

Falling Coronary Heart Disease Rates A Better Explanation?

Russell V. Luepker, MD, MS, FACC, FAHA

The coronary heart disease (CHD) epidemic peaked in the 1960s. Since that time, age-adjusted mortality has declined steadily in the United States and many other industrialized countries.¹ Hospitalization for CHD has also declined, particularly in the past 2 decades with CHD severity decreasing as non-ST-segment-elevation myocardial infarctions increased, indicating milder forms of CHD.¹ Finally, lifestyle factors and associated risk factors improved such as smoking, hypertension, and cholesterol.¹ These changes and the trends over time lead naturally to the question of causality. Are changes in lifestyles, risk factors, or acute and chronic clinical care playing roles in this evolving picture, and how does each influence the desired outcomes? In this issue of *Circulation*, the article by Mannsverk and colleagues² in Norway provides insights into the evolving cardiovascular disease epidemic.

Article see p 74

The underlying causes of the CHD epidemic are well studied.³ After World War II, there were major changes in health habits. Returning war veterans kept their smoking habit and women soon followed. A diet high in fats became prevalent. Physical activity declined as labor-saving devices entered work places and automobiles became the dominant form of transportation. The resulting peak in CHD in the mid-1960s is now well recognized.

More serious research into the causes of the decline began in the 1970s, highlighted at the National Institutes of Health conference in 1979 that “discovered” the declining mortality from CHD.⁴ At that conference, numerous explanations from cardiopulmonary resuscitation to Medicare were advanced, but few data were available to understand the observations. In subsequent years, a debate ensued with some favoring primary prevention attributable to changes in lifestyle and risk factor reduction. Others cited secondary prevention with associated acute and chronic medical care. Most agree that many factors played some role in the decline but dispute their relative contributions.⁵ The relative contributions are more than an intellectual exercise, because different prevention and treatment approaches have implications for resources and health policy.

The opinions expressed in this article are not necessarily those of the editors or of the American Heart Association.

From Division of Epidemiology and Community Health, University of Minnesota, Minneapolis.

Correspondence to Russell V. Luepker, MD, MS, FACC, FAHA, Division of Epidemiology and Community Health, University of Minnesota, 1300 South Second St, Suite 300, Minneapolis, MN 55454-1015. E-mail luepker@epi.umn.edu

(*Circulation*. 2016;133:8-11.

DOI: 10.1161/CIRCULATIONAHA.115.019862.)

© 2015 American Heart Association, Inc.

Circulation is available at <http://circ.ahajournals.org>

DOI: 10.1161/CIRCULATIONAHA.115.019862

The debate also affects the so-called epidemiological transition or the anticipated rise of chronic diseases, particularly CHD, in developing countries.⁶

One reason for the challenges in understanding trends is the lack of comprehensive high-quality data. Population data before 1970 are extremely limited and of poor quality. Even mortality can be a challenge because both the fact of death and the cause of death are frequently misclassified.⁷ Hospitalized morbidity rates are similarly weak depending on discharge diagnoses from administrative data. These are influenced by evolving diagnostic fashion, new technology, and reimbursement.⁸ Outpatient clinic morbidity is even more variable and difficult to gather. Some suggest that “big data” from administrative data sets will answer these questions, but these data are subject to misclassification and bias. Finally, limited data are available on risk factor patterns and trends. The National Health and Nutrition Examination Survey, initiated in the 1960s, uses a national sampling strategy, but the numbers in subgroups are small and the methods have changed over time.⁹

Nonetheless, there have been numerous attempts to understand the magnitude, causes, and relative impact of primary prevention, acute care, and secondary prevention on CHD.⁵ Cohort studies such as Framingham are used to describe the impact of risk factor change on outcomes.¹⁰ Others have evaluated outcomes by using clinical trials or epidemiology data to estimate the magnitude of effect of various changes.⁵ More complex models such as IMPACT use modeling techniques to include these many factors.^{11,12} This results in proportions attributable to primary prevention or clinical care. The proportion varies by country with the Scandinavian countries finding public health approaches a dominant factor. Others have found proportions closer to half allocated to each in both US and Western European studies.¹³ All suffer from limits of data on the population under study. They also lack information on the incidence or first event most likely to be affected by primary prevention and other risk factors such as stress or socioeconomic status. Finally, few have recognized the central role of out-of-hospital sudden death accounting for more than half of all CHD mortality. Sudden death is frequently observed in individuals who have no previous history of CHD.¹³

The article by Mannsverk and colleagues² addresses many of the weaknesses in previous studies. Direct population data are collected over 15 years on all of the relevant parameters needed to make estimates of contributions to the decline. Particularly critical is the availability of incidence data and sudden death data at the population level.

Norway is recognized for high standards of living and quality of life according to studies by the United Nations.¹⁴ With universal health care and high-technology medicine widely available, Mannsverk’s study provides information

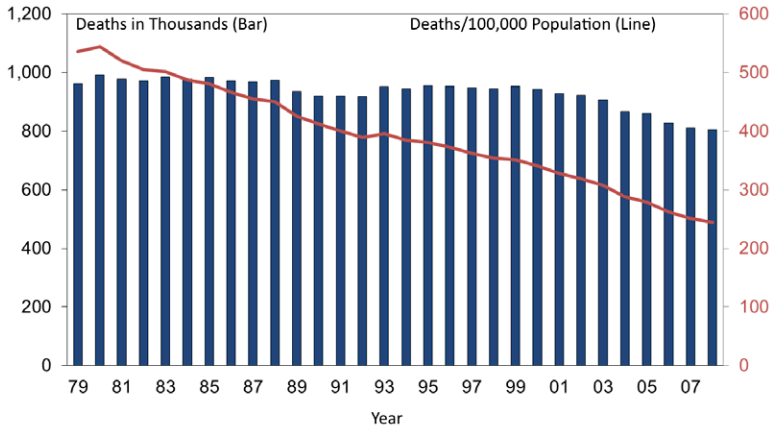


Figure 1. Deaths and age-adjusted death rates for cardiovascular diseases, United States, 1979 to 2008. NIH indicates National Institutes of Health.

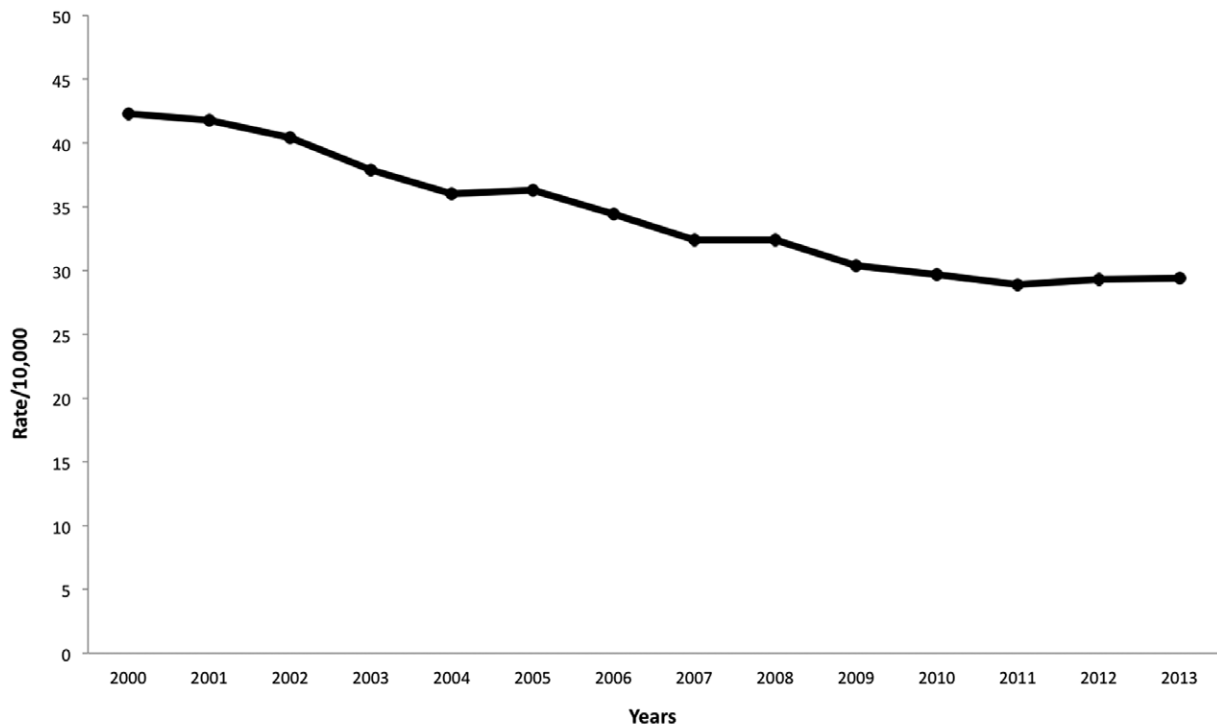
NIH Morbidity & Mortality: 2012 Chart Book on Cardiovascular, Lung, and Blood Diseases.

relevant to similar settings. This study is able to link hospital, clinic, and death records with population surveillance because all citizens have a single identification number. The data are collected with standard methods and quality control. The city of Tromsø is relatively compact and isolated with little out migration. With the use of the 3 population surveys (1994–1995, 2001–2002, 2007–2008), risk factors were measured in subjects ≥25 years, a total of 29 582 healthy men and women. Follow-up to 2010 resulted in 375 064 person-years of experience. These large numbers produce stable estimates of variables.

The Tromsø study finds that age- and sex-adjusted incidence of total coronary disease decreased by 3% annually

over the 15 years of follow-up. The decrease was found primarily in reductions in out-of-hospital sudden death and hospitalized ST-segment–elevation myocardial infarction. Reductions in serum cholesterol accounted for approximately one-third of the event decline, but decreases in smoking, blood pressure, and heart rate and increased physical activity all contributed. Interestingly, increases in body mass index and diabetes mellitus were associated with modest increases in disease outcomes. Overall, risk factors accounted for 66% of the decline in incidence. These data contain important lessons.

The United States has similarities and differences from Norway. The Norwegians have the ability to collect



Minnesota Public Health Data Access
 Minnesota Environmental Public Health Tracking Program
 Minnesota Department of Health

Figure 2. Minnesota CHD hospitalizations (ICD-9 code 410) for adults 35+ years. 95% confidence intervals. CHD indicates coronary heart disease; and ICD-9, *International Classification of Diseases, Ninth Revision*.

comprehensive data at all levels in a population. Universal health care allows the Norwegians to make policy decisions regarding the emphasis and allocation of resources. The United States has a similar high-technology environment. However, health disparities in CHD incidence and outcomes add to the US burden.¹ The focus of Scandinavia public health approaches is best exemplified in Finland. The Finns were recognized in the 1950s to have among the highest CHD rates in the world. This was associated with elevated levels of risk factors.³ A focused public health program resulted in dramatic reductions in cardiovascular risk factors and a parallel decline in CHD morbidity and mortality.^{15,16}

There have also been major changes in the United States, however. As shown in Figure 1, CHD mortality has been falling steadily since 1979 and before. These changes average a 3% per year decline in the age-adjusted data. The result of this observation is that the expected lifespan of American citizens is, on average, rising. A second observation in Figure 1 is found in the bars representing absolute deaths. These were flat for many years because cardiovascular diseases were pushed to growing older populations. However, in the past decade, the absolute number of deaths has also been falling $\approx 3\%$ per year. As found in Norway, this suggests that the incidence of CHD and sudden death is declining in the United States. One might speculate as to the reasons for these declines, and there are many postulated contenders, but in the United States there are few data to answer the question. Information from the Centers for Disease Control and Prevention in their National Health and Nutrition Examination Survey surveys are not of adequate size to address these trends. And these data are not linked to morbidity information from clinic visits and hospitalizations. This renders the analyses ecological where subjects cannot be connected to individual health characteristics and disease outcomes.

There are suggestions that big data can solve this problem. The enormous amounts of patient data contained in private insurance, Medicare, and other registers are cited as a unique opportunity to gather low-cost information. However, these data are collected for billing and other administrative purposes and frequently lack the quality to draw scientific inferences. There is also the continuing problem of linking of different data sets with individuals, their care, and outcomes in a multisource healthcare system.

The direction of US trends is also evident in Figure 2. This figure depicts trends in CHD hospitalizations in the state of Minnesota. Hospitalizations with CHD discharge codes have steadily fallen $\approx 3\%$ per year in the past decade. This figure contains incidence (new cases) admissions, recurrent cases (same patient/same year), and the admissions among those who were previously diagnosed. Further analyses of these data find the falling trend of ST-segment–elevation myocardial infarction with a more modest falling trend in non–ST-segment–elevation myocardial infarction.

The American Heart Association's Annual Heart Disease and Stroke Statistics Update is the most comprehensive source of annual estimates of incidence, prevalence, and risk factor distribution of the country.¹⁷ It is a carefully collated report from many federal and private sources of varying designs, populations, and sample sizes. It is the best data that we have.

However, it is neither nationally representative nor able to provide incidence data on CHD. As it stands, it is only an estimate of important trends. Public health goals targeting the improvement in CHD outcomes include the Millions Heart Initiative, American Heart Association 2020 goals, and the Healthy People 2020 goals. With the current systems, it will not be possible to rigorously evaluate the outcomes of these recommendations.¹⁸

In 2011, The Institute of Medicine reports recommended that a national surveillance program be established funded by the Affordable Care Act. At present, there is no national surveillance effort to understand the origin of trends occurring in the United States.^{18,19}

The Norwegian experience demonstrates that high-quality data can be collected in a population and inferences made regarding the roles of public health and medical interventions in population disease outcomes. The need to plan policy and allocate resources, always present, is more imperative because the rising costs for care of the chronically ill are becoming unsustainable and much of the potential for prevention is, as yet, unrealized.

Sources of Funding

This work was supported by the National Heart, Lung, and Blood Institute titled: Minnesota Heart Survey (grant R01-HL023727).

Disclosures

None.

References

1. National Institutes of Health. National Heart, Lung, and Blood Institute. *Morbidity & Mortality: 2012 Chart Book on Cardiovascular, Lung, and Blood Diseases*. www.nhlbi.nih.gov/files/docs/research/2012_ChartBook.pdf. Accessed November 3, 2015.
2. Mannsverk J, Wilsgaard T, Mathiesen EB, Løchen ML, Rasmussen K, Thelle DS, Njølstad, I, Hopstock LA, Børnaa, KH. Trends in modifiable risk factors are associated with declining incidence of hospitalized and nonhospitalized acute coronary heart disease in a population. *Circulation*. 2016;133:74–81. doi: 10.1161/CIRCULATIONAHA.115.016960.
3. Keys A. Seven Countries: A Multivariate Analysis of Death and Coronary Heart Disease. Cambridge, MA: Harvard University Press; 1980.
4. Havlik RJ, Feinleib M. *Proceedings of the Conference on the Decline in Coronary Heart Disease Mortality*. Bethesda, MD: National Heart, Lung and Blood Institute, US Public Health Services, National Institutes of Health; 1979. NIH publication 79–1610.
5. Jones DS, Greene JA. The contributions of prevention and treatment to the decline in cardiovascular mortality: lessons from a forty-year debate. *Health Aff (Millwood)*. 2012;31:2250–2258. doi: 10.1377/hlthaff.2011.0639.
6. Yusuf S, Reddy S, Ounpuu S, Anand S. Global burden of cardiovascular diseases: part I: general considerations, the epidemiologic transition, risk factors, and impact of urbanization. *Circulation*. 2001;104:2746–2753.
7. Mikkelsen L, Phillips DE, AbouZahr C, Setel PW, de Savigny D, Lozano R, Lopez AD. A global assessment of civil registration and vital statistics systems: monitoring data quality and progress. *Lancet*. 2015;386:1395–1406. doi: 10.1016/S0140-6736(15)60171-4.
8. Assaf AR, Lapane KL, McKenney JL, Carleton RA. Possible influence of the prospective payment system on the assignment of discharge diagnoses for coronary heart disease. *N Engl J Med*. 1993;329:931–935. doi: 10.1056/NEJM199309233291307.
9. National Health and Nutrition Examination Survey - Official Site. www.cdc.gov/nchs/nhanes/about_nhanes.htm. Accessed November 5, 2015.
10. Beaglehole R, LaRosa JC, Heiss G, Davis CE, Williams OD, Tyroler HA, Rifkind BM. Serum cholesterol, diet, and the decline in coronary heart disease mortality. *Prev Med*. 1979;8:538–547.
11. Capewell S, Morrison CE, McMurray JJ. Contribution of modern cardiovascular treatment and risk factor changes to the decline in coronary heart disease mortality in Scotland between 1975 and 1994. *Heart*. 1999;81:380–386.

12. Ford ES, Ajani UA, Croft JB, Critchley JA, Labarthe DR, Kottke TE, Giles WH, Capewell S. Explaining the decrease in U.S. deaths from coronary disease, 1980-2000. *N Engl J Med*. 2007;356:2388-2398. doi: 10.1056/NEJMsa053935.
13. Adabag AS, Peterson G, Apple FS, Titus J, King R, Luepker RV. Etiology of sudden death in the community: results of anatomical, metabolic, and genetic evaluation. *Am Heart J*. 2010;159:33-39. doi: 10.1016/j.ahj.2009.10.019.
14. The World Post. A Partnership of the Huffington Post and Berggruen Institute. Norway Best Place to Live: UN Report. http://www.huffingtonpost.com/2009/10/05/norway-best-place-live_n_309698.html. Accessed November 2, 2015.
15. Borodulin K, Vartiainen E, Peltonen M, Jousilahti P, Juolevi A, Laatikainen T, Männistö S, Salomaa V, Sundvall J, Puska P. Forty-year trends in cardiovascular risk factors in Finland. *Eur J Public Health*. 2015;25:539-546. doi: 10.1093/eurpub/cku174.
16. Dégano IR, Salomaa V, Veronesi G, Ferrières J, Kirchberger I, Laks T, Havulinna AS, Ruidavets JB, Ferrario MM, Meisinger C, Elosua R, Marrugat J; Acute Myocardial Infarction Trends in Europe (AMITIE) Study Investigators. Twenty-five-year trends in myocardial infarction attack and mortality rates, and case-fatality, in six European populations. *Heart*. 2015;101:1413-1421. doi: 10.1136/heartjnl-2014-307310.
17. Mozaffarian D, Benjamin EJ, Go AS, Arnett DK, Blaha MJ, Cushman M, de Ferranti S, Després JP, Fullerton HJ, Howard VJ, Huffman MD, Judd SE, Kissela BM, Lackland DT, Lichtman JH, Lisabeth LD, Liu S, Mackey RH, Matchar DB, McGuire DK, Mohler ER 3rd, Moy CS, Muntner P, Mussolino ME, Nasir K, Neumar RW, Nichol G, Palaniappan L, Pandey DK, Reeves MJ, Rodriguez CJ, Sorlie PD, Stein J, Towfighi A, Turan TN, Virani SS, Willey JZ, Woo D, Yeh RW, Turner MB; American Heart Association Statistics Committee and Stroke Statistics Subcommittee. Heart disease and stroke statistics-2015 update: a report from the American Heart Association. *Circulation*. 2015;131:e29-e322. doi: 10.1161/CIR.000000000000152.
18. Committee on a National Surveillance System for Cardiovascular and Select Chronic Diseases; Institute of Medicine of the National Academies. *A Nationwide Framework for Surveillance of Cardiovascular and Lung Diseases*. Washington, DC: The National Academics Press; 2011.
19. Sidney S, Rosamond WD, Howard VJ, Luepker RV; National Forum for Heart Disease and Stroke Prevention. The "heart disease and stroke statistics-2013 update" and the need for a national cardiovascular surveillance system. *Circulation*. 2013;127:21-23. doi: 10.1161/CIRCULATIONAHA.112.155911.

KEY WORDS: Editorials ■ coronary heart disease ■ death, sudden, cardiac ■ epidemiology ■ incidence ■ morbidity ■ mortality

Falling Coronary Heart Disease Rates: A Better Explanation?

Russell V. Luepker

Circulation. 2016;133:8-11; originally published online November 18, 2015;

doi: 10.1161/CIRCULATIONAHA.115.019862

Circulation is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231

Copyright © 2015 American Heart Association, Inc. All rights reserved.

Print ISSN: 0009-7322. Online ISSN: 1524-4539

The online version of this article, along with updated information and services, is located on the
World Wide Web at:

<http://circ.ahajournals.org/content/133/1/8>

Permissions: Requests for permissions to reproduce figures, tables, or portions of articles originally published in *Circulation* can be obtained via RightsLink, a service of the Copyright Clearance Center, not the Editorial Office. Once the online version of the published article for which permission is being requested is located, click Request Permissions in the middle column of the Web page under Services. Further information about this process is available in the [Permissions and Rights Question and Answer](#) document.

Reprints: Information about reprints can be found online at:
<http://www.lww.com/reprints>

Subscriptions: Information about subscribing to *Circulation* is online at:
<http://circ.ahajournals.org/subscriptions/>