Reducing the cardiovascular disease burden for people of all ages in the Americas region: analysis of mortality data, 2000–15

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Summary

Background In accordance with the age parameters specified in Sustainable Development Goal target 3.4, current policy and monitoring of non-communicable disease (NCD) mortality trends focus on people aged 30–69 years. This approach excludes the majority of NCD deaths, which occur at older ages. We aimed to compare cardiovascular mortality for different age groups in the WHO Region of the Americas.

Methods We extracted mortality data from the Pan American Health Organization regional mortality database for 36 countries for the period 2000 to 2015. We calculated age-standardised mortality rates (ASMRs) from cardiovascular diseases for different age groups for these countries. Joinpoint regression models were used to estimate mortality trends, providing estimates of the average annual percentage change for the period 2000–15.

Findings Individuals aged 70 years or older accounted for the majority of cardiovascular disease deaths in all countries (range 52–82%). Considerable variation in cardiovascular deaths was observed between countries for all age categories. Between 2000 and 2015, in most countries, the largest reductions in ASMR were observed in the older age groups (aged ≥70 years). The total number of regional cardiovascular disease deaths that hypothetically could have been averted in 2015 for people aged 30–79 years was 440 777, of which 211 365 (48%) occurred among people aged 70–79 years.

Interpretation Data for the WHO Region of the Americas are sufficiently robust to permit comparative analysis of cardiovascular disease mortality trends for people aged 70 years and older over time and across countries. Although the reduction of cardiovascular disease mortality in individuals aged 30–69 years is a valid policy goal for the Americas region, this objective should be expanded to include people at older ages.

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Introduction

The WHO Independent High-level Commission on Noncommunicable Diseases has raised justifiable concerns about the slow progress towards reducing non-communicable disease (NCD) mortality in all WHO regions, including the Region of the Americas.[1] Consistent with the Sustainable Development Goal target 3.4, global monitoring of NCD mortality exclusively focuses on people aged 30–69 years. For example, 2018 WHO country NCD profiles[2] provide no information on mortality among older people (aged ≥70 years). However, individuals aged 70 years and older account for the majority of NCD deaths in all WHO regions with the exception of Africa, where they account for 38% of all NCD deaths.[3]

The Lancet NCD Countdown 2030 Collaborators[4] observed that NCD targets that exclude certain age groups are inconsistent with the wider Sustainable Development Goals principle of leaving no one behind, and call for a more inclusive approach. The extent to which this is possible in different WHO regions is a matter of debate. Estimation of cause-specific death rates becomes increasingly uncertain at older ages because an increased proportion of deaths are coded as due to ill-defined causes, multimorbidity is high, and uncertainty exists about precise ages recorded in mortality and population data sources.[5]

We aimed to assess the viability of including people aged 70 years and older in NCD monitoring for the Region of the Americas with reference to cardiovascular disease, which is the leading cause of death in the region. We examined the distribution of cardiovascular disease deaths across different age groups, compared age-standardised mortality rates (ASMRs) for cardiovascular disease for different age groups across countries, and compared national trends in cardiovascular disease ASMRs for different age groups between 2000 and 2015. We also considered the implications of our findings for health policy targets in the Americas and other regions.

Methods

Data sources

We extracted mortality data from the Pan American Health Organization regional mortality database (updated

Research in context

Evidence before this study

Numerous published studies report that in most countries in the WHO Region of the Americas mortality due to cardiovascular disease has decreased in the past 20 years. Before initiating this study, we did a broad review of MEDLINE and relevant policy documents, which identified no published studies that focused on people older than 70 years or compared mortality between older and younger age groups.

Added value of this study

This is the first study to compare age-standardised cardiovascular disease mortality across different age groups for the Region of the Americas, using the most recent data available (up to 2015).

Implications of all the available evidence

Between 2000 and 2015, in the Region of the Americas, reductions in cardiovascular disease mortality were larger among older age groups (aged ≥70 years) than younger age groups (aged <70 years), albeit with large national variations, suggesting that a large proportion of deaths among people 70 years or older are avoidable. Consequently, individuals aged 70 years and older should not be excluded from global health targets, several of which aim to reduce premature mortality.

in July, 2017), which comprises deaths registered in national vital registration systems and reported annually to the Pan American Health Organization by national authorities in all 36 countries of the WHO Region of the Americas.[6] This dataset contains information on sex, age, date of death, place of residence, and underlying cause of death coded using the International Classification of Diseases, tenth revision (ICD-10).[7]

Quality of data on registered deaths was assessed by measuring data completeness, including variables with missing values (sex and age with unknown categories), and years with no reported data; cause-of-death diagnostic and coding quality, by quantifying the proportion of death with ill-defined causes of death and so-called garbage codes; and estimation of the coverage level (appendix p 20). Mortality data were validated according to ICD-10 classification standards and corrected to overcome data quality issues following standard methods.[8] Briefly, underlying cause-of-death codes are validated against a list of accepted mortality codes and verified against age and sex restrictions. Deaths with unknown sex or age were redistributed pro rata among deaths with known sex and ages. Deaths with underlying causes coded as ill-defined causes of death (ICD-10 codes R00–R94 or R96–R99) were redistributed proportionally among deaths with non-injury causes of death by strata of country, year, sex, and age group. Deaths with underlying causes coded as events of undetermined intent (ICD-10 codes Y10–Y34) were redistributed proportionally among deaths due to injuries. Registered deaths for countries with estimated under-registration higher than 3% and available data in the WHO life table[8] were corrected according to their level of under-registration by strata of year, sex, age, and underlying cause of death. After addressing data quality issues, the number of deaths was estimated by country, sex, age group, and four-digit code of cause-of-death for the whole time period (2000–15) with reported data as part of annual estimation cycles.

See Online for appendix

For more on **Joinpoint software** see https://surveillance.cancer.gov/joinpoint/

We used mid-year population estimates obtained from a database that integrates data from the World Population Prospects, 2017 Revision[9] (for countries with population size of 90 000 or more) and data from the US Census Bureau International Database[10] (for countries and territories with population of less than 90 000) to calculate death rates. The WHO Standard[11] was used to calculate ASMRs. Deaths due to cardiovascular disease were defined as all deaths classified using ICD-10 codes I00–I99.

11 countries and territories with a population size of less than 90 000 were excluded from the analysis. Additionally, Bolivia, Haiti, and Honduras were excluded because of low data quality and poor data completeness (appendix p 20). Overall, the countries and territories excluded represent only 3% of the total population of the Americas.

Data analysis

We calculated the number of cardiovascular disease deaths by 5-year age group and sex, and the proportion of cardiovascular disease deaths by age group (0–30, 30–49, 50–69, 70–79, and ≥80 years), by broader age group (30–69 and ≥70 years), and by sex. We computed age-specific and sex-specific death rates from cardiovascular disease per 100 000 person-years for 5-year age groups (0–4, 5–9, 10–14, ..., 75–79, 80–84, and ≥85 years) for men, women, and both sexes combined. We also computed the cardiovascular disease age-standardised death rates per 100 000 person-years at all ages and for age groups 30–49, 50–69, 70–79, and 80 years and older, and age groups 30–69 and 70 years and older in men, women, and both sexes combined by the direct method. We used the Joinpoint Regression Program (version 4.5.0.1) to assess mortality trends over time, whereby models provided estimates of the average annual percentage change (AAPC) and 95% CIs for the period 2000–15 using age-standardised death rate as the dependent variable and year as the independent variable. Analysis of trends via estimation of conventional annual percent change in age-adjusted rates by fitting a simple linear model of the logarithm of annual age-adjusted rates regressed on time, and transforming the slope to determine the percent change per year is easy to calculate and understand. However, this is not a reliable estimate

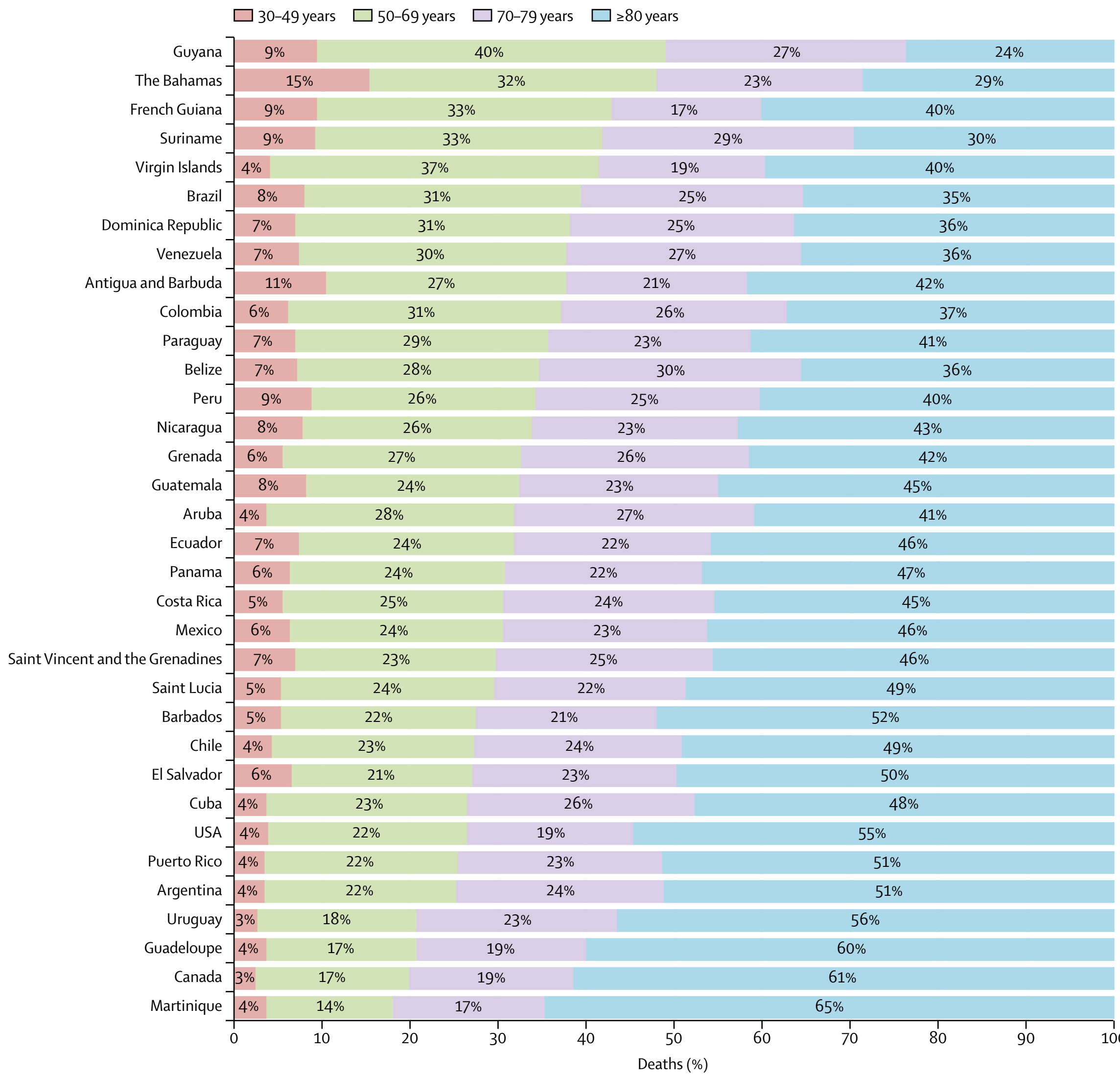

Figure 1: **Cardiovascular disease deaths by age group in adults aged 30 years and older in selected countries and territories of the Americas, 2013–15**
34 of 36 countries or territories had available data for the period 2013–15.

if the rate of change over time is not constant. In such circumstances many studies now estimate the AAPC using Joinpoint, which provides segmented analysis of rates over the entire time period.[12,13] Each p value is calculated using the Monte Carlo method,[14] and the overall asymptotic significance level is maintained through a Bonferroni correction. We used 4499 randomly permuted datasets (default setting in the Joinpoint software). These tests also consider situations with non-constant variance to account for rates with Poisson variation and possibly autocorrelated errors. The AAPC is a summary measure of the trend over a prespecified fixed interval, which is computed as a weighted average of the annual percent change from the Joinpoint model, with the weights equal to the length of the annual percent change interval. The AAPC is considered statistically significant when its value differs from zero at α level 0·05. To interpret the AAPC, a constant trend was considered when the zero value was within the lower and upper limits of the 95% CI of the AAPC; an increasing trend was considered present when both limits of the 95% CI were positive, and a decreasing trend was considered present when both limits of the 95% CI were negative.

Incidence rates were compared with those in Canada and presented as incidence rate ratios.

To determine the number of cardiovascular disease deaths that could have hypothetically been avoided, we compared the actual number of deaths in 2015 with the expected number of deaths that would have occurred assuming there was no change in ASMRs between 2000 and 2015.

	Year*	30–49 years		50–69 years		70–79 years		≥80 years	
		ASMR	Incidence rate ratio† (95% CI)	ASMR	Incidence rate ratio† (95% CI)	ASMR	Incidence rate ratio† (95% CI)	ASMR	Incidence rate ratio† (95% CI)
Antigua and Barbuda	2015	84·2	5·2 (3·6–7·6)	354·2	2·8 (2·1–3·6)	1180·4	2·0 (1·5–2·8)	5622·2	2·1 (1·7–2·6)
Argentina	2014	31·5	1·9 (1·8–2·1)	275·0	2·1 (2·1–2·2)	1154·4	2·0 (1·9–2·0)	4059·4	1·5 (1·5–1·6)
Aruba	2015	25·2	1·6 (0·8–3·1)	244·7	1·9 (1·5–2·4)	1049·1	1·8 (1·4–2·3)	4997·2	1·9 (1·6–2·3)
The Bahamas	2013	98·7	6·1 (5·0–7·4)	350·9	2·7 (2·4–3·1)	1302·7	2·2 (1·9–2·6)	3927·6	1·5 (1·3–1·7)
Barbados	2013	54·9	3·4 (2·5–4·5)	276·4	2·2 (1·9–2·5)	1035·9	1·8 (1·5–2·1)	4603·6	1·7 (1·6–1·9)
Belize	2014	48·6	3·0 (2·2–4·1)	408·8	3·2 (2·7–3·8)	2532·9	4·3 (3·7–5·1)	7673·1	2·9 (2·5–3·4)
Brazil	2015	48·0	3·0 (2·8–3·1)	327·9	2·6 (2·5–2·6)	1278·5	2·2 (2·2–2·2)	4012·1	1·5 (1·5–1·5)
Canada	2013	16·2	1·0 (1·0–1·0)	128·0	1·0 (1·0–1·0)	582·5	1·0 (1·0–1·0)	2646·9	1·0 (1·0–1·0)
Chile	2015	21·6	1·3 (1·2–1·4)	182·5	1·4 (1·4–1·5)	842·9	1·4 (1·4–1·5)	3180·3	1·2 (1·2–1·2)
Colombia	2013	35·6	2·2 (2·1–2·3)	331·0	2·6 (2·5–2·6)	1522·3	2·6 (2·6–2·7)	4705·2	1·8 (1·8–1·8)
Costa Rica	2014	26·1	1·6 (1·4–1·8)	204·4	1·6 (1·5–1·7)	936·8	1·6 (1·5–1·7)	3466·2	1·3 (1·3–1·4)
Cuba	2015	32·3	2·0 (1·9–2·1)	311·9	2·4 (2·4–2·5)	1367·0	2·3 (2·3–2·4)	4129·0	1·6 (1·5–1·6)
Dominican Republic	2013	59·1	3·6 (3·4–3·9)	504·0	3·9 (3·8–4·1)	1843·7	3·2 (3·1–3·3)	4864·5	1·8 (1·8–1·9)
Ecuador	2015	33·9	2·1 (1·9–2·2)	216·9	1·7 (1·6–1·8)	901·5	1·5 (1·5–1·6)	3791·1	1·4 (1·4–1·5)
El Salvador	2014	37·4	2·3 (2·1–2·5)	203·1	1·6 (1·5–1·7)	829·2	1·4 (1·4–1·5)	4209·1	1·6 (1·5–1·6)
French Guiana	2014	26·6	1·6 (1·0–2·6)	190·7	1·5 (1·2–1·9)	803·4	1·4 (1·0–1·9)	2472·5	0·9 (0·7–1·2)
Grenada	2015	95·3	5·9 (3·8–9·0)	613·7	4·8 (3·9–5·9)	2201·7	3·8 (3·0–4·7)	7137·0	2·7 (2·3–3·2)
Guadeloupe	2014	22·7	1·4 (1·0–2·0)	135·9	1·1 (0·9–1·2)	607·4	1·0 (0·9–1·2)	2489·7	0·9 (0·9–1·0)
Guatemala	2015	36·7	2·3 (2·1–2·4)	243·9	1·9 (1·8–2·0)	973·5	1·7 (1·6–1·7)	4244·1	1·6 (1·6–1·6)
Guyana	2013	101·7	6·3 (5·4–7·3)	890·0	7·0 (6·5–7·5)	3464·1	5·9 (5·5–6·5)	10 077·4	3·8 (3·5–4·2)
Jamaica	2011	46·8	2·9 (2·6–3·2)	257·8	2·0 (1·9–2·1)	1254·8	2·2 (2·0–2·3)	4588·4	1·7 (1·7–1·8)
Martinique	2014	26·8	1·7 (1·1–2·4)	114·3	0·9 (0·7–1·1)	496·1	0·9 (0·7–1·0)	2967·7	1·1 (1·0–1·2)
Mexico	2015	31·0	1·9 (1·8–2·0)	235·5	1·8 (1·8–1·9)	1070·7	1·8 (1·8–1·9)	3788·0	1·4 (1·4–1·4)
Nicaragua	2015	44·3	2·7 (2·5–3·0)	318·3	2·5 (2·4–2·6)	1304·1	2·2 (2·1–2·4)	4721·9	1·8 (1·7–1·8)
Panama	2015	32·1	2·0 (1·8–2·2)	238·2	1·9 (1·8–2·0)	975·7	1·7 (1·6–1·8)	3612·3	1·4 (1·3–1·4)
Paraguay	2014	45·2	2·8 (2·5–3·1)	332·9	2·6 (2·5–2·7)	1280·9	2·2 (2·1–2·3)	5057·4	1·9 (1·8–2·0)
Peru	2015	28·5	1·8 (1·7–1·9)	165·1	1·3 (1·3–1·3)	765·9	1·3 (1·3–1·4)	2531·0	1·0 (0·9–1·0)
Puerto Rico	2015	23·7	1·5 (1·3–1·7)	177·7	1·4 (1·3–1·5)	737·7	1·3 (1·2–1·3)	2421·7	0·9 (0·9–0·9)
Saint Lucia	2014	56·1	3·5 (2·4–5·0)	410·8	3·2 (2·7–3·8)	1471·6	2·5 (2·1–3·1)	4942·8	1·9 (1·6–2·1)
Saint Vincent and the Grenadines	2015	50·9	3·1 (1·9–5·2)	338·9	2·6 (2·1–3·4)	2000·4	3·4 (2·7–4·3)	8270·0	3·1 (2·7–3·7)
Suriname	2014	68·6	4·2 (3·5–5·2)	518·3	4·0 (3·7–4·5)	2196·4	3·8 (3·4–4·2)	5537·2	2·1 (1·9–2·3)
Trinidad and Tobago	2011	69·6	4·3 (3·8–4·9)	522·4	4·1 (3·9–4·3	2179·4	3·7 (3·5–4·0)	6483·1	2·4 (2·3–2·6)
USA	2015	37·3	2·3 (2·2–2·4)	233·9	1·8 (1·8–1·9)	834·8	1·4 (1·4–1·5)	3488·5	1·3 (1·3–1·3)
Uruguay	2015	26·2	1·6 (1·4–1·9)	250·5	2·0 (1·9–2·1)	1075·7	1·8 (1·8–1·9)	3690·8	1·4 (1·4–1·4)
Venezuela	2013	47·2	2·9 (2·8–3·1)	378·2	3·0 (2·9–3·0)	1748·3	3·0 (2·9–3·1)	5300·6	2·0 (2·0–2·0)
Virgin Islands	2015	36·0	2·2 (1·2–4·3)	268·3	2·1 (1·7–2·6)	520·2	0·9 (0·7–1·2)	3233·7	1·2 (1·0–1·5)

Data are number of deaths per 100 000 person-years. ASMR=age-standardised mortality rate. *Last year data was available. †Relative to Canada.

Table 1: **Cardiovascular disease mortality across countries and territories of the Americas by age group**

Role of the funding source

There was no funding source for this study. The corresponding author had full access to all the data in the study and had final responsibility to submit for publication.

Results

We analysed data from 36 countries. Individuals aged 70 years or older accounted for the majority of cardiovascular disease deaths in all countries, ranging from 52% in the Bahamas to 82% in Martinique (figure 1). The proportion of cardiovascular disease deaths in the 30–49 year age group was highest in the Bahamas (15%) and lowest in Canada (3%).

ASMR varied considerably between countries across all age categories (table 1). For all age categories, the highest incidence rates relative to Canada were observed for Guyana (incidence rate ratio 6·3 for individuals aged 30–49 years; 7·0 for individuals aged 50–69 years; 5·9 for individuals aged 70–79 years; and 3·8 for individuals aged ≥80 years). Countries with the lowest incidence rate ratios relative to Canada varied by age group (1·3 for

	Period	30–49 years	50–69 years	70–79 years	≥80 years
Antigua and Barbuda	2000–15	5·9 (–2·2 to 14·5)	–1·0 (–3·1 to 1·0)	–2·4 (–3·6 to –1·2)	–0·4 (–1·8 to 1·1)
Argentina	2000–14	–3·7 (–4·5 to –2·9)	–2·6 (–2·9 to –2·2)	–2·2 (–2·6 to –1·9)	–2·0 (–2·4 to –1·6)
Aruba	2000–15	–4·1 (–6·5 to –1·6)	–3·3 (–5·4 to –1·1)	–4·3 (–8·6 to 0·3)	–1·7 (–3·7 to 0·4)
The Bahamas	2000–13	4·4 (0·1 to 8·8)	–0·6 (–2·4 to 1·2)	–2·2 (–3·4 to –0·9)	–2·8 (–4·3 to –1·3)
Barbados	2000–13	1·9 (–1·0 to 4·8)	–1·9 (–3·2 to –0·6)	–3·0 (–4·3 to –1·6)	–2·4 (–3·0 to–1·8)
Belize	2000–14	–5·1 (–7·6 to –2·4)	–5·8 (–9·0 to –2·6)	–5·1 (–9·5 to –0·5)	–1·1 (–2·5 to 0·3)
Bermuda	2000–15	2·3 (–2·2 to 7·1)	–3·6 (–7·3 to 0·2)	–4·9 (–7·3 to –2·4)	–5·6 (–7·6 to –3·5)
Brazil	2000–15	–2·9 (–3·2 to –2·6)	–2·9 (–3·0 to –2·7)	–2·9 (–3·1 to –2·8)	–4·1 (–4·3 to –3·9)
Canada	2000–13	–2·1 (–2·6 to –1·6)	–3·8 (–4·1 to –3·5)	–4·8 (–5·2 to –4·4)	–4·2 (–4·4 to –4·0)
Chile	2000–15	–0·7 (–1·2 to –0·2)	–2·2 (–2·5 to–1·9)	–2·9 (–3·2 to–2·6)	–1·6 (–2·0 to –1·1)
Colombia	2000–13	–1·7 (–2·1 to –1·3)	–2·2 (–2·9 to –1·5)	–2·0 (–2·3 to –1·7)	–2·3 (–2·7 to –1·9)
Costa Rica	2000–14	–1·6 (–2·7 to –0·5)	–1·6 (–2·2 to –1·0)	–2·3 (–3·0 to –1·7)	–2·1 (–2·5 to –1·7)
Cuba	2001–15	–2·1 (–3·4 to –0·8)	–1·9 (–2·3 to –1·5)	–2·0 (–2·5 to –1·5)	–1·7 (–2·3 to –1·0)
Curaçao	2001–07	2·2 (–8·2 to 13·8)	0·4 (–6·8 to 8·1)	4·8 (–1·1 to 11·1)	0·2 (–7·0 to 8·0)
Dominican Republic	2000–13	–1·6 (–3·0 to –0·2)	–0·4 (–1·5 to 0·7)	–0·4 (–1·3 to 0·6)	0·3 (–0·9 to 1·5)
Ecuador	2000–15	–4·1 (–4·6 to –3·6)	–2·8 (–3·2 to –2·4)	–2·5 (–3·0 to –2·1)	–1·2 (–2·1 to –0·3)
El Salvador	2000–14	–1·4 (–2·1 to –0·6)	–2·5 (–3·0 to –1·9)	–4·1 (–4·6 to –3·7)	–3·6 (–4·2 to –3·0)
French Guiana	2001–14	–4·1 (–7·3 to –0·8)	–3·7 (–5·7 to –1·6)	–4·2 (–6·9 to –1·4)	–6·0 (–8·5 to –3·4)
Grenada	2002–15	–1·3 (–5·2 to 2·8)	–1·0 (–2·4 to 0·4)	–0·3 (–2·0 to 1·4)	–0·1 (–2·8 to 2·6)
Guadeloupe	2000–14	–2·9 (–5·1 to –0·7)	–4·8 (–6·3 to –3·3)	–5·6 (–6·5 to –4·6)	–3·6 (–4·2 to –3·0)
Guatemala	2005–15	–2·1 (–3·2 to –0·9)	0·1 (–1·0 to 1·2)	0·3 (–0·6 to 1·1)	–1·1 (–1·8 to –0·4)
Guyana	2000–13	6·0 (3·7 to 8·4)	1·1 (–0·5 to 2·6)	3·3 (1·7 to 4·8)	1·6 (–3·1 to 6·4)
Jamaica	2000–11	–3·9 (–7·1 to –0·7)	–3·1 (–4·0 to –2·2)	–2·0 (–2·3 to –1·7)	–1·7 (–2·2 to –1·2)
Martinique	2000–14	–1·3 (–3·8 to 1·3)	–4·1 (–5·4 to –2·7)	–5·7 (–6·6 to –4·7)	–2·4 (–4·0 to –0·8)
Mexico	2000–15	0·0 (–1·0 to 1·1)	–0·9 (–1·1 to –0·7)	0·1 (–0·2 to 0·4)	–0·8 (–1·2 to –0·5)
Nicaragua	2000–15	–2·6 (–3·7 to –1·4)	–2·8 (–3·5 to –2·2)	–2·6 (–3·1 to –2·1)	–2·4 (–3·0 to –1·7)
Panama	2000–15	0·4 (–0·3 to 1·2)	–0·8 (–1·5 to –0·1)	–1·8 (–2·4 to –1·3)	–1·7 (–2·1 to –1·3)
Paraguay	2000–14	–2·9 (–4·2 to –1·5)	–2·5 (–3·6 to –1·4)	–2·4 (–4·0 to –0·8)	–2·3 (–3·7 to –0·8)
Peru	2000–15	–1·5 (–2·3 to –0·7)	–1·9 (–2·5 to –1·4)	–2·2 (–2·7 to –1·7)	–3·1 (–3·6 to –2·5)
Puerto Rico	2000–15	–2·6 (–3·3 to –1·8)	–3·1 (–3·5 to –2·7)	–3·1 (–3·5 to –2·8)	–2·3 (–2·6 to –2·0)
Saint Lucia	2000–14	–0·6 (–4·0 to 3·1)	–1·3 (–3·2 to 0·6)	–1·5 (–3·3 to 0·3)	–0·7 (–1·8 to 0·5)
Saint Vincent and the Grenadines	2000–15	0·6 (–2·4 to 3·7)	1·4 (–0·3 to 3·2)	1·3 (–0·3 to 3·0)	1·7 (–2·7 to 6·4)
Suriname	2000–14	–3·7 (–4·8 to –2·6)	–3·3 (–5·6 to –1·0)	–2·4 (–3·8 to –0·9)	–2·9 (–5·3 to –0·4)
Trinidad and Tobago	2000–11	–3·8 (–7·4 to 0·0)	–3·1 (–3·6 to –2·6)	–1·7 (–3·1 to –0·3)	–0·2 (–2·5 to 2·0)
USA	2000–15	–1·1 (–1·3 to –0·8)	–2·3 (–2·6 to –2·0)	–3·5 (–3·8 to –3·2)	–3·0 (–3·4 to –2·5)
Uruguay	2000–15	–3·3 (–3·8 to –2·8)	–2·9 (–3·2 to –2·6)	–2·9 (–3·4 to –2·3)	–2·9 (–3·5 to –2·3)
Venezuela	2000–13	–3·0 (–3·4 to –2·6)	–1·6 (–2·2 to –1·1)	–1·6 (–1·9 to –1·3)	–0·3 (–0·7 to 0·1)
Virgin Islands	2000–15	–4·4 (–7·9 to –0·9)	–2·4 (–4·2 to –0·5)	–5·9 (–7·9 to –3·9)	–3·8 (–5·4 to –2·2)

Data are AAPC (95% CI). Negative AAPC estimates represent a reduction in age-standardised cardiovascular death rate. Bermuda and Curaçao have been included because all countries and territories with available data for the specified time periods were included. AAPC=average annual percentage change.

Table 2: **AAPC in age-standardised cardiovascular mortality rate by age group for selected countries and territories of the Americas, 2000–15**

individuals aged 30–49 years in Chile; 0·9 for individuals aged 50–69 years and individuals aged 70–79 years in Martinique; and 0·9 for individuals aged ≥80 years in Puerto Rico).

Between 2000 and 2015, ASMRs decreased in most countries for all age categories (table 2), which reflects the regional trend, although wide variation was observed between countries. Of the more populous countries in the Region of the Americas, Mexico stands out in terms of the limited progress made. Large disparities were identified among smaller countries, although the robustness of the data is limited by small population sizes. Between 2000 and 2015, the cardiovascular disease ASMRs in all age groups in Brazil, Canada, Colombia, Mexico, and the USA generally decreased, with the exception of Mexico, and the largest reductions were observed in the older age groups (70–79 years and ≥80 years; figure 2). ASMR data for all countries are shown in the appendix (p 10).

Table 3 presents the number of cardiovascular disease deaths by age group that could have hypothetically been averted for selected countries. Hypothetically, for the region as a whole, in 2015, 440 777 cardiovascular disease

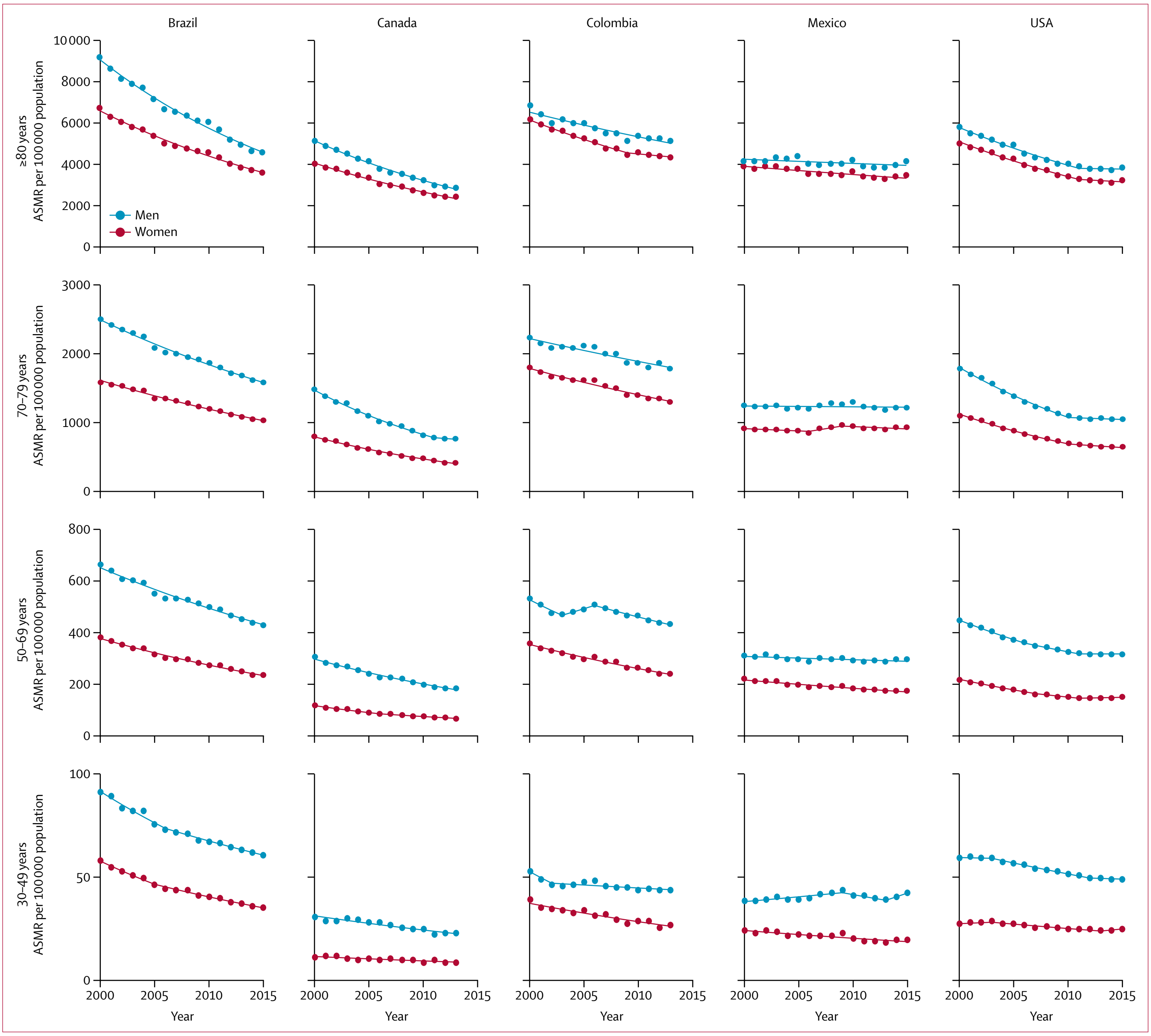

Figure 2: **Level and trends of age-standardised cardiovascular disease death rates by sex and age group in selected countries of the Americas, 2000–15**
ASMR=age-standardised mortality rate.

deaths in people aged 30–79 years could have been averted, of which 211 365 (48%) occurred among people aged 70–79 years.

Discussion

Cardiovascular disease continues to be the leading cause of all deaths in the WHO Region of the Americas, accounting for 1·6 million deaths annually.[3] Around two-thirds of these deaths occur among people aged 70 years and over, reflecting the rate of demographic and epidemiological transition in most countries. The proportion of the population aged older than 70 years is expected to increase from 5·6% in 2000 to 10·5% by 2030.[9]

Available data for the Region of the Americas are sufficiently robust to permit comparative analysis of cardiovascular disease mortality trends over time, across countries, and between age groups. This includes the population aged 70–79 years and, to a lesser extent, people aged 80 years and older, indicating the viability of including these groups in targets and monitoring.

Our findings are consistent with previous studies of the Americas region, which report a 19% decline in cardiovascular disease mortality at all ages and a 21% decline for people younger than 70 years between 2000 and 2010.[15,16] These findings are also consistent with a separate analysis of the WHO mortality database,[17] which shows that reduced cardiovascular disease mortality at older ages was one of the most important contributors to overall improvements in life expectancy among older populations in low-income and middle-income countries between 1980 and 2010. Although trends in age-specific cardiovascular disease mortality based on ASMR show a clear reduction between 2000 and 2015, the total number of people with cardiovascular disease and associated mortality has increased, resulting in a higher burden on health services. Globally, the absolute number of cardiovascular disease deaths increased by 41% between 1990 and 2013, of which half is attributed to population ageing and a quarter to population growth, with similar trends observed in the Americas region, highlighting the importance of including older people in NCD policies.[18]

Despite the regional trend of decreasing age-specific cardiovascular disease mortality, large national disparities exist. Variations are to be expected between countries with small populations, as a result of the small numbers of observations. However, we also observed variation between countries with larger populations, such as Chile and Colombia. This is consistent with the findings of a global study of age-specific cardiovascular disease mortality,[18] which reported large variations between countries.

The drivers of trends in cardiovascular disease mortality might differ between countries and require further study, particularly in a region as heterogeneous as the Americas. Future research should focus on modifiable risk factors associated with both prevention and treatment. Available data do not permit comparative analysis of risk factors or associated policies. However, it is possible to make some broad observations. First, a number of risk factors, especially hypertension, increase in prevalence with age and relative risks usually persist into at least the eighth decade of life. Consequently, tackling risk factors such as uncontrolled hypertension lowers mortality in older people to a similar extent as that in younger people.[19–21] Second, increasing evidence suggests that improved access to effective treatment can reduce mortality. A Swedish study[22] reported a sustained decline in 28-day case fatality between 1994 and 2010 for older individuals admitted to hospital for myocardial infarction, stroke, and other cardiovascular conditions in people aged up to 99 years. However, in many countries older people continue to be treated much less intensively than younger people.[23,24]

Reducing cardiovascular disease death rates in older people prevents many more deaths than does a similar reduction in younger people, since mortality is higher in older populations than younger populations. Individuals aged 70–79 years accounted for nearly half of all deaths that could have hypothetically been averted in the Americas region between 2000 and 2015. This finding calls into question the exclusive focus of global NCD targets on people aged 30–69 years and supports calls from *The Lancet* NCD 2030 Countdown Collaborators for more inclusive monitoring.[4] More generally, our findings demonstrate that describing the deaths of people younger than 70 years as premature (ie, implying that less can, or should, be done to avert deaths at older ages) has no scientific foundation and might lead to discrimination.

There are a number of approaches that could be used in concurrence with premature mortality to track progress in reducing mortality from cardiovascular disease and other causes. One approach would be to raise the threshold

	30–49 years	50–69 years	70–79 years	≥80 years
Antigua and Barbuda	–18	4	18	–1
Argentina	2419	9750	9076	18 137
Aruba	5	79	77	46
The Bahamas	–56	41	58	160
Barbados	6	81	104	179
Belize	23	268	120	86
Brazil	16 190	66 809	50 692	114 607
Canada	484	8077	12 323	27 678
Chile	192	2423	3493	4054
Colombia	1453	9004	6846	11 380
Costa Rica	110	568	710	1208
Cuba	438	3208	3072	4572
Dominican Republic	494	225	207	–627
Ecuador	1042	2247	1975	1929
El Salvador	137	880	1810	3180
French Guiana	11	35	22	35
Grenada	5	20	17	25
Guadeloupe	9	100	170	355
Guatemala	336	–106	–59	641
Guyana	–99	–290	–225	–106
Jamaica	175	461	392	758
Martinique	2	114	183	214
Mexico	176	5216	–265	4856
Nicaragua	358	981	831	1263
Panama	–28	223	277	738
Paraguay	425	1284	936	1476
Peru	762	2746	3179	6219
Puerto Rico	116	784	974	1387
Saint Lucia	9	–4	18	75
Saint Vincent and the Grenadines	2	1	–8	–39
Suriname	95	243	134	200
Trinidad and Tobago	55	691	404	284
USA	5185	74 888	108 806	221 915
Uruguay	173	834	1007	2168
Venezuela	1880	4906	3901	1249
Virgin Islands	11	46	89	80
Overall	32 576	196 836	211 365	430 382

The number of avoidable deaths were calculated based on the assumption that age-standardised mortality rate remained the same between 2000 and 2015.

***Table 3:* Avertable cardiovascular disease deaths in 2015, by age group in selected countries of the Americas**

for what is categorised as a premature death, perhaps to 80 years of age. This is the approach taken by the NCD 2030 Countdown Collaborators.[4] However, across the region of the Americas substantial reductions were observed in ASMRs for cardiovascular disease for people 80 years and older. Establishing a cutoff for health targets at any age contradicts the view that good health care is a universal right and the Sustainable Development Goals principle of leaving no one behind.

A more suitable approach would be to complement or replace the premature mortality targets with a target to reduce avoidable deaths among people of all ages. These targets would combine amenable mortality (deaths avoidable through appropriate personal health-care interventions) and preventable mortality (control of risk factors). A study of 51 countries[17] estimated that 38% of deaths occurring in men aged 60 years or older and 29% of deaths in women aged 60 years or older in 2011 were avoidable. Of those avoidable deaths, 72% occurred among people older than 70 years. Estimates of avoidable mortality are possible even in countries with low-quality civil registration data and do not require an arbitrary age threshold.

Alternatively, the quantification of premature mortality could be complemented by measuring years of life lost (YLLs) due to premature death. YLLs are calculated by subtracting age at death from the longest life expectancy observed for a person at that age in any territory with a population of more than 5 million.[25] Thus, if the longest life expectancy observed at age 72 years was 86 years, the YLLs for someone dying at this age would be 14 years. Emerging evidence[26] suggests that this approach can be effectively applied to NCD mortality trends in regions such as the Americas.

This study has a number of limitations. Death data are not available for country-years without reported data. Consequently, we used an incomplete series of mortality estimates for the study period for some countries. The mortality correction processes do not include the redistribution of some cause of death considered so-called garbage codes. This could minimally affect the analysis, since heart failure (ICD-10 code I50) represents 15% of all garbage codes in the Americas that are included as cardiovascular disease (ICD-10 codes I00–I99). 11 countries and territories were excluded from the analysis because of small populations and three were excluded because of data quality issues. However, these exclusions do not invalidate the results because the level and trends of mortality were analysed by country, and the excluded countries and territories represented a small proportion of the total population of the Americas. Additionally, we did not calculate 95% uncertainty intervals for ASMRs by age group because we did not use a sample population to calculate the ASMRs. However, we corrected the registered deaths to overcome data quality issues. Despite these limitations, the mortality estimates and results from the comparative analysis are valid and robust, and demonstrate country-level reductions in cardiovascular disease mortality for adults of all age groups in the Americas.

Decreasing cardiovascular disease mortality among adults of all ages in the Americas should not lead to complacency. Without sustained action to reduce risk factors through better prevention and treatment this decrease in mortality might level out, as observed in the USA.[27] Although the reduction of cardiovascular disease mortality in individuals aged 30–69 years is a valid policy goal for the Region of the Americas, this objective should be expanded to include people at older ages.

Contributors

All authors made substantial contributions to the content and writing of this paper. PLS led drafting of the paper. PO and RM led data analysis. MM and SE made substantial intellectual contributions to several drafts.

Declaration of interests

RM and PO are employed by the Pan American Health Organization. The findings and conclusions of this report are those of the authors and do not necessarily represent the official position of the Pan American Health Organization. We declare no competing interests.

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