** is a procedure that helps restore a normal heart rhythm.
- An i**mplantable cardioverter** defibrillator (ICD) detects irregular heartbeats and releases gentle shocks to restore a normal rhythm.
- The **left ventricular assist device (LVAD)** is a small pump placed inside your body that helps the heart circulate blood.
- A heart transplant replaces a damaged heart with a healthy one from a donor. This option is usually for patients with the most severe cases of left-sided heart failure.

Prevention

Living a heart-healthy lifestyle can lower the chance of developing left-sided heart failure. If you have already had this condition, adopting healthy habits can help prevent future problems.

To reduce risk, focus on controlling blood pressure and managing coronary artery disease. Regular exercise and a good night's sleep are also important. Keep your weight in check and eat plenty of fruits and vegetables. Managing stress through deep breathing or relaxation can make a difference. Lastly, quit smoking if you use tobacco and avoid secondhand smoke to protect your heart.

Outlook / Prognosis

What is the outlook for people with left-sided heart failure?

It can be excellent as long as routine appointments with a care team are kept and taking medications as recommended by a healthcare provider.

What are the complications of left-sided heart failure?

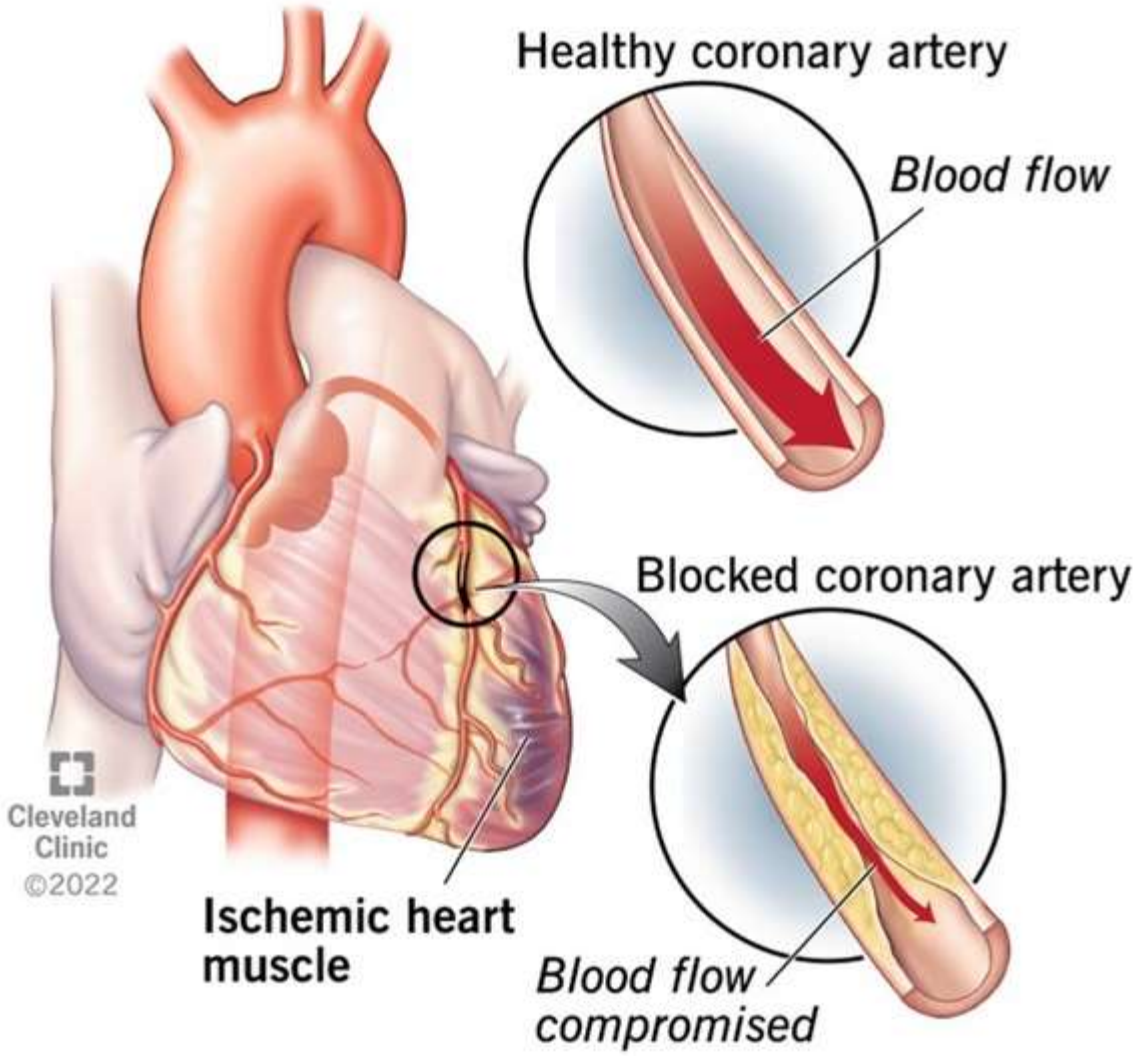
Complications of left-sided heart failure can include:

- Arrhythmias or abnormal heart rhythms such as ventricular tachycardia and atrial fibrillation (Afib).
- Obstructive and central sleep apnea.
- Heart valve disease (leaky valves).
- Liver disease.
- Right-sided heart failure.
- Frailty and muscle weakness.
- Anemia.
- Kidney disease.
- Depression or anxiety.

6. Myocardial Ischemia

Myocardial ischemia is a lack of blood flow getting to your heart muscle. That means your heart muscle isn't getting enough blood to do what it needs to do. Often, the cause is a collection of fat and cholesterol (plaque) that doesn't let enough blood go through your coronary arteries. Medicines and surgeries can treat myocardial ischemia.

Exhibit 9. Myocardial Ischemia



Source: Cleveland Clinic

What is myocardial ischemia?

Myocardial ischemia (or cardiac ischemia) means your heart muscle is not getting enough blood (which contains oxygen and nutrients) to work as it should. If this lack of blood from your coronary arteries is severe or goes on for more than a few minutes, it can damage your heart muscle. Then it becomes a myocardial infarction (heart attack).

A heart attack is an emergency. You should call 911 for an ambulance instead of having someone drive you to the hospital.

Who does myocardial ischemia affect?

People who get myocardial ischemia often have:

- High blood pressure.
- High cholesterol.
- Diabetes.
- A family history of cardiovascular disease.
- A history of tobacco product use.

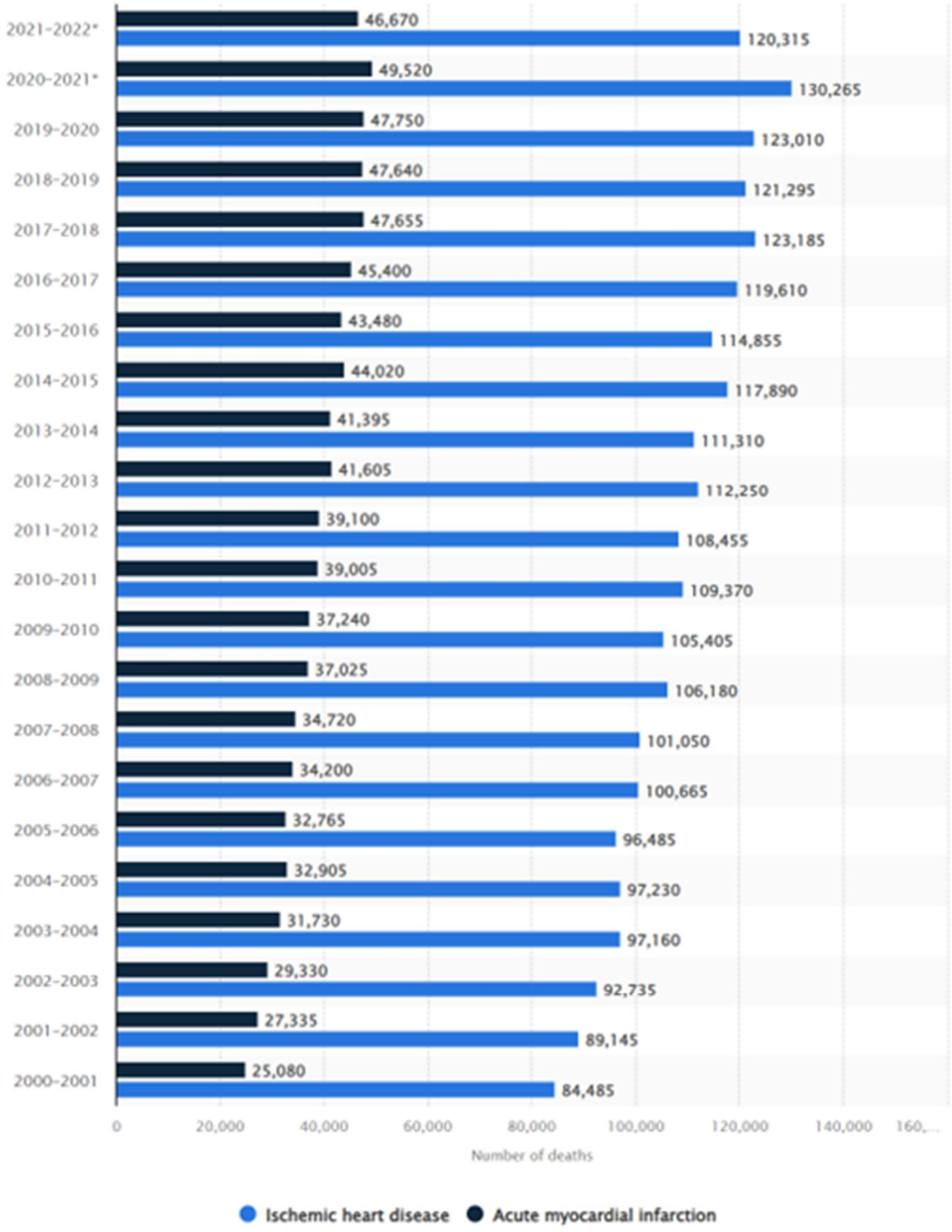
How common is myocardial ischemia?

Each year, more than 1 million people in the United States die from myocardial infarction (heart attack). This is due to myocardial ischemia, a lack of blood flow and oxygen to your heart muscle.

How does myocardial ischemia affect my body?

Myocardial ischemia makes it difficult to exercise, especially in the cold. As your condition gets worse, you can have symptoms of myocardial ischemia with less and less activity. In time, it can be hard to go up a flight of stairs. Eventually, you can even have symptoms when you're at rest.

Exhibit 10. Number of deaths from ischemic heart disease and acute myocardial infarction in Canada from 2000 to 2022.



Symptoms and Causes

What are the symptoms?

The most common symptom of myocardial ischemia is angina (also called angina pectoris). This is chest pain (similar to indigestion or heartburn) that feels like:

- Chest discomfort.
- Heaviness.
- Tightness.
- Pressure.
- Aching.
- Burning.
- Numbness.
- Fullness.
- Squeezing.

There are two types of angina:

- Stable angina, which usually stops soon after you rest or take medication to manage it.
- Unstable angina, which can happen at any time, even when you're relaxed or sleeping. It may not go away when you take medication.

Other myocardial ischemia symptoms can also include:

- Pain or discomfort in your upper body, including your arms, left shoulder, back, neck, jaw or stomach.
- Trouble breathing or feeling short of breath.
- Sweating or "cold sweat."
- Feeling full, indigestion, or a choking feeling (may feel like heartburn).
- Nausea or vomiting.

- Feeling lightheaded, dizzy, very weak or anxious.
- Fast or irregular heartbeat.

If you have angina or any of the symptoms of ischemia listed above that last for more than five minutes, call 911 right away.

It's possible to have ischemia — or even a heart attack — and not have any warning signs. This is called silent myocardial ischemia. This is most common in people with diabetes, but it can happen to anyone with heart disease.

What causes myocardial ischemia?

Often, a person has more than one cause of myocardial ischemia.

Causes of myocardial ischemia include:

- **Coronary artery disease.** This is a buildup of plaque and cholesterol inside your coronary arteries, which supply blood to your heart muscle. The buildup narrows your artery so much that the oxygen-rich blood your heart needs can't get through, and your heart muscle becomes starved for oxygen. This causes ischemia and angina. Atherosclerotic plaque causes 70% of fatal heart attacks. For more information on rare causes of coronary events, such as Spontaneous Coronary Artery Dissection (SCAD), please refer to *Appendix D Spontaneous Coronary Artery Dissection*.
- **Blood clot.** When plaque that forms in your narrow coronary artery breaks apart, it can attract a blood clot. When a blood clot settles in a coronary artery that's already narrow, it can cause a blockage (thrombosis).
- **Coronary artery spasm.** This happens when the coronary arteries spasm, which temporarily reduces or cuts off blood supply to your heart.
- **Cocaine use.**
- **Coronary artery dissection.** This rare condition can keep blood from getting to your heart.

Ischemia is most likely to happen when your heart needs more oxygen and nutrients than it's getting. It happens when your heart can't keep up with your body's increased demand for blood.

Your body needs more blood when you're:

- Active/exercising.

- Eating.
- Excited.
- Stressed.
- Cold.

Diagnosis and Tests

How is myocardial ischemia diagnosed?

In addition to getting your medical history and doing a physical exam, your healthcare provider may do the following tests:

- Electrocardiogram (EKG).
- Echocardiogram.
- Holter monitor.
- Exercise stress test.
- Coronary angiogram.
- Chest X-ray.
- Heart MRI.

Your provider may also do blood tests to check for:

- Proteins and enzymes that only show up in the blood when the heart muscle is damaged.
- Causes of ischemia.
- High cholesterol.

Management and Treatment

How is myocardial ischemia treated?

Myocardial ischemia treatments may include medications or procedures to improve blood flow to your heart muscle. Your treatment for myocardial ischemia depends on the cause of the problem. Your healthcare provider will talk to you about the treatment that's best for you.

What medications/treatments are used?

Medicines or treatments for myocardial ischemia may include:

- Nitroglycerin for quick relief of angina.
- Beta-blockers.
- Calcium channel blockers.
- Thrombolytics (clot-busting drugs).
- Angioplasty and stent placement.
- Coronary artery bypass graft.

Complications/side effects of the treatment

Complications of coronary artery bypass graft may include:

- Infection.
- Bleeding.
- Kidney failure.
- Stroke.
- Heart attack.
- Arrhythmia (abnormal heart rhythm).

Rarely, some of these complications can happen with angioplasty/ stent placement as well.

How long does it take to recover from this treatment?

After a coronary artery bypass graft, you'll need to spend about a week in the hospital. After that, you'll need six to 12 weeks to recover at home.

After angioplasty or stent placement, you'll probably spend the night in the hospital and go home the next day.

Prevention

How can you reduce your risk?

Your healthcare provider may recommend medications or lifestyle changes to reduce your risk of myocardial ischemia.

Medicines

- Taking a baby aspirin (or another dose your provider suggests for you) every day to prevent a heart attack. People who can't take aspirin can take clopidogrel.
- Beta-blockers.
- Cholesterol-lowering drugs.
- ACE inhibitors.

Lifestyle changes

- Get treatment for diabetes.
- Get treatment for high blood pressure.
- Get treatment for high cholesterol.
- Exercise 30 to 60 minutes on most days.
- Eat less fat and lots of fruits, vegetables and whole grains.
- Don't use tobacco products.

Outlook / Prognosis

What can you expect if you have myocardial ischemia?

It's common for people with unstable angina to have a heart attack in the next three months. Heart attacks are fatal in the first few hours for up to a third of people who have them.

Most people who get through the first few days after a heart attack recover completely. However, 10% live less than a year after their heart attack.

How long does myocardial ischemia last?

Angina from myocardial ischemia lasts 10 minutes or less in most cases.

How do I take care of oneself?

Exercise is very helpful for improving your cardiovascular health. It gets more oxygen to your heart muscle, which helps with symptoms. Healthcare providers recommend getting at least 30 to 60 minutes of exercise five or more days a week.

Other ways to stay healthy include:

- Keep taking all medicines your provider prescribed for you.
- Eat a healthy diet.
- Stay at a healthy weight.
- Avoid tobacco products.

When should I see my healthcare provider?

Contact your healthcare provider if your medicines aren't helping you or if the side effects are severe. If you've had an angioplasty and stent placement or coronary artery bypass graft, you'll most likely need to see your provider every six months during the first year after your procedure.

When should I go to the ER?

Call 911 and chew an aspirin if you think you're having a heart attack. If you have a clot in your coronary artery, aspirin can help make it smaller.

You should also get help immediately if you've taken three nitroglycerin doses (one every five minutes) and still have angina.

What questions should you ask your doctor?

- How often will you need to see me once I start exercising?
- Will I need to take the medicines you prescribed for the rest of my life?
- How high is my individual risk of a heart attack?

Additional Common Questions

Is myocardial ischemia the same as angina?

No. Angina (chest pain) is a very common symptom of myocardial ischemia.

Is myocardial ischemia a stroke?

No. Myocardial ischemia is a lack of blood supply to your heart muscle. A stroke affects your brain.

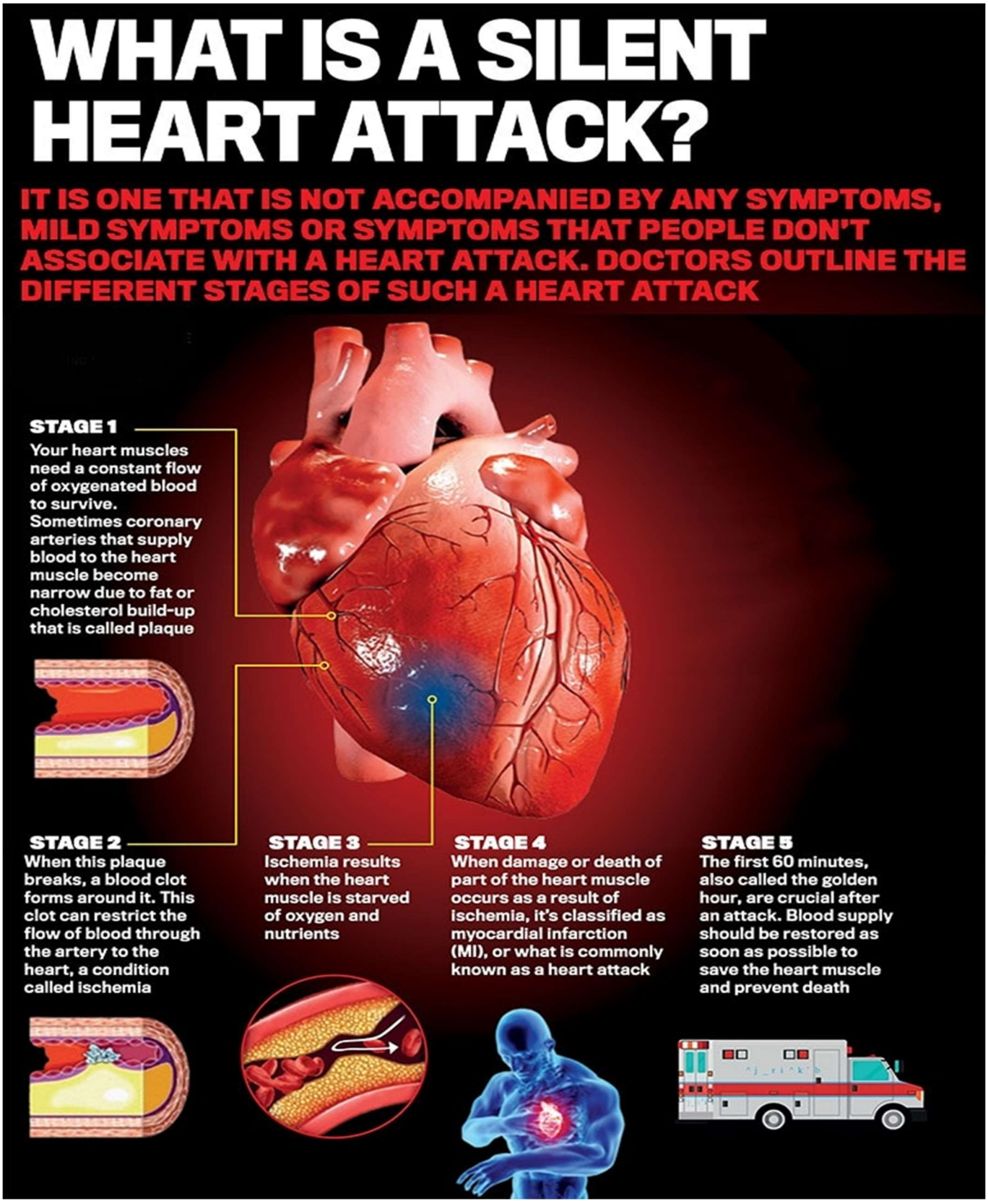
How long can you live with myocardial ischemia?

It depends on many factors, such as:

- Whether you have a heart attack.
- How quickly you get diagnosis and treatment.
- How well you do with following your healthcare provider's instructions for making lifestyle changes.
- How well you manage conditions that cause myocardial ischemia (usually atherosclerosis).

Part III. Silent Heart Attacks

Exhibit 11. What is Silent Heart Attack?



About half of all heart attacks are mistaken for less serious problems and can increase your risk of dying from coronary artery disease.

You can have a heart attack and not even know it. A silent heart attack, known as a silent myocardial infarction (SMI), account for 45% of heart attacks and strike men more than women.[48]

They are described as "silent" because when they occur, their symptoms lack the intensity of a classic heart attack, such as extreme chest pain and pressure; stabbing pain in the arm, neck, or jaw; sudden shortness of breath; sweating, and dizziness.

"SMI symptoms can feel so mild, and be so brief, they often get confused for regular discomfort or another less serious problem, and thus men ignore them," says Dr. Jorge Plutzky, director of the vascular disease prevention program at Harvard-affiliated Brigham and Women's Hospital.

For instance, men may feel fatigue or physical discomfort and chalk it up to overwork, poor sleep, or some general age-related ache or pain. Other typical symptoms like mild pain in the throat or chest can be confused with gastric reflux, indigestion, and heartburn.

Also, the location of pain is sometimes misunderstood. With SMI, you may feel discomfort in the center of the chest and not a sharp pain on the left side of the chest, which many people associate with a heart attack. "People can even feel completely normal during an SMI and afterward, too, which further adds to the chance of missing the warning signs," says Dr. Plutzky.

SMI: Unaware of possible danger [49]

The number of people who suffer an SMI and don't realize it is alarming. A study in the Nov. 10, 2015, Journal of the American Medical Association looked at almost 2,000 people ages 45 to 84 (half of whom were men) who were free of cardiovascular disease.

After 10 years, 8% had myocardial scars, which are evidence of a heart attack. Most surprising was that 80% of these people were unaware of their condition. Overall, the prevalence of myocardial scars was five times higher in men than in women.

SMI and regular heart attacks share the same risk factors: smoking, being overweight, lack of exercise, high blood pressure, high cholesterol levels, and diabetes. They can be just as dangerous, too. "SMI often leaves scarring and damage to the heart, which, combined with the fact that many people who have an SMI don't

[48] Harvard Health. (2020, November 3). *The danger of "silent" heart attacks*. https://www.health.harvard.edu/heart-health/the-danger-of-silent-heart-attacks

[49] Harvard Health. (2020, November 3). *The danger of "silent" heart attacks*. https://www.health.harvard.edu/heart-health/the-danger-of-silent-heart-attacks

seek immediate care, can further raise a person's risk of a second and potentially more harmful heart attack," says Dr. Plutzky. In fact, people who have an SMI and don't get treatment have a three times greater risk of dying from coronary artery disease. "A silent heart attack is a loud signal your body sends that you have some kind of underlying health issue that needs attention," says Dr. Plutzky.

Heart muscle damage can be found with an EKG or echocardiogram. These tests show if there's damage. A blood test can also detect troponin T. This protein is released from injured heart cells. Emergency rooms use it to check for heart attacks.

After an SMI, manage your risk factors with a doctor's plan. This may mean diet changes and exercise. Drugs like statins can help prevent future attacks.

Dr. Plutzky warns, "Don't ignore even minor SMI signs." It's better to get help than risk the effects.

SMI symptoms are often mild and short. Get help right away if you have these:

- Chest discomfort for minutes, or if it returns. It may feel like pressure or pain.
- Discomfort in your arms, back, neck, jaw, or stomach.
- Trouble breathing before or during chest discomfort.
- Cold sweats, feeling sick, or dizziness.

Myocarditis is when the heart muscle swells. It affects the heart's signals and causes fast or odd heartbeats. Myocarditis can weaken the heart, leading to a condition called cardiomyopathy.

Dr. Nisha Aggarwal Gilotra from Johns Hopkins explains myocarditis. She talks about its signs, causes, and care.

Myocarditis happens when the heart muscle gets inflamed. This swelling is from your immune system fighting infections. Viruses or autoimmune problems can cause it. When it's bad, the heart gets weak. It has trouble pumping blood well.

There are different types of myocarditis. Here are some:

Acute myocarditis comes on fast. It's often from a virus. The signs can show up and go away quickly.

Chronic myocarditis takes longer to treat. Symptoms might come back. This can happen with autoimmune problems. These make the immune system attack healthy cells.

Lymphocytic myocarditis is a rare kind of myocarditis. It can mean a hospital stay for care. It happens when white blood cells cause the heart muscle to swell. A virus can cause this issue.

1. Introduction

Silent myocardial infarctions (SMIs), commonly known as silent heart attacks, represent a significant yet largely overlooked public health concern in Canada. Unlike typical heart attacks characterized by chest pain, shortness of breath, and other recognizable symptoms, SMIs occur with minimal or no symptoms, making them particularly dangerous[50,51].

Causing comparable damage to traditional heart attacks, the oversight of SMIs is particularly troubling when compared to other asymptomatic conditions that receive substantial attention, funding, and established screening protocols within Canadian healthcare.

Consider colorectal cancer (CRC), a condition that affects approximately 26,900 Canadians annually. Despite being largely asymptomatic in early stages, CRC has benefited from comprehensive screening programs across provinces, with regular colonoscopies recommended for all Canadians aged 50 and above[5253]. These screening efforts have contributed to earlier detection and improved survival rates, demonstrating the efficacy of systematic screening for asymptomatic conditions.

Similarly, type 2 diabetes (another condition that can develop and progress without noticeable symptoms) has received substantial attention in Canadian healthcare. Regular blood glucose screening for at-risk populations has become standard practice, enabling early intervention and management of a condition that might otherwise go undetected until complications develop.

Hypertension offers another compelling example. Often called “the silent killer,” high blood pressure typically presents no symptoms yet significantly increases the risk of heart attack, stroke, and other cardiovascular complications. Regular blood pressure screening has become normalized in clinical practice, with measurements taken routinely during most healthcare visits[54].

[50] Gul, Z., Shams, P. & Makaryus, A. N. Silent myocardial ischemia. in *StatPearls* (StatPearls Publishing, Treasure Island (FL), 2025).
[51] Cohn, P. F., Fox, K. M. & Daly, C. Silent myocardial ischemia. *Circulation*, 108, 1263–1277 (2003).
[52] Public Health Agency of Canada. Colorectal cancer in Canada. https://www.canada.ca/en/public-health/services/publications/diseases-conditions/colorectal-cancer.html (2017).
[53] Screening tests for older adults. https://www.fraserhealth.ca/health-topics-a-to-z/seniors/screening-tests-for-older-adults.
[54] Screening tests for older adults. https://www.fraserhealth.ca/health-topics-a-to-z/seniors/screening-tests-for-older-adults.

The disparity between the approach to these conditions and SMIs is striking. Despite their high prevalence, SMIs remain largely unaddressed through systematic screening programs[55]. This oversight constitutes an important gap in Canadian cardiovascular care and public health policy.

This report examines the prevalence, causes, and impact of SMIs in Canada, comparing current screening practices, awareness levels, and funding allocations with those of other asymptomatic conditions. By highlighting these disparities, we aim to demonstrate the need for comprehensive screening protocols for SMIs, particularly among Canadians at high risk. Through policy recommendations, we advocate for a change in cardiovascular screening that acknowledges the significance of SMIs and implements appropriate preventive measures to reduce their substantial health and economic burden on Canadian society.

2. Prevalence and Demographics

Silent Heart Attacks

SMIs account for up to 54% of all heart attacks, representing a substantial yet largely unaddressed health concern[56]. A study published in the *Journal of the American Medical Association* in 2015, saw nearly 2,000 individuals aged 45 to 84, half of whom were men, with no history of cardiovascular disease (CVD)[57]. After a decade, 8% had developed myocardial scars, indicating a past heart attack. Notably, 80% of those affected were unaware of their condition. Another study published in 2016 showed that men are more likely than women to experience an SMI, just as they are with typical heart attacks[58]. However, women have a higher risk of death due to differences in how they perceive and respond to the event.

Survival rates following SMIs present a troubling picture. Individuals who experience a SMI without receiving treatment face a threefold increase in the risk of death from coronary artery disease[59]. Thus, the lack of diagnosis and subsequent treatment directly contributes to poorer outcomes.

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[55] Gul, Z., Shams, P. & Makaryus, A. N. Silent myocardial ischemia. in *StatPearls* (StatPearls Publishing, Treasure Island (FL), 2025).

[56] Li, F. *et al.* Silent myocardial infarction and long-term risk of frailty: The Atherosclerosis Risk in Communities study. *Clin. Interv. Aging* 16, 1139–1149 (2021).

[57] Turkbey, E. B. *et al.* Prevalence and correlates of myocardial scar in a US cohort. *JAMA* 314, 1945–1954 (2015).

[58] Zhang, Z.-M. *et al.* Race and sex differences in the incidence and prognostic significance of silent myocardial infarction in the Atherosclerosis Risk in Communities (ARIC) study. *Circulation* 133, 2141–2148 (2016).

[59] The danger of 'silent' heart attacks. *Harvard Health* (2020). https://www.health.harvard.edu/heart-health/the-danger-of-silent-heart-attacks

Key risk factors for SMIs include[60,61]:

- Diabetes mellitus
- History of hypertension
- Age
- Family history of CVD
- Sedentary lifestyle
- Obesity
- Smoking history
- Previous radiation therapy to the chest
- Chronic kidney disease

Notably, diabetes emerges as the most significant risk factor, with diabetic individuals having a markedly increased risk of experiencing silent cardiac events due to diabetic neuropathy affecting pain perception[62].

Comparison with Other Screened Conditions

CRC is the third most prevalent cancer in Canada, affecting approximately 1 in 14 men and 1 in 18 women over their lifetime[63]. Consequently, the disease benefits from systematic screening programs across Canada. These programs have contributed to a steady decline in mortality rates over the past two decades, demonstrating the effectiveness of population-based screening approaches. In fact, nearly 47% of colorectal cancer cases in Canada are detected at an early stage (stages I or II), and the five-year survival rate following diagnosis is approximately 65%.

Between 2016 and 2019, nearly 9% of Canadian adults aged 20 to 79 had diabetes[64]. Prevalence varied by age, affecting 1% of those aged 20 to 39 and rising to 18% among seniors aged 60 to 79. Men (10%) were more likely to have diabetes than women (7%). Recognizing the condition is essential for initiating treatment and managing blood glucose levels, yet only 81% of Canadians meeting the diagnostic criteria

[60] Gul, Z., Shams, P. & Makaryus, A. N. Silent myocardial ischemia. in *StatPearls* (StatPearls Publishing, Treasure Island (FL), 2025).

[61] Li, F. *et al.* Silent myocardial infarction and long-term risk of frailty: The Atherosclerosis Risk in Communities study. *Clin. Interv. Aging* 16, 1139–1149 (2021).

[62] Cohn, P. F., Fox, K. M. & Daly, C. Silent myocardial ischemia. *Circulation* 108, 1263–1277 (2003).

[63] Public Health Agency of Canada. Colorectal cancer in Canada. (2017). https://www.canada.ca/en/public-health/services/publications/diseases-conditions/colorectal-cancer.html

[64] Government of Canada & Canada, S. Diabetes among Canadian adults (2023). https://www.statcan.gc.ca/o1/en/plus/5103-diabetes-among-canadian-adults

were aware they had diabetes. While diabetes itself is not directly fatal in most cases, it substantially increases the risk of cardiovascular events, including SMIs. As such, the healthcare system has rightfully established routine screening protocols for diabetes, particularly among individuals over 40, those with family history, and members of high-risk ethnic groups. This systematic approach has enabled earlier detection and management, reducing complication rates.

Hypertension affects an estimated 7.5 million Canadians, with an age-standardized prevalence of 23% among adults[65]. Like SMIs, hypertension is frequently asymptomatic until complications develop. Untreated hypertension increases cardiovascular mortality risk by 3-4 times, yet benefits from widespread screening initiatives. In fact, blood pressure measurement has become a standard component of virtually all healthcare encounters, leading to detection rates exceeding 60% among hypertensive individuals[66,67]. This high detection rate contrasts sharply with SMIs, which remain largely undetected until incidental findings or complications arise.

3. Causes and Symptoms

Silent Heart Attacks

SMIs share the same fundamental pathophysiology as symptomatic heart attacks: reduced or blocked blood flow to the heart muscle, resulting in oxygen deprivation and cardiac tissue damage[68,69,]. This typically occurs due to coronary artery disease, where atherosclerotic plaque accumulates in coronary arteries, potentially rupturing and forming clots that obstruct blood flow. What distinguishes SMIs is their atypical or absent symptom presentation. While traditional heart attacks commonly manifest with chest pain, pressure, or discomfort that radiates to the arm, neck, or jaw, SMIs may present with[70,71].

[65] Padwal, R. S., Bienek, A., McAlister, F. A., Campbell, N. R. C. & Outcomes Research Task Force of the Canadian Hypertension Education Program. Epidemiology of hypertension in Canada: An update. *Can. J. Cardiol.* 32, 687–694 (2016).

[66] Screening tests for older adults. https://www.fraserhealth.ca/health-topics-a-to-z/seniors/screening-tests-for-older-adults.

[67] Baker, R. *et al.* Levels of detection of hypertension in primary medical care and interventions to improve detection: a systematic review of the evidence since 2000. *BMJ Open* 8, e019965 (2018).

[68] Gul, Z., Shams, P. & Makaryus, A. N. Silent myocardial ischemia. in *StatPearls* (StatPearls Publishing, Treasure Island (FL), 2025).

[69] Cohn, P. F., Fox, K. M. & Daly, C. Silent myocardial ischemia. *Circulation* 108, 1263–1277 (2003).

[70] Li, F. *et al.* Silent myocardial infarction and long-term risk of frailty: The Atherosclerosis Risk in Communities study. *Clin. Interv. Aging* **16**, 1139–1149 (2021).

[71] The danger of 'silent' heart attacks. *Harvard Health* (2023). https://www.health.harvard.edu/heart-health/the-danger-of-silent-heart-attacks

- Unusual fatigue or sudden unexplained weakness
- Mild discomfort in the chest, upper back, or arms that is dismissed as musculoskeletal pain
- Sleep disturbances or unexplained insomnia
- Slight shortness of breath, particularly during activities that previously caused no respiratory difficulty
- Mild indigestion or nausea unattributed to gastrointestinal causes
- Dizziness or light-headedness without obvious cause

These symptoms are often subtle enough to be attributed to aging, stress, or minor ailments, resulting in individuals not seeking medical attention[72]. In many cases, absolutely no symptoms are reported, with the cardiac event only discovered later through electrocardiographic changes or imaging studies conducted for unrelated reasons.

The unclear symptomatic presentation is compounded by neurological factors. Research indicates that variations in pain perception pathways, particularly in diabetic patients with neuropathy or those with prior heart damage, may contribute to reduced pain signaling during cardiac events[73]. Additionally, individuals with higher pain thresholds or those who have experienced chronic pain conditions may subconsciously minimize or misinterpret cardiac symptoms.

Comparison of Symptomatology

Early-stage CRC shares a key characteristic with SMIs: it frequently presents with no symptoms, making screening essential for early detection[74]. When symptoms do appear, they include:

- Changes in bowel habits
- Blood in stool
- Abdominal discomfort or cramping
- Unexplained weight loss
- Feeling of incomplete bowel emptying

The asymptomatic nature of early CRC mirrors that of SMIs, with both conditions potentially progressing significantly before detection. However, CRC benefits from established screening protocols that detect

[72] Turkbey, E. B. *et al.* Prevalence and correlates of myocardial scar in a US cohort. *JAMA* 314, 1945–1954 (2015).

[73] Cohn, P. F., Fox, K. M. & Daly, C. Silent myocardial ischemia. *Circulation* 108, 1263–1277 (2003).

[74] Menon, G. & Cagir, B. Colon cancer. in *StatPearls* (StatPearls Publishing, Treasure Island (FL), 2025).

precancerous polyps or early-stage disease before symptoms develop, offering a preventive approach currently lacking for SMIs[75,76].

Type 2 diabetes is another condition with insidious onset and minimal early symptoms. The pathophysiology involves insulin resistance, leading to chronic hyperglycemia. Early-stage diabetes frequently presents with no noticeable symptoms, or with subtle manifestations including[77]:

- Increased thirst and urination
- Fatigue
- Blurred vision
- Slow-healing wounds
- Recurrent infections

Like SMIs, these symptoms are often attributed to other causes or considered normal aspects of aging. However, despite this symptomatic similarity, diabetes benefits from routine blood glucose screening, allowing detection before complications develop. This stands in stark contrast to the approach toward SMIs, where screening is not systematically implemented despite similar symptom obscurity. Notably, diabetes and SMIs share more than symptomatic similarities; they demonstrate significant comorbidity[78,79]. Diabetic individuals face substantially higher risk for SMIs due to diabetic neuropathy affecting pain perception pathways. This interconnection further emphasizes the need for cardiac screening in diabetic patients, yet this remains inconsistently implemented across Canada.

Hypertension provides perhaps the most direct parallel to SMIs in terms of symptom presentation. Like SMIs, hypertension typically produces no symptoms until significant damage has occurred to blood vessels and organs[80]. Both conditions:

- Progress silently while causing cardiovascular damage
- Remain undetected without specific testing

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[75] Menon, G. & Cagir, B. Colon cancer. in *StatPearls* (StatPearls Publishing, Treasure Island (FL), 2025).

[76] Quynh Anh, N. & Ha, N. T. Does national colorectal cancer screening program represent good value for money? Results from a return-on-investment model in Vietnam. *Health Serv. Insights* **14**, 11786329211017418 (2021).

[77] Type 2 diabetes. *Mayo Clinic* https://www.mayoclinic.org/diseases-conditions/type-2-diabetes/symptoms-causes/syc-20351193.

[78] Cohn, P. F., Fox, K. M. & Daly, C. Silent myocardial ischemia. *Circulation* **108**, 1263–1277 (2003).

[79] Type 2 diabetes. *Mayo Clinic* https://www.mayoclinic.org/diseases-conditions/type-2-diabetes/symptoms-causes/syc-20351193.

[80] High blood pressure (hypertension). *Mayo Clinic* (2024). https://www.mayoclinic.org/diseases-conditions/high-blood-pressure/symptoms-causes/syc-20373410

- Contribute significantly to mortality when left untreated
- Respond well to early intervention

Despite these similarities, hypertension screening through blood pressure measurement has become standard practice in virtually all healthcare settings, whereas SMIs receive no comparable attention. This disparity exists despite both conditions sharing common risk factors and pathophysiological connections.

How Stress Affects the Heart[81]

Stress can increase the risk of heart disease in multiple ways. Chronic stress leads to higher inflammation levels, which can cause plaque to build up in arteries. This buildup may result in coronary artery disease, increasing the chances of heart attacks, irregular heartbeats, or heart failure.

Stress also triggers the release of catecholamines, hormones produced by the adrenal glands. One of these hormones is adrenaline, often called the "fight or flight" hormone. It makes you more alert during stressful events but also speeds up the heart and raises blood pressure. Constant high levels of adrenaline can harm the heart over time.

Another stress hormone, cortisol, stays elevated with long-term stress. It raises blood pressure and increases blood sugar, cholesterol, and triglycerides. These changes put extra strain on the heart and blood vessels, raising the risk of heart problems.

Physiological Effects: Stress causes the body to release hormones like adrenaline and cortisol. These hormones make blood vessels narrow, which raises blood pressure and increases the heart rate. Stress can also change how platelets in the blood work. This may lead to blood clots that block blood flow to the heart. Chronic stress increases inflammation in the body, including around the heart. This inflammation can raise the risk of developing heart disease.

Effects on Lifestyle: Stress often leads to unhealthy habits. Many people smoke, eat too much, or drink too much alcohol when stressed. These behaviors raise the chance of heart problems. Stress can also make it hard to stay active. A lack of exercise can cause weight gain and other health issues.

[81] Katella, K. (2024, February 12). *Yes, stress can hurt your heart: 3 things to know*. Yale Medicine. https://www.yalemedicine.org/news/stress-affects-your-heart

Stress and Heart Damage: In some cases, severe emotional stress can weaken the heart muscle temporarily. This condition is called stress cardiomyopathy or broken heart syndrome. It often causes temporary heart failure, but most people recover within weeks or months.

Ways to Manage Stress and Avoid Heart Attacks: Reducing stress is key. Meditation, yoga, and deep breathing exercises can help lower stress and blood pressure. Regular exercise releases endorphins, which improve mood and reduce stress. A healthy diet, getting enough sleep, and avoiding smoking and excess alcohol also help lower the risk of heart disease.

Getting Help: If stress becomes overwhelming or affects daily life, see a therapist or counselor. Joining a support group can also provide comfort and practical coping tips. Taking these steps can help protect the heart and improve overall health.

"Stress is sometimes underrecognized as a risk factor for heart disease," says Rachel Lampert, MD, a Yale Medicine cardiologist.

Some experts believe that stress is a major cause of heart disease, which is the leading cause of death in the US. It ranks alongside poor diet, lack of exercise, smoking, too much alcohol, and obesity as a top risk factor.

4. Screening, Awareness, and Funding

Current Status of SMI Screening in Canada

The comparison of symptomatology across these conditions reveals a significant inconsistency in healthcare approaches: while they all progress silently until significant damage occurs or complications develop, only SMIs lack systematic screening protocols. In fact, the Canadian Cardiovascular Society guidelines currently contain no specific recommendations for routine screening to detect SMIs, despite acknowledging their prevalence and impact. This absence stands in stark contrast to the detailed screening recommendations provided for other cardiovascular conditions like atrial fibrillation or thoracic aortic disease[82].

[82] Guidelines and Clinical Practice Update Library. *Canadian Cardiovascular Society* (2024). https://ccs.ca/guidelines-and-clinical-practice-update-library/

This inconsistency becomes particularly troubling when considering that SMIs can be detected through non-invasive, cost-effective methods such as electrocardiograms (ECGs) and cardiac biomarkers, similar to the blood pressure measurements used for hypertension screening or blood glucose tests for diabetes. Instead, ECGs are typically performed only when patients present with symptomatic cardiovascular complaints or require pre-operative assessments. This reactive rather than preventive approach directly contradicts the established medical understanding that early detection significantly improves outcomes, resulting in preventable mortality and morbidity.

The causes and asymptomatic nature of SMIs reflect a condition ideally suited for screening programs, particularly given:

1. The defined high-risk populations that could be targeted
2. The availability of non-invasive detection methods
3. The significant impact of early intervention on outcomes
4. The established precedent for screening other similarly asymptomatic conditions

Thus, the disparity in approach cannot be justified on the basis of symptom presentation, as SMIs are no more symptomatic than conditions currently receiving systematic screening. Rather, this gap appears to reflect historical healthcare priorities and awareness levels rather than evidence-based policy.

Comparison of Screening Approaches

CRC screening in Canada demonstrates what comprehensive, well-funded screening can achieve. Every province and territory has implemented organized CRC screening programs targeting adults aged 50-74, with some jurisdictions beginning screening at age 45 for higher-risk populations[83]. These programs use fecal immunochemical tests (FIT) as the primary screening tool, with colonoscopy reserved for positive results or high-risk individuals.

The Canadian Partnership Against Cancer estimates that between 18% and 55% of eligible Canadians participate in colorectal screening programs, a participation rate that continues to improve through public awareness campaigns and primary care provider engagement[84]. This participation has contributed to a reduction in CRC mortality over the past two decades. Moreover, funding for CRC research and support

[83] Screening guidelines in Canada. *Colorectal Cancer Canada* https://www.colorectalcancercanada.com/app/uploads/2019/05/Screening_Guidelines_in_Canada.pdf

[84] Participation rate. *Canadian Partnership Against Cancer* (2021). https://www.partnershipagainstcancer.ca/topics/colorectal-indicators-2017-2018/indicators/participation-rate/

comes from various sources, including the Canadian Cancer Society, government initiatives, and partnerships with organizations like Pfizer and Thermo Fisher Scientific. For instance, Colorectal Cancer Canada has $1.6 million in reserve funds, enough to cover 107% of its annual program expenses, equivalent to one year and one month of funding[85].

Diabetes screening in Canada has been systematically implemented with clear guidelines and funding support. The Diabetes Canada Clinical Practice Guidelines recommend screening for type 2 diabetes every 3 years in individuals aged 40 and older, with more frequent screening for those with additional risk factors[86]. These guidelines have been widely adopted across provincial healthcare systems and incorporated into primary care quality metrics. Furthermore, diabetes screening tests (fasting glucose, HbA1c) are fully covered by provincial health plans when ordered by healthcare providers, removing financial barriers to access. This coverage extends to preventive screening in asymptomatic individuals based solely on age and risk factor profile. In 2021, the Government of Canada allocated $25 million over five years to support the development of a national diabetes framework, along with research, surveillance, and prevention efforts[87].

As for hypertension screening, it represents perhaps the most successfully implemented screening program in Canadian healthcare. The Hypertension Canada guidelines explicitly recommend blood pressure measurement at all appropriate primary care visits for adults, with annual measurements for those over 40 or with risk factors[88]. These recommendations have achieved exceptionally high implementation rates across healthcare settings, ensuring near-universal screening coverage for Canadians. Provincial health plans fully cover blood pressure measurements, and public health campaigns have successfully increased awareness of hypertension as "the silent killer," prompting individuals to seek regular screening.

Funding Allocation

The lack of a formal screening infrastructure and awareness for SMIs may stem from a lack of funds solely for the disease. Though encompassed within broader CVD initiatives, SMIs receive comparatively less

[85] Colorectal Cancer Canada. *Charity Intelligence* https://www.charityintelligence.ca/charity-details/693-colorectal-cancer-canada.

[86] Diabetes Canada. https://guidelines.diabetes.ca/cpg/chapter4.

[87] Public Health Agency of Canada. Diabetes: What Canada's doing. (2023). https://www.canada.ca/en/public-health/services/chronic-diseases/diabetes/what-canadas-doing.html

[88] Rabi, D. M. *et al.* Hypertension Canada's 2020 comprehensive guidelines for the prevention, diagnosis, risk assessment, and treatment of hypertension in adults and children. *Can. J. Cardiol.* 36, 596–624 (2020).

dedicated funding. The Government of Canada's recent $5 million investment in the Canadian Heart Function Alliance focuses on heart failure research, without specific mention of SMIs[89]. Similarly, the Heart and Stroke Foundation allocates 66.2% of its expenditures to mission-related activities, including research, advocacy, and health promotion, but does not specify funding dedicated to SMIs[90]. This disparity underscores the need for increased awareness and targeted research into SMIs, given its significant impact on patient outcomes.

5. Economic Impact

Cost Effectiveness of Screening for CVDs

Studies Advocating for CVD Screenings

In 2009, a study published in the *Canadian Journal of Cardiology* reviewed the economic costs of CVD in Canada and other developed countries (United States, Europe, and Australia), focusing on research published from 1998 to 2006[91]. The findings revealed that CVD accounted for 74,255 deaths (33% of all deaths) in Canada and remains one of the most costly diseases, imposing a significant economic burden on healthcare systems. As such, the cost-effectiveness of screening programs for the disease must be evaluated.

On one hand, a German study evaluated the cost-effectiveness of using high-sensitivity troponin-I (hsTnI) as a tool for assessing CVD risk in a general population[92]. It compared the "screen & prevent" strategy, guided by hsTnI, against a "do-nothing" strategy using a discrete-event simulation model for two countries: low-risk Germany and high-risk Kazakhstan. On the other hand, a Danish study evaluated the cost-effectiveness of screening men for CVD compared to no screening, using data from a randomized controlled trial with a 5.7-year follow-up[93]. The screening approach included multiple diagnostic methods

[89] Public Health Agency of Canada. Message from the Minister of Health and Minister of Sport and Physical Activity – Heart Month, February 2024. *Government of Canada* (2024). https://www.canada.ca/en/public-health/news/2024/02/message-from-the-minister-of-health-and-minister-of-sport-and-physical-activity--heart-month-february-2024.html

[90] Where every dollar goes. *Heart and Stroke Foundation of Canada* https://www.heartandstroke.ca/what-we-do/finances/where-every-dollar-goes.

[91] Tarride, J.-E. *et al.* A review of the cost of cardiovascular disease. *Can. J. Cardiol.* 25, e195–202 (2009).

[92] Jülicher, P. & Varounis, C. Estimating the cost-effectiveness of screening a general population for cardiovascular risk with high-sensitivity troponin-I. *Eur. Heart J. Qual. Care Clin. Outcomes* 8, 342–351 (2022).

[93] Søgaard, R. *et al.* Cost effectiveness of population screening vs. no screening for cardiovascular disease: the Danish Cardiovascular Screening trial (DANCAVAS). *Eur. Heart J.* 43, 4392–4402 (2022).

such as low-dose CT for coronary artery calcification, limb blood pressure measurements for peripheral artery disease and hypertension, telemetric heart rhythm assessment for atrial fibrillation, and blood tests for cholesterol and HbA1c levels. The conclusions of both studies were the same: implementing comprehensive screening programs for heart diseases in high-risk groups is cost-effective.

In the Danish study, the incremental cost-effectiveness ratio (ICER) for CVD screening was €10,812 per life year (LY) gained, which falls within the commonly accepted cost-effectiveness thresholds in many developed countries, including Canada[94,95]. This suggests that, for every €10,812 spent, one additional life year could be gained through screening. Given that CVD is responsible for one-third of all deaths in Canada, widespread screening could result in significant improvements in population health outcomes, translating into saved lives and reduced long-term healthcare costs[96].

Similarly, the German study demonstrated that the "screen & prevent" strategy was cost-saving, meaning that the intervention not only prevented CVD events but also reduced overall healthcare costs[97]. In Germany, where the strategy was cost-effective, the ICER was $6,755 per quality-adjusted life year (QALY) gained. This is far below Canada's willingness-to-pay threshold of $50,000 per QALY, further strengthening the argument for adopting similar screening programs. For every $6,755 spent, one additional QALY would be gained, indicating a highly cost-efficient intervention in the prevention of CVD events.

In a Canadian context, where the direct costs of CVD treatment are already high, these findings offer a clear financial incentive for implementing preventive screenings. The cost-effectiveness ratios in both studies suggest that with relatively low costs per LY or QALY gained, widespread screening could prevent thousands of CVD-related deaths and reduce the long-term treatment burden on Canada's healthcare system. For example, if screening programs were to prevent just a fraction of the CVD events in Canada, this could result in a significant reduction in hospitalizations, treatments, and long-term care costs, ultimately leading to net savings for the healthcare system.

Comparison with Other Screening Programs

When compared to existing cancer screening programs, such as those for CRC ($1,498–$49,531 depending on the test and interval), breast cancer (£21,000 per QALY in the UK, potentially lower with adjusted

[94] Tarride, J.-E. *et al.* A review of the cost of cardiovascular disease. *Can. J. Cardiol.* 25, e195–202 (2009).
[95] Søgaard, R. *et al.* Cost effectiveness of population screening vs. no screening for cardiovascular disease: the Danish Cardiovascular Screening trial (DANCAVAS). *Eur. Heart J.* 43, 4392–4402 (2022).
[96] Tarride, J.-E. *et al.* A review of the cost of cardiovascular disease. *Can. J. Cardiol.* **25**, e195–202 (2009).
[97] Jülicher, P. & Varounis, C. Estimating the cost-effectiveness of screening a general population for cardiovascular risk with high-sensitivity troponin-I. *Eur. Heart J. Qual. Care Clin. Outcomes* **8**, 342–351 (2022).

screening intervals), or prostate cancer (over $39,000 depending on the interval), the Danish study found that CVD screening was found to be similarly cost-effective[27].

Nonetheless, the cost-effectiveness of CVD screening remains a subject of ongoing debate, while CRC screening has long been recognized as cost-effective, with multiple studies confirming its economic benefits[13,25,28]. This fact is supported by a systematic review of 33 studies, which highlighted that CRC screening is not only cost-effective but in many cases, cost-saving, especially in the United States[98]. In contrast, although several studies suggest that CVD screening programs can be similarly cost-effective to CRC screening, there is still no widespread consensus[99,100].

The challenge lies in the complexity of CVD, which encompasses a range of conditions with varying risk factors and treatment protocols, making it difficult to apply a one-size-fits-all approach to screening. Furthermore, the long-term outcomes and the economic impact of early detection for CVD are not as clearly defined as they are for CRC, which has more established and predictable screening benefits. Despite these uncertainties, recent evidence points to the potential for CVD screening programs to be just as cost-effective as CRC screening. However, the lack of universally accepted models and the variation in cost-effectiveness depending on regional healthcare systems and population demographics continue to fuel the debate.

Impact of Untreated SMIs vs. Various Cancers

Without timely medical intervention, individuals with SMIs face a substantially higher risk of sudden cardiac death (SCD), as undetected heart damage can predispose them to fatal arrhythmias and heart failure. A 2020 study published in the *Journal of the American Heart Association* emphasizes that SMIs contribute to increased morbidity and mortality rates, comparable to symptomatic myocardial infarctions[101]. Furthermore, the lack of early treatment means these patients are less likely to receive guideline-directed therapies, such as anticoagulants, beta-blockers, or lifestyle modifications, which could mitigate long-term complications. As a result, untreated SMIs not only pose a direct threat to patient survival but also lead to a progressive decline in cardiac function, increasing the likelihood of recurrent cardiovascular events.

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[98] Ran, T. *et al.* Cost-effectiveness of colorectal cancer screening strategies-A systematic review. *Clin. Gastroenterol. Hepatol.* **17**, 1969–1981.e15 (2019).

[99] Ran, T. *et al.* Cost-effectiveness of colorectal cancer screening strategies-A systematic review. *Clin. Gastroenterol. Hepatol.* 17, 1969–1981.e15 (2019).

[100] Søgaard, R. *et al.* Cost effectiveness of population screening vs. no screening for cardiovascular disease: the Danish Cardiovascular Screening trial (DANCAVAS). *Eur. Heart J.* 43, 4392–4402 (2022).

[101] Cheng, Y.-J. *et al.* Association between silent myocardial infarction and long-term risk of sudden cardiac death. *J. Am. Heart Assoc.* 10, e017044 (2021).

Not only do undetected SMIs cut short the lives of countless people, but the cost of its consequences, such as heart failures, is quite heavy on the Canadian economy. For instance, a recent study recorded a total of 436,160 hospitalizations with heart failure as the primary diagnosis in Canada[102]. Between 2010/2011 and 2018/2019, the number of hospitalizations rose from 43,114 to 54,743, while the number of affected patients increased from 34,960 to 44,567. During this period, total hospitalization costs escalated from $684.3 million to $776.0 million, accumulating to $6.65 billion. Looking ahead, from 2019/2020 to 2039/2040, an estimated 1.69 million heart failure hospitalizations are expected, placing a financial strain of $19.5 billion on the Canadian healthcare system.

Similarly, a 2022 study found that the Canadian healthcare system bore a significant portion of the economic burden of cancer, with total health system costs reaching CAD 18.4 billion in 2021[103]. The largest share of these costs was attributed to the initial phase of care, which accounted for CAD 5.6 billion as patients underwent treatments and hospitalization shortly after diagnosis. The continuing phase of care, which represents the majority of those living with cancer, followed closely behind with CAD 8.1 billion in healthcare expenses, reflecting long-term treatment needs and follow-up care. In contrast, the terminal phase of care saw a reduction in healthcare costs, totaling CAD 4.4 billion, likely due to increased reliance on end-of-life services.

While both conditions are severely impactful on the healthcare system, untreated SMIs may have a broader long-term effect, especially as they contribute to increased cardiovascular morbidity and mortality, which can result in more frequent and prolonged hospitalizations. Yet, most SMIs remain undetected for decades. From a purely economic perspective, the current approach to SMIs represents a missed opportunity for healthcare cost containment and resource optimization. The evidence suggests that implementing targeted screening programs would generate substantial economic returns while simultaneously improving health outcomes for Canadians.

THE DIAGNOSTIC REVOLUTION

Despite the grim outlook, modern tools help assess heart risk. Hospitals now check for more than just cholesterol and blood sugar. They also suggest tests for C-reactive protein. High levels may mean a higher risk of cardiac arrest. Plasma ceramides are also checked. Some have been linked to plaque build-up. Brain

[102] Ellis, E. E. *et al.* Economic burden of heart failure hospitalizations in Canada: A population-based study. *CJC Open* (2024) doi:10.1016/j.cjco.2024.11.019.

[103] Garaszczuk, R., Yong, J. H. E., Sun, Z. & de Oliveira, C. The economic burden of cancer in Canada from a societal perspective. *Curr. Oncol.* 29, 2735–2748 (2022).

natriuretic peptides get tested as well. They ease heart pressure when pumping is hard. Calcium Scoring detects plaque build-up. Troponin T is tested, too. Increased levels raise risk. Experts say these tests are more sensitive and affordable now. "Blood tests are easy to take," says Dr. Atul Limaye. "We can monitor any problems. We've caught heart attacks early using blood biomarkers."

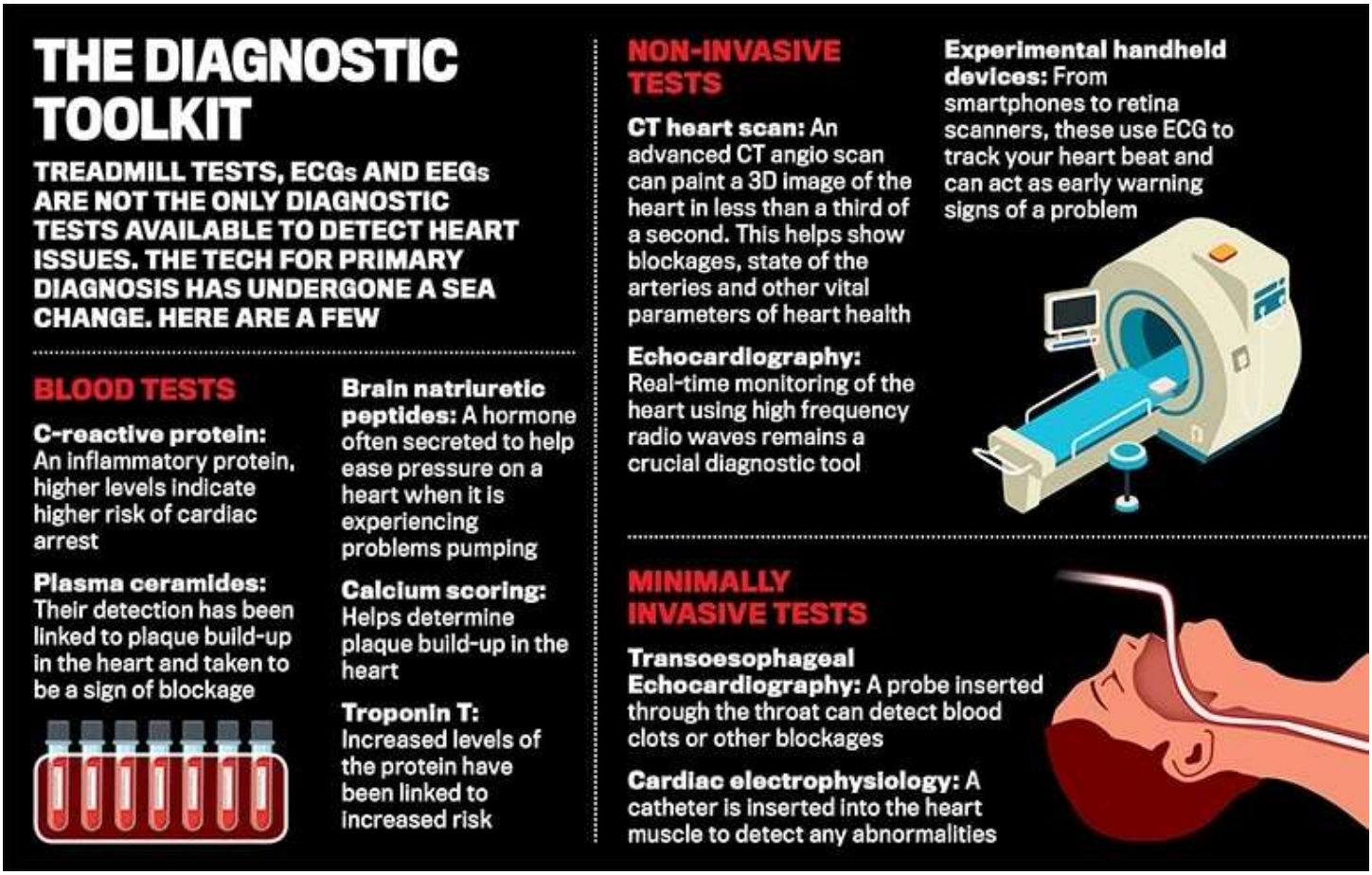
Doctors use other tools. Treadmill stress tests and angiography are still common. But they now measure blood flow and blockages better. CT heart scans are also more accurate. These non-invasive tests have improved a lot. Heart CT scans now use up to 256 slices. Earlier scans used only 64. This gives a better heart image. Hospitals also have new devices to find problems. These include echocardiography. It monitors the heart using radio waves. Transoesophageal echocardiography uses a probe to check for clots. Gamma cameras use radiation to check heart health. Cardiac Electrophysiology uses a catheter to find heart issues.

Doctors advise annual blood tests to start. But those with genetic risks should get advanced tests. CT Angio scans are best for early diagnosis, says Dr. Seth. "They show heart blockages clearly. So treatment can start sooner."

Experts advise people to pay close attention to their symptoms. Dr. Bahl warns that pain lasting more than a few minutes needs immediate medical attention. Ongoing pain could signal a serious issue, not just a heart problem. Often, people ignore minor symptoms until their condition gets worse. Diya Pawaskar, 39, from Pune, felt weak and struggled to walk. Diagnosed with heart disease in 2019, she waited two days before seeking help. She feared a major illness would ruin her life. Since then, Pawaskar traveled to Europe, had another child, and survived Covid.

Doctors reassure patients that heart treatments are not always invasive. Most cases can be treated with stent surgery to clear blocked arteries. This quick, minimally invasive procedure is common today. Keyhole surgeries are also popular. Some hospitals use computers to help surgeons with accuracy. Cardiac stents, tiny mesh coils that open blocked arteries, have greatly improved. Dr. Seth notes they are now safer and more effective. In the 1990s, bare metal stents had a 25% chance of causing new blockages. Medicated stents reduced this risk to less than 5%. Today, thinner stents and better imaging lower the risk of future problems to just 1 or 2%. Newer stents even dissolve in the body over time, leaving arteries open without permanent implants.

Exhibit 12. The Big Advances in Treatment



Many hospitals now use bioresorbable scaffolds that dissolve naturally. New stents include bio-engineered options for better support. Drug-eluting stents prevent blood clots. Dual therapy stents use cell technology for faster healing.

Lost in the system that has too many systems

Our health system is actually many systems in one. It was made to treat people with single health issues. For instance, some hospitals focus on heart problems or strokes. Some centers are experts in memory issues related to blood vessels. Other clinics treat heart failure, prevent strokes, and handle heart defects in adults. These experts are key to managing each health issue well. Primary health teams should help patients and families navigate the system.

But even with one issue, patients face problems. They move between services and specialists during diagnosis, treatment, and recovery. Much of this happens outside hospitals. Dr. Patrice Lindsay says this can be hard. People with less knowledge, resources, or support struggle more. Language and culture can also make things harder as people adjust to new lives.

Access to care is a constant challenge. Many Canadians can't get needed medicines, even with insurance. Over one in five without insurance struggle to pay for drugs. Even one in ten with insurance find it hard.

Sarah Lansdown had two strokes. She says you must fight for yourself. Without money, resources, education, language, and drive, she would have struggled. She worries about others without support.

Heart & Stroke runs online support groups. They also have a registry for people with heart issues, strokes, and memory problems. Their families can join too. Analysis of online talks and surveys shows these problems are common.

People share how hard it is to live after a diagnosis. They need to feel less alone, keep up relationships, and try to live well.

“When I went from one cardiologist or hospital to another, they did not talk to each other, so I’m the one who had to ask for and pay for my dossier. I had to tell my story over and over again every time there was a new person,” says Caroline Lavallée, who had symptoms of supraventricular tachycardia, a heart rhythm problem, for five years before she was finally diagnosed.

For patients and healthcare providers caring for them, access to electronic health records is imperative. Everyone within the circle of care, regardless of entry point, should have the same information available, improving continuity and quality of care.

The impact of these conditions extends to family members. Caregivers can face isolation, stress and lack of support, as well as advocacy fatigue

Heart & Stroke’s role

A key role for Heart & Stroke is to be a catalyst for change. We provide the new knowledge, data and energy that bring together diverse organizations and people to improve prevention and management of heart, brain and mind conditions and support people living with them. This work takes place within the health and public policy systems and at the individual level.

As advocates and supporters of people with lived experience, and as educators and influencers for systems change, we act where we can have impact, and serve as a catalyst where we cannot act alone — all with a sense of urgency — in order to reduce suffering and save lives.

Influencing and supporting people:

- Raise public awareness of the complexity and connections associated with heart, brain and mind conditions to help people make informed decisions about their health.
- Provide guidance to patients and families to help them advocate for themselves when talking about heart, brain and mind connections with their healthcare professionals.
- Engage and support people with heart conditions, stroke and vascular cognitive impairment and their caregivers by:
- Facilitating and improving health and recovery knowledge through effective online support (peer support)
- Enabling and encouraging effective self-advocacy and self-management of chronic disease.
- Providing health information and supportive resources.

Influencing governments:

- Advocate for policies that enable and support healthy environments and choices, such as:
- Strong legislation to restrict unhealthy food and beverage marketing to kids
- A revised Food Guide
- Mandatory front-of-package nutrition labelling
- Tobacco control policies
- Public policies that address inequities and reduce barriers to health for those most vulnerable or at risk.
- Advocate for a national, universal pharmacare program with equitable and timely access to proven and safe medically-necessary prescription drugs for all people in Canada regardless of domestic

geography, socioeconomic status, age, ethnicity or sex/gender. Ensure public funders are the first payers.

- Invest in research around heart, brain and mind connections and ensure gender- based analysis and reporting.
- Raise awareness and understanding and work to address inequities in awareness, support, diagnosis, treatment and research around women's heart, brain and mind health.

Influencing health systems, services and providers:

- Build awareness and understanding of the connections between the heart, brain and mind with health professionals, decision-makers, researchers, and educators:
- Partner with key health professional bodies to influence curricula, education and clinical practice guidelines
- Provide professional educational events that address these connections and solutions for improving integration and continuity of care
- Integrate heart, brain and mind concepts and complexity into clinical practice guidelines.
- Work with provincial health authorities to plan systems of care that are evidence- based and informed by reliable data.

Conclusion of This Report

Cardiovascular disease (CVD) remains the leading cause of death in Canada and globally, posing immense personal, societal, and economic burdens. Despite advancements in medical care and technology, gaps in early detection, access to screening, and equitable health service delivery continue to compromise outcomes. Silent heart attacks, in particular, represent a hidden epidemic that urgently demands the same systematic screening approaches that have successfully reduced mortality in conditions such as colon and breast cancer.

Through comprehensive analysis, this report underscores the necessity for immediate and targeted policy interventions, including the establishment of a national heart disease registry, expanded cardiac screening programs for high-risk populations, culturally sensitive outreach initiatives, and sustainable funding models. Early detection, combined with robust public awareness campaigns and the integration of digital health solutions, will be critical to reversing current trends.

By prioritizing early cardiovascular screening and adopting the policy recommendations outlined in this report, Canada can significantly reduce the incidence and mortality associated with heart disease, enhance the quality of life for millions, and achieve more equitable health outcomes across all communities. The time to act is now — to prevent the preventable, to detect the undetected, and to ensure that no more lives are lost needlessly to silent killers.

Appendix A. 10 Shocking Statistics about Heart Disease in 2025

Heart disease affects individuals of all ethnicities and genders, with millions of cases reported annually in the United States. In past years, hundreds of thousands of people are expected to die from this condition. The alarming rise in heart disease underscores the urgent need for ongoing public health campaigns focused on education and prevention. Despite its prevalence, research indicates that more than half of American adults remain unaware of the severity and widespread impact of heart disease. This highlights a significant gap in public knowledge that must be addressed. To effectively combat the growing burden of heart disease, it is critical to raise awareness, present the latest statistics, and emphasize the importance of preventative measures. By doing so, we can help bridge the knowledge gap and reduce projected disease rates in the coming years.

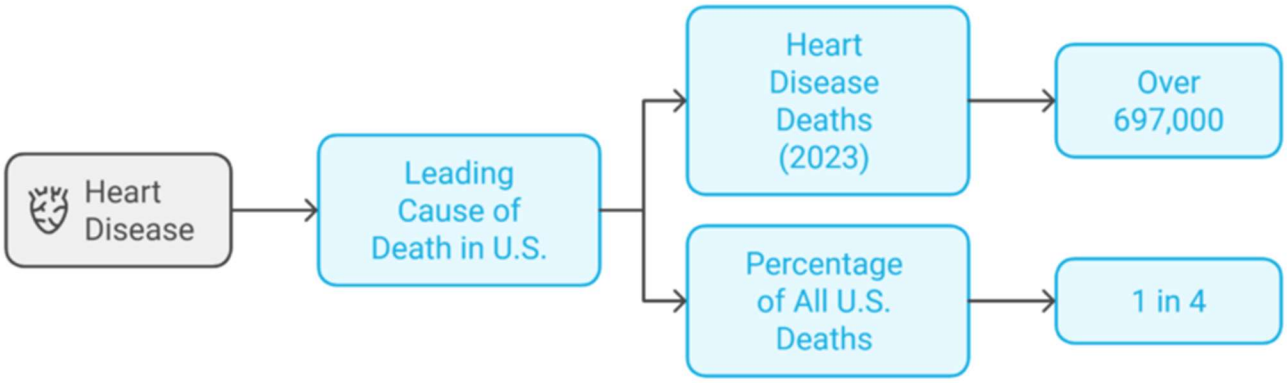
Key Takeaways

- Heart disease remains the leading cause of death in the U.S., responsible for 1 in 4 deaths.
- Heart failure mortality has increased by 3% over the last 25 years, reversing prior progress.
- Coronary artery disease (CAD) causes 40% of all heart-related deaths; heart attacks occur every 40 seconds.
- Hypertension affects more than 1 in 3 adults and is a leading risk factor for heart disease.
- Salt reduction could save 900,000 lives by 2030, highlighting the importance of dietary interventions.
- COVID-19 accelerated heart failure mortality, worsening health disparities and outcomes.

Heart Disease is the Leading Cause of Death

Heart.org notes that in 2021, cardiovascular disease (CVD) accounted for 931,578 deaths in the United States, with coronary heart disease (CHD) alone responsible for 375,476 deaths. Heart disease claimed more lives than all forms of cancer and chronic lower respiratory disease combined. This staggering number highlights heart disease's devastating impact and underscores its status as the leading cause of mortality in the U.S. Despite advances in healthcare, the persistence of such high mortality rates emphasizes the need for continued public health efforts to raise awareness, promote prevention, and improve treatment strategies.

Exhibit A.1 Heart Disease – The leading cause of death in the United States



Heart disease continues to dominate as the leading cause of death in the U.S., responsible for one in every four deaths as per. This stark statistic highlights the need for more robust interventions, greater public awareness, and improved healthcare strategies focused on prevention. Even as modern medicine makes strides, heart disease mortality persists at alarming rates, reflecting the urgency for both medical and lifestyle-based prevention efforts.

A Report of U.S. and Global Data from the American Heart Association, heart disease has been the leading cause of death in the U.S. for 100 years.

On average, there are about 55 deaths from sudden cardiac arrest in the U.S. each day.

2. Increasing Prevalence of this Disease

From 2017 to 2020, 127.9 million U.S. adults (48.6%) were diagnosed with some form of CVD, showcasing the widespread nature of this condition. The prevalence of CVD is especially pronounced in non-Hispanic Black individuals, with 59.0% of females and 58.9% of males affected. This statistic points to significant racial disparities in CVD prevalence and suggests a need for targeted public health interventions aimed at high-risk populations. It also indicates the enormity of the challenge in managing CVD across various demographics.

CNN notes that more than half of the US population will have some kind of cardiovascular problem.

According to 2022 U.S. data, the majority of adult Out-of-Hospital Cardiac Arrests (OHCA) occur at home or in residence (72.1%), with public settings (17.3%) and nursing homes (10.6%) being the next most common locations.

Among EMS-treated non-traumatic OHCAs, the overall survival rate to hospital discharge was 9.3%. However, survival rates were higher for arrests witnessed by bystanders (14.0%) and even more so for those witnessed by 9-1-1 responders (17.0%).

3. Reversal in Heart Failure Mortality Trend

Table A.1 Trends in Heart Failure Mortality: A Reversal in Recent Progress

Statistic	Value	Insights
Increase in heart failure mortality	3% higher than 25 years ago	After years of progress, heart failure mortality rates have increased, signaling a reversal in health outcomes related to this condition.

Despite medical advancements, the heart failure mortality rate is now 3% higher than it was 25 years ago. This troubling trend suggests that the healthcare system's approach to managing and preventing heart failure has stagnated or even regressed.

Heart failure, driven by factors such as rising obesity and diabetes rates, represents a major public health challenge that requires renewed focus on prevention strategies.

Incorporating Heart Rate Variability (HRV) monitoring as a predictive tool for cardiovascular health could help detect early signs of heart failure progression, allowing for timely interventions.

4. Prevalence of Coronary Artery Disease (CAD) and Heart Attacks

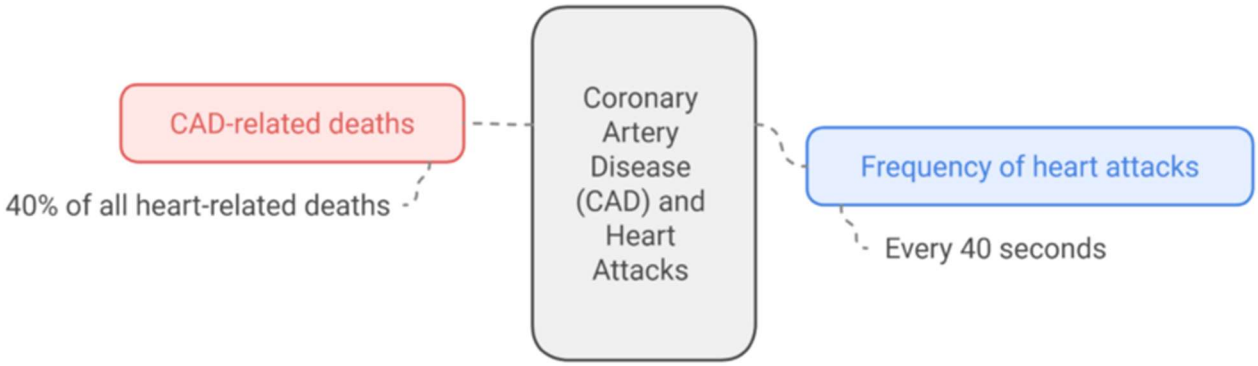
Coronary artery disease (CAD) is particularly dangerous as it accounts for nearly half of all heart-related deaths. With a heart attack occurring every 40 seconds in the U.S., the prevalence and frequency of these incidents are alarmingly high.

This data underlines the necessity for targeted interventions that address the prevention, early detection, and treatment of CAD.

There are 2,552 deaths from total cardiovascular disease (CVD) each day, based on 2021 data.

Statins are commonly prescribed to lower cholesterol, specifically reducing bad LDL cholesterol, which helps prevent heart attacks and strokes by reducing fatty deposits in the arteries. Most people tolerate statins well with minimal side effects, and studies show they can lower the risk of heart attack or stroke by 25%. It's important to take statins daily and consult your doctor if any concern arises.

Exhibit A.2 Heart Attacks in the U.S. Chart



5. Economic Impact of Cardiovascular Disease

Table A.2 Economic and Health Impact of Heart Disease in the U.S.

Statistic	Value	Insights
Annual U.S. healthcare costs (hospital care and medications)	Over $254 billion	Heart disease imposes a significant economic burden, both in terms of direct costs and lost productivity.
Annual deaths due to heart disease	Over 600,000	The high death rate correlates with immense financial strain on the healthcare system.

The economic burden of CVD is equally alarming. Between 2019 and 2020, the direct and indirect costs of CVD in the U.S. totaled $422.3 billion, with $254.3 billion attributed to direct healthcare costs and $168.0 billion to lost productivity and mortality according to NJBIZ. These figures reflect the significant financial strain that CVD places on the healthcare system and the economy. As the prevalence of heart disease continues to rise, the associated costs are likely to escalate, creating a critical need for cost-effective prevention strategies and improved management of cardiovascular risk factors.

6. Salt Consumption and Health Risk

Too much salt can lead to high blood pressure. Nearly every country in the WHO European Region exceeds the recommended daily salt intake of 5 grams, with street food and processed foods being the primary sources according to WHO. Excessive salt intake is a major contributor to hypertension and, consequently, heart attacks and strokes. Regulatory policies, such as mandatory limits on salt in processed foods, could significantly reduce these health risks and save lives.

Table A.3 Global Salt Consumption: A Public Health Challenge in the WHO European Region

Statistic	Value	Insights
Number of countries exceeding WHO salt recommendations	52 out of 53 countries in the WHO European Region	Excessive salt consumption drives hypertension and cardiovascular deaths, making salt reduction a critical public health priority.

7. Incidence of Heart Attacks

Approximately every 40 seconds, someone in the United States suffers a myocardial infarction (heart attack). The annual incidence of heart attacks, based on data from 2005 to 2014, was estimated at 605,000 new attacks and 200,000 recurrent attacks according to NCBI research. This frequency underscores the urgent and ongoing threat posed by heart disease in the population.

Despite the decline in the age-adjusted death rate from coronary heart disease by 15% from 2011 to 2021, the actual number of deaths has slightly increased (0.05%), indicating that heart attacks remain a significant health crisis in the U.S.

8. Hypertension Prevalence

Table A.4 Prevalence of Hypertension in Adults: A Key Risk Factor for Cardiovascular Disease

Statistic	Value	Insights
Hypertension prevalence in adults	More than 1 in 3 adults aged 30–79	High blood pressure is alarmingly common and is a leading risk factor for cardiovascular diseases.

Hypertension, or high blood pressure, is prevalent in more than one-third of adults aged 30-79 in the European Region as per NCBI study. This silent killer is a major driver of heart attacks, strokes, and other cardiovascular diseases. Its widespread prevalence, coupled with the fact that it often goes undiagnosed due to a lack of symptoms, poses a serious public health threat that needs urgent addressing through both prevention and treatment.

9. Projected Lives Saved by Salt Reduction

Implementing policies to reduce salt intake by 25% by 2030 could save an estimated 900,000 lives from cardiovascular disease in the European Region. This demonstrates the power of population-level interventions and the critical need for governments to adopt mandatory salt reduction strategies in both food manufacturing and consumption to protect public health.

Table A.5 Impact of 25% Salt Intake Reduction by 2030: Potential Lives Saved.

Statistic	Value	Insights
Potential lives saved by reducing salt intake by 25% by 2030	900,000 lives	Reducing salt intake could have a massive impact, saving nearly a million lives from cardiovascular disease.

10. Impact of COVID-19 on Heart Failure Mortality

Even a mild case of COVID-19 can increase your risk of heart failure or a heart attack
The COVID-19 pandemic worsened the already rising trend in heart failure deaths, with a sharp increase in mortality rates during 2020 and 2021. Marko Zuin stated in his study the following:

"COVID-19 not only increased the likelihood of heart failure among those hospitalized for pneumonia but also worsened health disparities."

These trends underline the need for integrated care strategies.

Table A.6 Impact of COVID-19 on Heart Failure Mortality: A 7.06% Annual Increase in 2020–2021

Statistic	Value	Insights
Annual percentage increase in heart failure mortality during COVID	7.06% (2020–2021)	The pandemic significantly accelerated the rise in heart failure deaths, particularly among vulnerable populations.

Methodology

Our research process involved a detailed analysis of multiple authoritative sources, including:

- **American Heart Association** – 2024 Heart Disease and Stroke Statistics Update
- **WHO** reports on cardiovascular disease and hypertension
- Peer-reviewed studies from **NCBI**, including those on coronary artery disease and hypertension trends
- Epidemiological data from the **CDC** and research publications like **Lancet**

We focused on key areas:

- **Data Trend Analysis**: By examining mortality rates from 1999 to 2024, we observed shifts in heart failure deaths and the prevalence of related comorbidities, such as hypertension, diabetes, and obesity.
- **Public Health Interventions**: We evaluated the impact of salt reduction strategies and hypertension control as recommended by the **WHO** and cross-referenced these with mortality projections.
- **Impact of COVID-19**: We incorporated recent findings on how the pandemic exacerbated heart failure rates, with key insights from **Zuin et al.**'s study.

Appendix B. British Heart Foundation Global Heart & Circulatory Diseases Factsheet, January 2025

Heart & Circulatory Diseases (Cardiovascular Disease; CVD)

Heart and circulatory diseases is an umbrella term for all diseases of the heart and circulation. It includes everything from conditions that are inherited or that a person is born with, to those that develop later, such as coronary heart disease, atrial fibrillation, heart failure, stroke and vascular dementia.

- There are around 640 million people living with heart and circulatory diseases across the world – this number has been rising due to changing lifestyles, an ageing and growing global population, and improved survival rates from heart attacks and strokes – and will continue to rise if these trends continue.

- Globally it's estimated that around 1 in 12 people are living with a heart or circulatory disease.

- In 2021 globally it's estimated that there were a similar number of men and women were living with heart and circulatory diseases – around 320 million of each sex.

- In 1990 an estimated 305 million people were living with heart and circulatory diseases globally; this rose to 375 million in 2000 and 480 million in 2010.

- Since 1993, the estimated number of people living with heart and circulatory diseases globally has doubled.

- The most common cardiovascular conditions are coronary (ischemic) heart disease (global prevalence estimated at 250 million in 2021), peripheral arterial (vascular) disease (110 million), stroke (94 million) and atrial fibrillation (53 million).

- Each year around 67 million people across the world develop a heart or circulatory disease – that's almost the same as the entire population of the UK.

Exhibit B2.1. Global Heart & Circulatory Disease Prevalence in 2021

Global Deaths from Heart & Circulatory Diseases

- Heart and circulatory diseases cause nearly 1 in 3 deaths globally; an estimated 20 million deaths in 2021 - an average of 55,000 people each day or one death every 1.5 seconds. They are the world's biggest killers.

- Globally, heart and circulatory diseases killed an estimated 10.5 million men and 9.6 million women in 2021.

- The global number of deaths from heart and circulatory diseases is projected to rise further.

- Age-standardized death rates from heart and circulatory diseases have been falling across the world – this is primarily due to improvements in life expectancy. But such trends have led to more

people living to an age when it is more common to develop, or die from, heart and circulatory diseases.

Biggest Killers Worldwide

NB coverage and accuracy will vary between nations, and 2021 estimates will be modelled on historical mortality data, where available. The Lancet's Global Burden of Disease (GBD) and the World Health Organization (WHO) have both produced 2021 estimates.

We present GBD data on the next page; see references for alternative analysis and rankings by the WHO.

Exhibit B2.2 Biggest Killers Worldwide (GBD 2021 Estimates)

	MEN		WOMEN		TOTAL	
1	Coronary heart disease	5.0 million	Coronary heart disease	4.0 million	Coronary heart disease	9.0 million
2	COVID-19	4.8 million	Stroke	3.5 million	COVID-19	7.9 million
3	Stroke	3.8 million	COVID-19	3.1 million	Stroke	7.3 million
4	COPD	2.1 million	COPD	1.6 million	COPD	3.7 million
5	Lung cancer	1.3 million	Alzheimer's and dementia	1.3 million	Lower respiratory disease	2.2 million

COPD = chronic obstructive pulmonary disease
COVID-19 = coronavirus disease

- Heart and circulatory diseases are the world's biggest killers – in every recent year, bar the pandemic years of 2020 and 2021, coronary heart disease was the single biggest killer globally, and stroke was the second biggest.

- Other common cardiovascular causes of death are hypertensive heart disease, atrial fibrillation and rheumatic heart disease.

Exhibit B2.3. Highest & Lowest Cardiovascular Death Rates Worldwide.

	HIGHEST	ASDR 2021
1	Nauru (Micronesia)	748.3
2	Egypt	612.1
3	Afghanistan	567.4
4	North Macedonia	560.3
5	Turkmenistan	552.3

	LOWEST	ASDR 2021
1	San Marino	66.9
2	Japan	72.5
3	Israel	75.2
4	Singapore	75.8
5	France	78.7

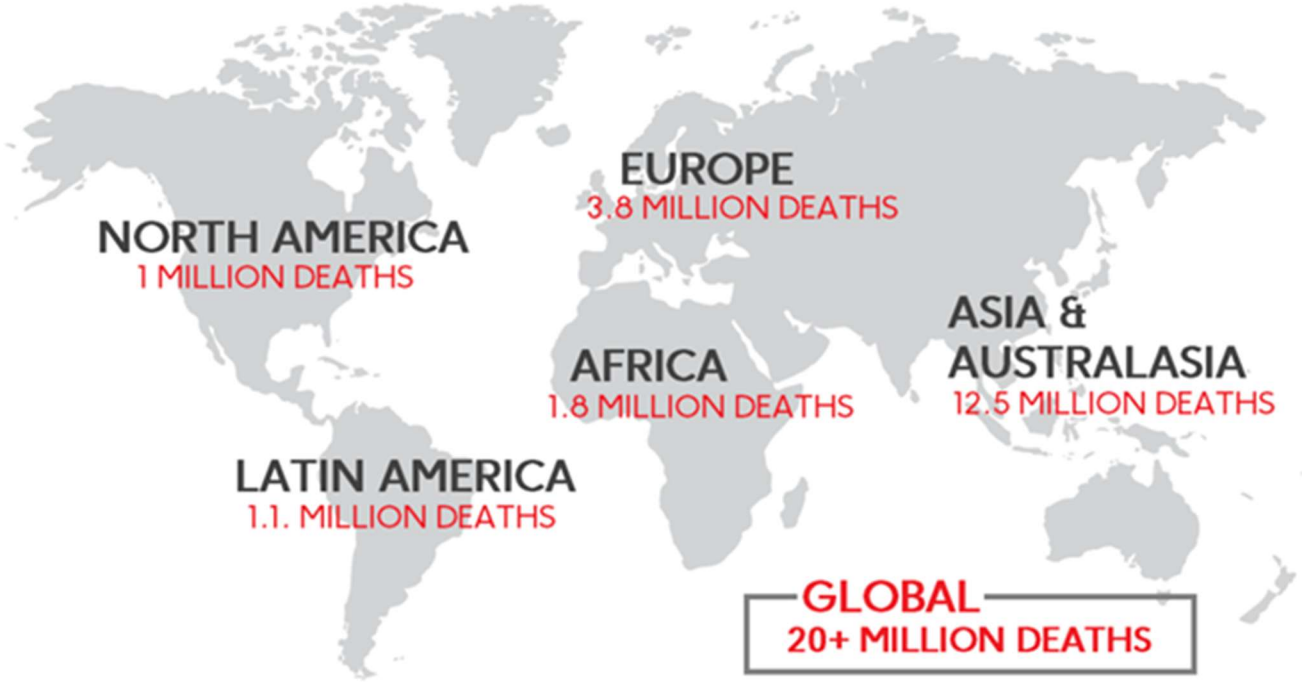
ASDR = Age-Standardised Death Rates for cardiovascular disease – heart and circulatory diseases - CVD (ICD-10 I00-99)

For comparative purposes, the UK ASDR in 2021 was 107 and the global ASDR was 235.

Please note that these are modelled estimates, based on national sources which may have different statistical and clinical definitions.

- The age-standardised death rate for heart and circulatory diseases (CVD) in Nauru in Micronesia is over ten times higher than that of Japan and San Marino.

Exhibit B2.4 Estimated Deaths from Heart & Circulatory Diseases (2021)



Coronary Heart Disease (Ischaemic Heart Disease; CHD)

- Coronary (ischaemic) heart disease is the most commonly diagnosed heart disease worldwide.
- It's estimated over 250 million people are living with coronary heart disease.
- Globally around 145 million men and 110 million women have coronary heart disease.
- Coronary heart disease kills an estimated nine million people each year – in 2021 it was the world's single biggest killer.
- Around 1 in 7 deaths globally are caused by coronary heart disease.
- Before the coronavirus pandemic, coronary heart disease had been the leading cause of death worldwide for at least 30 years.
- Worldwide, coronary heart disease is now killing more people each year than ever before.
- In 2011, CHD overtook neonatal disorders as the biggest cause of premature mortality worldwide (when defined as deaths before the 70th birthday) and remained at #1 until 2019 (COVID-19 was #1 in 2020 and 2021)

Stroke (Cerebrovascular Disease; CBVD)

- There are an estimated 94 million stroke survivors worldwide.
- Globally around 48 million men and 46 million women are stroke survivors.
- Stroke was the third most common killer globally in 2021, causing an estimated 7.3 million deaths (a record annual total).
- 1 in 9 deaths globally are caused by cerebrovascular disease (stroke).
- Stroke was the third biggest cause of premature mortality worldwide in 2021 (when defined as deaths before the 70th birthday).

Heart Failure

- It's been estimated that heart failure affects at least 64 million worldwide (and numbers have been increasing).

Congenital Heart Disease

- Congenital heart disease is a large and rapidly emerging global problem in child health.
- Congenital heart disease is diagnosed in around 1 in 110 births globally, with more diagnoses later in life - that's an estimated 1.2 million babies a year - an average of 3,300 per day (or a diagnosis every 26 seconds)
- Globally congenital heart disease is the direct cause of at least 250,000 deaths each year, the majority are before the first birthday.
- It's estimated at least 16 million people are living with congenital heart disease worldwide; there are likely to be millions more undiagnosed.

Exhibit B2.5 Risk Factors for Heart & Circulatory Diseases (CVD)

Risk Factors

- Globally more than 4 in 5 deaths from heart and circulatory diseases are associated with modifiable risk factors.
- Modifiable risk factors are often preventable; in most cases risk can be reduced with medical treatment and lifestyle changes **
- Environmental risk factors (e.g. air pollution) also have a significant impact on cardiovascular risk, as well as gender, age, family history and ethnicity.

Global Risk Factors for Heart & Circulatory Diseases (CVD)

Associated or attributable burden relating to cardiovascular mortality

	MODIFIABLE RISK FACTOR & ATTRIBUTABLE BURDEN	2021 CVD DEATHS	% OF BURDEN
1	High systolic blood pressure (hypertension)	10.4 million	54%
2	Dietary risks (poor diet)	5.8 million	30%
3	Air pollution (ambient particulate matter pollution)	4.1 million	23%
4	High LDL cholesterol (raised cholesterol)	3.6 million	19%
5	Tobacco (cigarette smoking; second-hand smoke)	2.8 million	15%
6	High fasting plasma glucose (diabetes)	2.2 million	11%
7	Kidney dysfunction (renal failure)	2.1 million	11%
8	High body-mass index (obesity and excess weight)	1.9 million	10%

Other modifiable risk factors include physical inactivity, built environment, non-optimal temperature (low/high) and alcohol misuse.

*NB ** modifiable risk factors are affected by the circumstances in which we live. Our social, physical and commercial environments all have an impact on factors like our access to healthier foods, exposure to environmental risks and health-related behaviours.*

Appendix C. The Relationship Between Oral Health and Heart Disease.

We often ignore oral health, but it impacts much more than just our mouths. A healthy mouth can lead to a healthy heart! Research now links oral health to heart problems. Gum disease might cause heart issues and raise heart attack risk. Tooth decay as a kid may lead to clogged arteries later in life.

Older adults face extra risks. Many seniors already have chronic diseases like heart disease, which can worsen with poor oral health. Millions of seniors can't get dental care because Medicare doesn't cover it.

Health leaders must act to cut risks from both dental and heart disease. But how are oral health and heart disease linked?

Germs grow in our mouths when we have poor oral health. These germs can enter the blood and harm other body parts. Bacteria from the mouth can cause heart inflammation, leading to serious brain and heart conditions. Dental bacteria may cause endocarditis, an infection of the heart lining. They can also lead to clogged arteries and heart attacks. Plus, dental disease might raise stroke risk.

Poor oral health might not be the only cause of these threats, but connections exist. People with gum disease have a 28% higher chance of heart attack. Poor oral health also raises risk of HPV infection, which can make heart attacks more likely.

Protecting heart and overall health starts with good oral health for all. Oral health impacts the heart early in life. A 2019 study found childhood oral infections may raise the risk of adult heart issues. Dental disease in kids could link to clogged arteries later.[104]

Poor oral health risks grow as we age. Those lacking dental care as teens may face high blood pressure as adults. Gum disease raises the risk of heart attack. Stroke risk, which could hurt vision and body functions, triples with gum disease. More dental coverage would help adults afford care. This could improve gum health, lowering heart disease and stroke risk.

Medicare dental coverage could strengthen the system and save money. Heart condition risks rise with age. Untreated dental disease is a known threat. Yet, many seniors lack needed dental care. Medicare excludes dental benefits, limiting access. Dental coverage also varies in Medicare Advantage plans.

[104] Shmerling, R. H., MD. (2024, October 8). *Gum disease and the connection to heart disease*. Harvard Health. https://www.health.harvard.edu/diseases-and-conditions/gum-disease-and-the-connection-to-heart-disease

Advocates pushed to add dental benefits to Medicare in 2021. Lawmakers aimed to advance this change via an infrastructure bill. Though excluded, research shows clear benefits. A CareQuest Institute analysis shows adding dental to Medicare would improve care.

Over 42% of Medicare adults have a heart condition. Comprehensive dental benefits could save the health system up to $27.8 billion yearly for those with heart disease. Savings would grow as more Medicare adults get gum disease treatment. Adding dental to Medicare is a win-win: lowering costs while boosting patient health.

Other solutions can promote better health for all. Health leaders and lawmakers push for Medicare progress. Here are three ways to expand dental access.

1. Strengthen Medicaid adult dental coverage. Medicaid is key for many low-income seniors. It covers kids' dental care, but adult coverage is optional for states. Coverage varies widely. Like Medicare, making dental care more accessible to older adults with low incomes would improve their oral health and generate cost savings.

2. Expand teledentistry. Virtual tech now connects people to oral health care. One FQHC in North Carolina used teledentistry to treat 1,200 students in a year. It helped families lacking insurance, with low incomes, or without transport. More communities could expand care access by using teledentistry.

3. Increase medical-dental integration (MDI). MDI supports oral health for adults who see doctors, but not dentists. MDI adds oral health.

Recent research reveals a surprising trend. People with poor oral health often face more heart issues. Gum disease and tooth loss link to a higher risk of heart attack or stroke. But what connects heart health to our mouths? [105]

Several ideas try to explain this link. First, mouth bacteria may travel. They could inflame blood vessels, causing clots and damage. Some find oral bacteria in distant, blocked vessels. Yet, antibiotics don't lower heart risk.

Another theory points to inflammation. The body's response to gum disease might harm blood vessels. This widespread damage could affect the heart and brain.

[105] Gum disease and the connection to heart disease October 8, 2024 By Robert H. Shmerling, MD, Senior Faculty Editor, Harvard Health Publishing; Editorial Advisory Board Member, Harvard Health Publishing

A third idea suggests a shared risk. Smoking, for example, could harm both gums and heart. Genes, healthcare access, and exercise habits might play a role too. People with poor health habits may face both oral and heart problems.

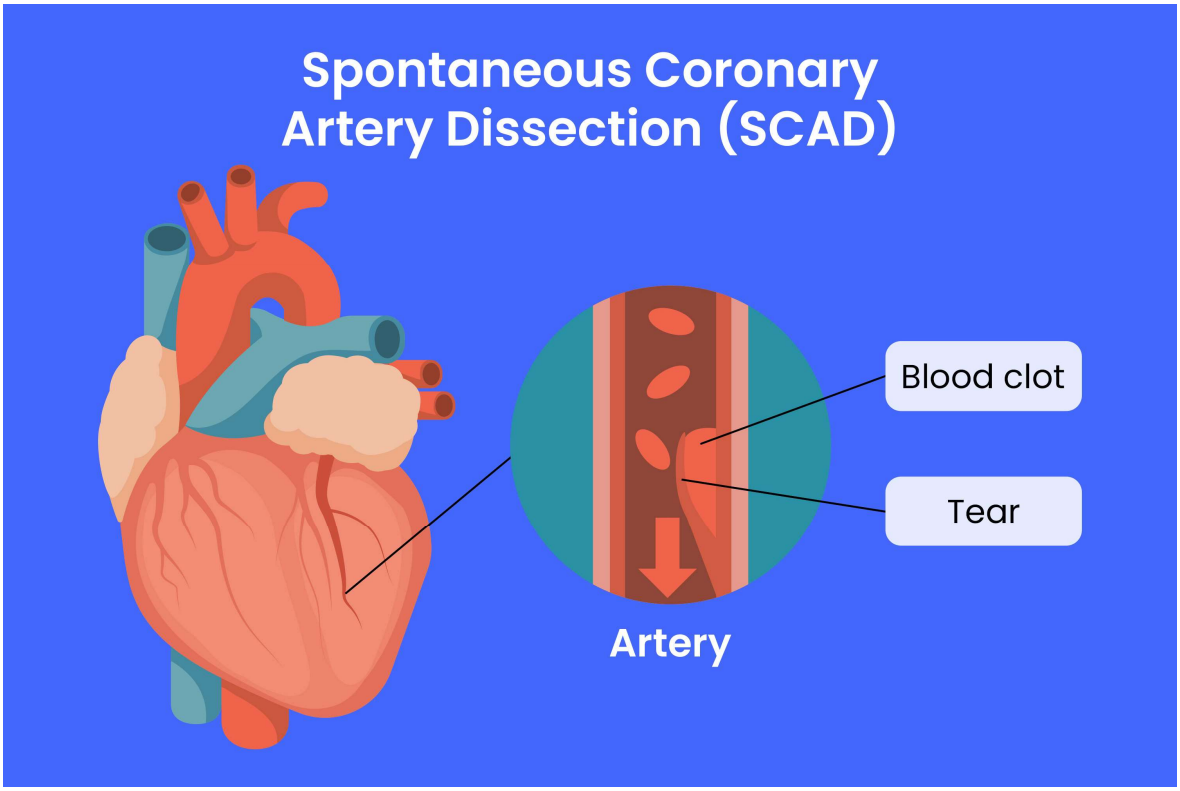
A large 2018 study looked at this question. Researchers checked data from nearly a million people. They saw over 65,000 heart events, like heart attacks. The study found a link between tooth loss and heart disease, adjusting for age. However, the link weakened when considering smoking habits.

This study hints that poor oral health isn't a direct cause. But other studies still find a connection, even after considering risks. One study rarely solves a long-debated question alone. More research is likely needed to fully understand this issue.

The plot thickens! Oral health might affect more than just the heart. Gum disease links to rheumatoid arthritis, especially with certain bacteria. The same bacteria also connect to pancreatic cancer risk in some studies. Like heart disease, these are just associations. More research must confirm these observations.

Appendix D. Spontaneous Coronary Artery Dissection

Exhibit D.1 Spontaneous Coronary Artery Dissection (SCAD)



Source: HealthCentral

Introduction

Spontaneous Coronary Artery Dissection (SCAD) is a rare but serious condition involving a sudden tear in the layers of a coronary artery wall. This tear can lead to the formation of a false lumen, reducing or blocking blood flow to the heart muscle, potentially resulting in a heart attack or sudden cardiac death. SCAD predominantly affects young to middle-aged women who may not exhibit traditional cardiovascular risk factors, making awareness and early detection crucial.

Symptoms That May Go Undiagnosed or Misdiagnosed

While SCAD can present with typical heart attack symptoms, there are less obvious symptoms that may not be immediately recognized as cardiac in origin:

Epigastric Pain or Indigestion-like Sensations

Description: Discomfort in the upper abdomen resembling indigestion or gastritis.

Misdiagnosis Risk: May be attributed to gastrointestinal issues, delaying cardiac evaluation.

Transient Neurological Symptoms

Description: Numbness, tingling, or weakness in limbs.

Misdiagnosis Risk: Could be mistaken for neurological disorders like stroke or multiple sclerosis.

Atypical Chest Pain

Description: Sharp, stabbing, or fleeting chest pain not fitting the classic angina profile.

Misdiagnosis Risk: May be considered musculoskeletal pain or anxiety-related.

Palpitations or Arrhythmias

Description: Sensation of a racing or irregular heartbeat.

Misdiagnosis Risk: Often attributed to stress, caffeine intake, or benign arrhythmias.

Shortness of Breath Without Chest Pain

Description: Difficulty breathing without accompanying chest discomfort.

Misdiagnosis Risk: May lead to assessments for pulmonary conditions like asthma or pulmonary embolism.

Fatigue and General Malaise

Description: Unexplained tiredness and feeling unwell.

Misdiagnosis Risk: Can be dismissed as symptoms of overexertion or depression.

Rare and Atypical Presentations of SCAD

SCAD can sometimes present in unusual ways, making diagnosis challenging:

Isolated Back or Neck Pain

Description: Pain localized to the back or neck without chest pain.

Implication: May lead to evaluations for musculoskeletal issues rather than cardiac causes.

Syncope (Fainting) Episodes

Description: Sudden loss of consciousness.

Implication: Could be investigated as neurological or vasovagal events.

Silent SCAD

Description: SCAD occurring without noticeable symptoms, identified incidentally during evaluations for other conditions.

Implication: Lack of symptoms delays diagnosis and treatment.

SCAD in Men and Older Adults

Description: While more common in younger women, SCAD can occur in men and older adults.

Implication: Lower suspicion in these populations can lead to misdiagnosis.

Underlying Diseases That Mimic SCAD

Several conditions can present with symptoms similar to SCAD, potentially leading to misdiagnosis:

Takotsubo Cardiomyopathy (Stress-Induced Cardiomyopathy)

Symptoms: Chest pain, shortness of breath.

Similarity: Both conditions can be triggered by emotional or physical stress.

Differentiation: Takotsubo involves temporary weakening of the heart muscle, identifiable via imaging.

Aortic Dissection

Symptoms: Sudden severe chest or back pain.

Similarity: Both involve arterial wall tears.

Differentiation: Aortic dissection affects the aorta; imaging studies can distinguish between the two.

Myocarditis

Symptoms: Chest pain, fatigue, arrhythmias.

Similarity: Inflammation of the heart muscle can mimic SCAD symptoms.

Differentiation: Diagnosed through blood tests, MRI, or biopsy.

Pericarditis

Symptoms: Sharp chest pain worsening with breathing or lying down.

Similarity: Chest pain can be similar to SCAD.

Differentiation: Echocardiogram and ECG changes help in diagnosis.

Pulmonary Embolism

Symptoms: Sudden shortness of breath, chest pain.

Similarity: Overlaps with SCAD respiratory symptoms.

Differentiation: CT pulmonary angiography confirms pulmonary embolism.

Gastroesophageal Reflux Disease (GERD)

Symptoms: Burning chest pain, indigestion.

Similarity: Chest discomfort may be mistaken for cardiac pain.

Differentiation: Response to antacids and absence of cardiac findings.

Health Conditions That Can Amplify Undiagnosed SCAD

Certain underlying health issues may exacerbate SCAD symptoms or contribute to it remaining undiagnosed:

Microvascular Dysfunction

Description: Abnormal function of the small coronary arteries.

Impact: Can cause chest pain without evident blockages, complicating diagnosis.

Anemia

Description: Low red blood cell count leading to decreased oxygen delivery.

Impact: Can worsen symptoms like fatigue and shortness of breath.

Hyperthyroidism

Description: Overactive thyroid gland increasing metabolism.

Impact: May cause palpitations and chest pain, mimicking SCAD symptoms.

Psychiatric Disorders

Examples: Anxiety, panic disorders.

Impact: Symptoms like chest pain and palpitations may be attributed to psychiatric conditions.

Autoimmune Diseases

Examples: Rheumatoid arthritis, systemic lupus erythematosus.

Impact: Chronic inflammation may affect coronary arteries, but symptoms may be attributed to the primary disease.

Challenges in Diagnosing SCAD

Non-Specific Symptoms

SCAD symptoms can be vague or mimic less serious conditions, leading to misdiagnosis.

Lack of Awareness

Limited knowledge among healthcare providers due to SCAD's rarity.

Normal Initial Tests

ECGs and blood tests may be normal or show non-specific changes.

Atypical Patient Profiles

Occurrence in individuals without traditional risk factors lowers clinical suspicion.

Imaging Limitations

Standard angiography may miss SCAD; advanced imaging is not always utilized.

Recommendations for Improved Diagnosis

Increased Clinical Vigilance

Consider SCAD in patients, especially women under 50, presenting with acute coronary syndrome symptoms.

Use of Advanced Imaging

Employ IVUS or OCT when SCAD is suspected but not confirmed by angiography.

Comprehensive Patient History

Assess for factors like recent childbirth, connective tissue disorders, or extreme stress.

Interdisciplinary Approach

Collaboration between cardiologists, radiologists, and other specialists to improve detection.

Patient Education

Encourage patients to report all symptoms and advocate for thorough evaluations.

Conclusion

SCAD's atypical presentations and overlap with other conditions make it a diagnostic challenge. Awareness of the subtle symptoms and potential mimicking conditions is essential for healthcare providers. Early recognition and appropriate management can significantly improve patient outcomes.

About the Authors

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