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Trends in deaths and disability-adjusted life-years of ischemic heart disease attributable to high body-mass index worldwide, 1990–2019

Wei Yan¹ and Yajun Hua^{1*}

Abstract

Background The objective of this study is to evaluate the global burden of ischemic heart disease (IHD) attributable to High body mass index (HBMI) by utilizing data from Global Burden of Disease (GBD) 2019.

Methods This study utilized data from the GBD 2019 to examine the impact of HBMI on deaths and disability-adjusted life years (DALYs). The analysis focused on age-standardized rates and considered a 30-year time frame. Trends were assessed using estimated annual percentage changes (EAPCs).

Results Since 1990, a significant global increase in IHD attributable to HBMI has been observed. This increase is particularly notable among elderly males and in regions with low-middle Socio-Demographic Index (SDI), such as Central Asia and Eastern Europe. In 2019, IHD globally resulted in 1,662,339 deaths and 41,369,773 DALYs. Despite the high age-standardized death rate (20.73 per 100,000) and DALY rate (499.41 per 100,000), a declining trend was noted. This trend is reflected by the EAPCs of -0.35 for DALYs and -0.67 for deaths. Notably, males and middle SDI countries exhibited higher rates of IHD, whereas high SDI regions such as High-income Asia Pacific and Western Europe showed decreasing trends in IHD.

Conclusion Over the past three decades, there has been a significant increase in IHD caused by HBMI, especially in low-middle and low SDI regions. This highlights the importance of targeted interventions in addressing this issue. Notably, regions including Central Asia, Eastern Europe, North Africa, and the Middle East have been heavily affected.

Keywords Ischemic heart disease, High body mass index, EAPC, Socio-Demographic Index

Background

Cardiovascular diseases (CVD) have been the leading cause of mortality worldwide for decades, with ischemic heart disease (IHD) being the most prevalent form and responsible for 16% of total global deaths. However, there are significant regional and national variations in the burden of IHD. This study seeks to evaluate the global

burden of IHD linked to high body mass index (HBMI) by conducting a meticulous analysis spanning 30 years, from 1990 to 2019. The aim is to assess the extent to which HBMI contributes to the global burden of IHD.

Obesity, once defined by the HBMI, has reached epidemic proportions worldwide [1]. The new definition of obesity is based on the waist-to-height ratio [2]. This study primarily examined the HBMI as a measure of obesity, as the HBMI still has research value. HBMI is known to indirectly increase the risk of IHD through the development of hyperlipidemia, hypertension, diabetes, and related conditions [3]. HBMI has become a widely used metric in epidemiological studies and has reached pandemic levels globally in the past two decades [4].

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The prevalence of obesity, a major contributor to Non-Communicable Diseases (NCDs) such as cardiovascular disease, cancer, chronic respiratory diseases, and diabetes, has alarmingly doubled since 1980 [5]. Presently, approximately one-third of the global population is classified as overweight or obese, with the number reaching 3 billion in 2019 [6]. This rise has been linked to over 5 million obesity-related deaths each year, primarily affecting adults aged 20 and above [7]. While previous research has established the association between HBMI and various cardiovascular outcomes, the specific impact on IHD risk yields varied findings [8].

Despite these insights, comprehensive data on the global burden of IHD attributable to HBMI, especially its temporal trends, remain limited. Accurate and up-to-date burden estimates are essential for guiding research, informing evidence-based strategies, and enhancing the effectiveness of efforts in IHD prevention and management.

Methods

Data source

Our study utilized data from the Global Burden of Disease Study 2019 (GBD 2019) to analyze the global impact of IHD attributable to HBMI. The GBD 2019 provides comprehensive assessments of health loss for 329 diseases in 204 countries and territories. These entities are categorized into 21 regions based on epidemiological and geographical considerations [9]. Furthermore, these regions are stratified into five Socio-Demographic Index (SDI) categories: high (>0.81), high-middle ($0.70-0.81$), middle ($0.61-0.69$), low-middle ($0.46-0.60$), and low (<0.46) [10]. For our analysis, we thoroughly examined data from 1990 to 2019, with a specific focus on mortality, disability-adjusted life years (DALYs) [10], and age-standardized rates (ASRs) relevant to IHD. To discern global trends and implications of HBMI on IHD, we conducted a detailed analysis by age, location, and year. This study is based on a publicly available database and does not require ethical approval.

Defining HBMI and clinical diagnostic criteria for IHD

Within the HBMI classification, overweight is defined as a BMI ranging from 25.00 to 29.99 kg/m², while obesity is defined as a BMI of ≥ 30.00 kg/m² [11].

In the GBD 2019 analysis, IHD is classified as a 'non-communicable disease' and a 'cardiovascular disease', specifically as a level 3 cause with the code B.2.2. To identify cases of IHD, the study uses the International Classification of Diseases, Ninth Revision (ICD-9) codes 410-414.9 and Tenth Revision (ICD-10) codes I20-I25.9 [12]. This comprehensive approach covers various conditions, including acute myocardial infarction, chronic IHD

and chronic stable angina, in accordance with the Fourth Universal Definition of Myocardial Infarction and the Rose Angina Questionnaire [13]. Moreover, premature mortality from IHD is defined as deaths occurring before the age of 55 in men and 65 in women, following international guidelines [14].

Statistical analyses

To account for differences in age structure and to provide a more precise assessment of the burden of IHD associated with HBMI, we utilized age-standardized rates in our analysis [15]. By adjusting for variations in age distribution, this methodology allows for a more accurate understanding of the IHD burden related to HBMI. To examine the temporal trends of these age-standardized rates from 1990 to 2019, we employed annual percent change (EAPC) analysis. A linear regression model, $\ln(\text{ASR}) = \alpha + \beta X + \epsilon$, where 'X' represents the calendar year, was used to assess trends. The EAPC and its 95% confidence interval (CI) were determined using the formula: $100 \times (\exp(\beta) - 1)$. Trends were considered stable if the 95% CI of the EAPC included 0 ($P \geq 0.05$); otherwise, they were classified as either increasing (EAPC and its 95% CI > 0) or decreasing (EAPC and its 95% CI < 0). This robust analytical approach improves our understanding of the IHD burden associated with HBMI, taking into account epidemiological and socio-demographic factors. For more comprehensive insights, we direct readers to the GBD Compare visualization tool (<https://vizhub.healthdata.org/gbd-compare/>) and the GBD Results Tool (<http://ghdx.healthdata.org/gbd-results-tool>) [11].

Result

Evolving global impact of IHD related to HBMI (1990–2019)

From 1990 to 2019, there was a notable global rise in the prevalence of IHD associated with HBMI. During this time period, there was a significant increase of 192.84% in deaths and a 195.76% increase in DALYs caused by HBMI-related IHD, as shown in Table 1. Differences in this trend based on gender were evident, with a 207.21% increase in deaths among men compared to a 177.92% increase among women. Conversely, the rise in DALYs was more substantial in women (55.41%) than in men (48.28%) during the same timeframe, as illustrated in Table 1.

The age-standardized death rate of IHD witnessed a global decline, dropping from 23.75 per 100,000 in 1990 to 20.73 per 100,000 in 2019 (Figure S2; Table 2). This downward trend was also observed in the age-standardized death and DALY rates (Figure S2). The global age-standardized DALY rate decreased from 521.77 per 100,000 in 1990 to 499.41 per 100,000 in 2019 (Table 1; Figure S1 B and Figure S2). Although there was

Table 1 Deaths and DALYs of ischemic heart disease attributable to high body-mass index, by regions in counts, age-standardized rates and EPAC by regions

	1990				2019			
	Deaths		DALYs		Deaths		DALYs	
	Counts	Age-standardized Rate (per 100,000)	Counts	Age-standardized Rate (per 100,000)	Counts	Age-standardized Rate (per 100,000)	Counts	Age-standardized Rate (per 100,000)
Global	86201.695(475900.75,1349787.03)	23.75(12.86,37.60)	21132749.78(11787710.02,32587503.76)	521.77(289.40,810.94)	1662338.55(1005193.09,2462324.57)	20.73(12.48,30.98)		
Sex								
Male	4391.357(2295.46,13,704459.52)	25.71(13.06,42.57)	12125905.19(6449037.21,19199770.21)	615.89(324.13,985.00)	909951.24(541874.66,1344943.43)	24.27(14.13,36.43)		
Female	42288.19(245394.84,644294.43)	21.30(12.14,33.04)	9006844.59(5308629.53,13466783.77)	423.92(249.86,639.26)	752387.31(460247.31,116330.28)	17.21(10.54,25.50)		
Sociodemographic index								
High-middle SDI	347621.24(204136.39,521143.84)	35.45(20.45,54.00)	8254863.97(4942532.79,12113919.55)	767.29(455.71,1141.07)	538462.38(325901.35,791335.61)	27.04(16.34,39.99)		
High SDI	296107.22(164754.91,455984.45)	28.64(15.91,44.32)	6402741.15(3668821.39,9518470.85)	631.72(363.23,936.12)	295357.81(17651986.44,2406.42)	15.34(9.45,22.07)		
Low-middle SDI	54380.28(22392.68,101093.63)	9.42(3.76,18.04)	1653027.57(686830.64,3083522.01)	241.73(100.02,448.23)	247568.37(142328.41,369739.91)	18.19(10.36,27.83)		
Low SDI	20682.13(7866.88,40229.00)	8.80(3.19,17.63)	627641.91(247444.99,1192558.02)	230.44(88.42,445.82)	73493.32(38562.05,117112.17)	13.96(7.20,22.71)		
Middle SDI	142727.50(72901.50,235686.20)	14.70(7.32,25.07)	4181524.13(2204226.11,6765138.81)	363.88(189.19,600.04)	506442.42(302316.98,743456.84)	21.16(12.35,32.11)		
Region								
Andean Latin America	3256.46(1696.22,5181.63)	16.08(8.24,26.22)	9197560(50914.41,140934.67)	403.14(219.83,622.96)	7813.18(4574.00,11760.43)	14.09(8.21,21.34)		
Australasia	7727.38(4374.46,116667.4)	33.48(18.91,50.52)	170511.58(99713.06,248748.52)	737.77(433.34,1075.50)	6764.64(3944.13,10209.44)	13.01(7.81,19.13)		
Caribbean	6866.87(3895.08,106387.6)	27.14(15.17,42.39)	176148.59(103603.75,260448.56)	657.87(385.80,980.32)	12492.85(7345.96,19087.19)	24.00(14.10,36.58)		
Central Asia	25471.38(15062.27,37984.36)	57.77(33.55,87.04)	636804.95(384229.37,927844.86)	1326.57(796.23,1950.56)	50382.87(31823.22,71017.25)	77.86(47.93,112.97)		
Central Europe	87207.96(53288.4,125189.11)	62.71(37.95,91.32)	20260780.31(1275535.02,2841791.46)	1389.20(870.75,1959.03)	83162.86(50976.24,121691.75)	38.63(23.97,56.33)		
Central Latin America	16776.34(9194.33,26129.14)	20.80(11.11,33.15)	462178.33(262316.00,689324.31)	502.73(281.61,762.93)	48891.03(28577.28,72961.27)	20.97(12.15,31.58)		
Central sub-Saharan Africa	2642.72(1181.83,4637.44)	11.80(5.13,21.11)	77269.51(34318.14,133074.49)	297.59(132.75,518.08)	6461.09(3070.72,10901.39)	12.42(5.85,21.66)		
East Asia	4132368(9970.25,93110.20)	5.19(1.24,12.04)	1236998.20(306081.84,2754944.79)	128.61(31.34,287.59)	207698.14(86038.60,37547.21)	10.98(4.45,20.38)		
Eastern Europe	168497.95(103595.44,243329.47)	64.57(39.24,94.20)	3793090.89(2384621.54,5367848.15)	1379.50(870.06,1965.71)	248304.78(155341.76,352515.12)	72.68(45.64,103.37)		
Eastern Sub-Saharan Africa	3873.60(1282.53,7989.12)	5.32(1.71,11.25)	118304.97(40234.11,239392.82)	136.36(45.84,280.38)	15831.48(7995.08,26150.25)	9.95(4.90,16.91)		
High-income Asia Pacific	12113.28(3966.33,23811.50)	6.42(2.05,12.93)	288122.70(98054.35,550138.66)	143.46(48.43,275.14)	13221.13(4802.91,26298.51)	2.80(1.08,5.19)		
High-income North America	128927.52(72050.22,195015.21)	36.73(20.84,55.14)	2835779.73(1668865.59,4088864.23)	850.70(503.68,1220.40)	150591.05(91809.59,214240.19)	23.48(14.71,32.75)		
North Africa and Middle East	94443.68(56646.14,138636.15)	56.15(32.71,85.07)	2732939.72(1680287.90,3920557.66)	1416.46(867.46,2054.54)	232665.71(150682.93,323535.72)	55.96(35.45,79.84)		
Oceania	931.94(448.13,1557.06)	28.24(13.07,48.68)	3203460(157883.65,52607.37)	842.21(409.75,1408.02)	268347(1443.58,4337.74)	34.04(17.48,56.13)		
South Asia	47988.16(18013.12,94243.05)	8.20(2.97,16.44)	1559807.03(591630.12,3067592.49)	226.39(65.29,443.41)	275596.54(157596.64,409373.08)	19.22(10.96,29.25)		
Southeast Asia	15901.61(5587.39,31583.34)	6.03(2.05,12.40)	516651.77(190206.70,1004502.34)	168.55(61.15,329.90)	85728.20(48190.45,129385.55)	13.85(7.56,21.46)		
Southern Latin America	1013645(5050.50,16524.87)	23.06(11.28,38.05)	233936.53(117832.51,372415.58)	506.07(255.19,800.385)	12733.72(7112.19,19344.13)	15.22(8.54,22.97)		
Southern sub-Saharan Africa	4648.81(2937.66,6688.30)	27.00(10.67,25.24)	136135.67(89038.62,189488.85)	444.49(287.54,635.42)	11794.10(7841.99,15987.59)	22.54(14.69,31.27)		
Tropical Latin America	22108.28(11921.93,34788.93)	24.83(13.11,39.93)	634427.61(347616.93,977029.77)	627.72(341.32,980.38)	46298.90(29826.55,64735.20)	19.11(12.33,27.03)		
Western Europe	153101.52(82668.11,238996.08)	26.65(14.45,41.52)	3151974.25(1759044.41,4774346.60)	572.81(321.10,863.49)	114157.34(62420.60,180961.15)	11.62(6.60,17.80)		
Western sub-Saharan Africa	8071.36(3371.36,14929.56)	9.68(3.89,18.50)	221579.50(96568.52,42600.48)	232.41(98.91,427.30)	29065.48(16596.33,44872.73)	16.42(9.05,25.90)		

Table 1 (continued)

	EAPC					
	2019			Deaths		
	DALYs Counts	Age-standardized Rate (per 100,000)	Age-standardized Rate (per 100,000)	Counts	Age-standardized Rate (per 100,000)	DALYs Counts
Global	41369772.74(26027703.45,58657878.32)	499.41(313.30,709.95)	2.09(2.02,2.17)	-0.67(-0.75,-0.60)	2.17(2.09,2.24)	-0.35(-0.43,-0.27)
Sex	-	-	-	-	-	-
Male	25115164.73(15479700.20,36014335.13)	626.10(386.23,903.54)	2.38(2.31,2.45)	-0.36(-0.42,-0.29)	2.39(2.32,2.47)	-0.11(-0.18,-0.04)
Female	16254608.01(10491739.23,23036695.94)	375.05(242.15,530.66)	1.77(1.68,1.85)	-0.97(-1.05,-0.88)	1.84(1.76,1.92)	-0.65(-0.74,-0.56)
Sociodemographic index	-	-	-	-	-	-
High-middle SDI	11920661.73(7529596.67,16739248.32)	595.20(375.47,835.26)	1.13(0.90,1.36)	-1.29(-1.53,-1.05)	0.83(0.55,1.11)	-1.31(-1.60,-1.02)
High SDI	6030177.99(3881281.71,8359465.47)	361.56(237.55,493.89)	-0.37(-0.53,-0.21)	-2.50(-2.65,-2.34)	-0.49(-0.64,-0.35)	-2.20(-2.35,-2.06)
Low-middle SDI	7303132.89(4288987.95,10675442.35)	487.52(284.38,713.84)	5.56(5.47,5.65)	2.44(2.39,2.50)	5.47(5.38,5.56)	2.63(2.56,2.70)
Low SDI	2257777.94(1198082.34,3490535.73)	370.66(195.44,579.32)	4.60(4.45,4.76)	1.76(1.67,1.84)	4.64(4.51,4.78)	1.78(1.71,1.86)
Middle SDI	13830936.89(8726164.75,19548989.32)	529.55(329.02,758.99)	4.53(4.49,4.58)	1.33(1.28,1.39)	4.30(4.24,4.36)	1.36(1.31,1.41)
Region	-	-	-	-	-	-
Andean Latin America	197092.54(120915.90,284151.74)	340.17(209.63,491.68)	3.08(2.87,3.30)	-0.43(-0.64,-0.21)	2.63(2.45,2.82)	-0.61(-0.81,-0.40)
Australasia	125440.01(79807.97,175646.90)	273.63(178.16,376.15)	-0.92(-1.14,-0.71)	-3.69(-3.89,-3.49)	-1.45(-1.67,-1.23)	-3.76(-3.98,-3.55)
Caribbean	3132902.0(189944.96,464323.36)	605.19(366.91,894.71)	2.14(1.89,2.39)	-0.38(-0.65,-0.10)	2.10(1.86,2.34)	-0.22(-0.49,0.04)
Central Asia	1294546.87(835247.22,1778142.96)	1687.95(1080.88,2351.58)	1.82(1.54,2.11)	0.61(0.24,0.98)	1.87(1.58,2.17)	0.33(-0.06,0.71)
Central Europe	1601568.53(1029717.51,2238270.83)	790.24(512.03,1092.69)	-0.61(-0.75,-0.46)	-2.10(-2.24,-1.97)	-1.28(-1.43,-1.14)	-2.42(-2.57,-2.27)
Central Latin America	1203529.30(727944.03,1732277.24)	495.47(297.40,715.95)	3.68(3.58,3.77)	-0.09(-0.19,0.02)	3.27(3.17,3.37)	-0.18(-0.30,-0.06)
Central sub-Saharan Africa	191824.41(91782.41,320728.53)	310.78(148.04,521.98)	2.57(2.15,3.00)	-0.29(-0.62,0.03)	2.68(2.25,3.11)	-0.32(-0.64,0.01)
East Asia	5177749.10(2276118.09,8957240.77)	253.79(110.54,440.58)	6.35(6.09,6.60)	3.25(2.98,3.52)	5.58(5.39,5.78)	2.89(2.69,3.10)
Eastern Europe	5195087.37(3343443.50,7178637.48)	1563.80(1015.22,2166.55)	0.87(0.41,1.33)	0.00(-0.48,0.48)	0.48(-0.08,1.05)	-0.10(-0.67,0.47)
Eastern Sub-Saharan Africa	47815985(248501.14,772939.12)	250.01(129.11,409.75)	5.12(4.93,5.31)	2.38(2.26,2.50)	5.04(4.89,5.20)	2.27(2.18,2.37)
High-income Asia Pacific	24226949(9702.16,1437726.66)	65.94(27.54,114.59)	0.21(0.08,0.34)	-2.91(-3.07,-2.74)	-0.63(-0.73,-0.53)	-2.65(-2.80,-2.50)
High-income North America	3137085.40(2047132.38,4190026.39)	544.56(365.44,716.65)	0.15(-0.01,0.31)	-1.92(-2.08,-1.76)	0.08(-0.05,0.20)	-1.85(-1.99,-1.71)
North Africa and Middle East	6382373.17(4224651.07,8695789.15)	1335.76(875.71,1839.00)	2.94(2.83,3.05)	-0.18(-0.26,-0.09)	2.75(2.64,2.86)	-0.39(-0.48,-0.31)
Oceania	91755.36(50517.90,144834.98)	998.67(537.79,1613.64)	3.61(3.44,3.78)	0.48(0.27,0.70)	3.61(3.42,3.80)	0.42(0.19,0.66)
South Asia	8475988.98(4917835.46,12381856.75)	540.25(312.84,795.24)	6.42(6.32,6.53)	3.11(2.96,3.26)	6.25(6.12,6.37)	3.23(3.09,3.36)
Southeast Asia	2644211.94(1530874.49,3905097.98)	387.47(221.53,576.36)	6.20(6.05,6.35)	3.09(2.96,3.23)	6.06(5.86,6.26)	3.14(2.97,3.30)
Southern Latin America	2755080.9(161619.34,396686.37)	339.96(201.17,489.33)	0.71(0.61,0.80)	-1.50(-1.59,-1.41)	0.49(0.41,0.57)	-1.44(-1.51,-1.37)
Southern sub-Saharan Africa	309400.58(215255.31,408741.92)	518.38(356.48,689.57)	3.29(2.83,3.76)	1.12(0.68,1.57)	2.89(2.41,3.38)	0.70(0.24,1.16)
Tropical Latin America	1231324.00(819867.32,1677260.59)	493.19(327.34,672.76)	2.73(2.66,2.80)	-0.78(-0.83,-0.72)	2.48(2.39,2.56)	-0.71(-0.77,-0.65)
Western Europe	1987932.84(1167054.95,2972952.20)	241.50(144.36,350.23)	-1.44(-1.62,-1.25)	-3.26(-3.43,-3.10)	-1.99(-2.16,-1.82)	-3.36(-3.52,-3.20)
Western sub-Saharan Africa	813634.72(470414.80,1236773.95)	386.18(222.51,591.27)	4.44(4.36,4.52)	1.83(1.74,1.91)	4.50(4.39,4.61)	1.73(1.61,1.85)

a slight decrease in the global age-standardized death rate of IHD from 23.75 per 100,000 in 1990 to 20.73 per 100,000 in 2019, these rates exhibited an overall decline over the three-decade period, as indicated by EAPC values of -0.35 (-0.43, -0.27) for DALYs and -0.67 (-0.75, -0.60) for deaths (Table 1; Fig. 1; Supplementary Table 6).

Regional and national variations in IHD Burden due to high BMI

The analysis of IHD attributable to HBMI at a regional level revealed striking contrasts. Australasia experienced the most pronounced decrease in the age-standardized DALY rate, with an EAPC of -3.98. Conversely, South Asia saw the steepest rise in this measure, with an EAPC of 3.09. In terms of the ASDR, Australasia again reported the largest decline, with an EAPC of -3.89, while East Asia witnessed a significant increase with an EAPC of 2.98 (Table 1; Supplementary Table 1; Fig. 1 and Figure S1).

In 2019, the region of Central Asia recorded the highest observed rates of DALY and deaths linked to IHD resulting from exposure to HBMI (Supplementary Table 1). Since 1990, South Asia has witnessed the most substantial increase in the age-standardized DALY rate for HBMI-attributable IHD, while East Asia has experienced a significant rise in ASDR (Figure S1 A, Figure S1 B, and Supplementary Table 2). Conversely, high-income regions such as Asia Pacific, Western Europe, and Australasia have demonstrated noteworthy decreases in both age-standardized death and DALY rates associated with IHD and HBMI over the past three decades (Supplementary Table 4; Supplementary Table 5).

At the national level, Uzbekistan and Nauru reported the highest ASDR and DALY rates due to HBMI in 2019, respectively. Meanwhile, Japan exhibited the lowest rates in both categories. Over the span of 30 years, Mozambique experienced the most significant increases in both ASDR and age-standardized DALY rates attributable to HBMI exposure. These findings are detailed in Table 3, Supplementary Table 2, Figure S1 A, and Figure S1 B. In contrast, Israel, Denmark, and the Netherlands showed the most substantial decreases in these rates, as indicated in Table 3, Supplementary Table 2, Supplementary Table 3, Figure S1 A, and Figure S1 B.

Age and gender disparities in the Burden of IHD related to HBMI

Age-specific analysis revealed significant variations in deaths and DALYs. Globally, there were notable differences in the percentages of deaths and DALYs across different age groups. The highest number of deaths, both in

males and females, was observed in the 60–69 age group, while the age-standardized rate peaked in the 95+ age group. Similarly, the counts of DALYs and age-standardized rates increased with age. In terms of DALYs, both sexes had the highest peak in the 60–64 age group, with the highest age-standardized rate in the 95+ age group. The age-standardized rates clearly indicate that the burden of IHD (both in terms of deaths and DALYs) is significantly higher in older age groups, highlighting the importance of age as a risk factor for IHD (Table 4).

In terms of deaths and DALYs, men across all age groups were found to carry a greater burden of IHD compared to women (Table 2). The impact of HBMI on the burden of IHD was observed to increase more rapidly in males, with the ASDR exhibiting an EAPC of -0.36 (95% CI: -0.42 to -0.29) for males, and a corresponding EAPC of -0.97 (95% CI: -1.05 to -0.88) for females. Likewise, the EAPC for the male age-standardized DALY rate was -0.11 (95% CI: -0.18 to -0.04), which was higher compared to the female rate of -0.65 (95% CI: -0.74 to -0.56) (Table 1; Figure S3).

Socio-demographic influences on IHD Burden Linked to HBMI

The relationship between the SDI and the burden of IHD caused by HBMI is complex and can vary. It is worth noting that the regions with the highest rates of DALYs and deaths due to IHD attributed to HBMI are the high-middle SDI regions, followed closely by the middle SDI regions. On the other hand, the regions with the lowest DALY rates are the high SDI and low SDI regions, with the lowest death rates specifically seen in the high SDI regions (Table 1; Figure S2; Figure S4).

This pattern demonstrates a worldwide rise in the number of deaths and DALYs linked to HBMI. Interestingly, regions with high-middle and high SDI demonstrate a decrease in age-standardized rates, indicating the effectiveness of management and intervention strategies. In contrast, regions with low-middle, low, and middle SDI experience an increase in these rates, emphasizing the ongoing public health challenges in addressing the impact of HBMI on IHD.

Discussion

Our global analysis spanning a period of 30 years and encompassing 204 countries and regions uncovered significant variations in the burden of IHD attributed to HBMI in 2019. Notably, Central Europe, Eastern Europe, and Central Asia, as well as South Asia, reported higher death rates, underscoring the persistent challenge in effectively managing IHD in these areas. Conversely, high-income regions demonstrated the lowest rates in 2019, suggesting that their healthcare systems have been

Table 2 Deaths and DALYs of ischemic heart disease attributable to high body-mass index in counts and age-standardized rates in each GBD region, by sex, in 2019

Deaths					
	Counts (M)	Counts (F)	Age-standardized Rate (M) (per 100,000)	Age-standardized Rate (F) (per 100,000)	
Global	909951.24(541874.66,1344943.43)	752387.31(460247.31,1116330.28)	24.27(14.13,36.43)	17.21(10.54,25.50)	
Sex	-	-	-	-	-
Male	909951.24(541874.66,1344943.43)	909951.24(541874.66,1344943.43)	24.27(14.13,36.43)	24.27(14.13,36.43)	
Female	752387.31(460247.31,1116330.28)	752387.31(460247.31,1116330.28)	17.21(10.54,25.50)	17.21(10.54,25.50)	
Sociodemographic index	-	-	-	-	-
High-middle SDI	277038.60(167411.82,404431.24)	261423.78(156402.39,387049.43)	31.44(18.66,46.87)	22.47(13.60,32.87)	
High SDI	16901.24(699300.40,246833.33)	126345.35(72430.58,191418.95)	20.47(12.30,29.73)	10.55(6.48,15.22)	
Low-middle SDI	138833.69(77552.74,211207.33)	108734.68(64567.74,163576.65)	20.73(11.33,32.45)	15.72(9.21,24.06)	
Low SDI	39432.73(19512.58,64923.72)	34060.59(18932.15,52149.89)	14.78(7.20,25.06)	13.11(7.09,20.63)	
Middle SDI	285064.11(166966.73,425712.87)	221378.31(137176.59,327529.44)	24.52(13.92,37.68)	17.91(10.84,27.01)	
Region	-	-	-	-	-
Andean Latin America	4371.81(2506.25,6634.49)	3441.37(2063.56,5180.54)	16.34(9.19,25.04)	11.93(7.10,18.01)	
Australasia	3886.40(2254.97,5742.15)	2878.24(1581.21,4481.60)	17.30(10.19,25.36)	8.95(5.11,13.44)	
Caribbean	6675.70(3812.88,10198.46)	5817.15(3463.45,8798.98)	27.44(15.58,42.21)	20.72(12.45,31.11)	
Central Asia	26453.27(16180.48,37578.10)	23929.61(15263.76,33406.71)	88.10(51.34,130.87)	67.68(42.50,96.57)	
Central Europe	43328.35(26743.28,62678.41)	39834.51(23530.60,59507.11)	49.76(30.00,72.59)	28.79(17.35,42.44)	
Central Latin America	27352.33(15643.06,41270.30)	21538.70(12627.76,31872.69)	25.19(14.28,38.35)	17.18(10.02,25.49)	
Central sub-Saharan Africa	3359.64(1573.16,5678.71)	3101.45(1479.30,5520.33)	13.52(6.37,22.75)	11.37(5.25,20.71)	
East Asia	119653.23(49072.78,217382.94)	88044.92(55687.86,167274.66)	136.3(51.25,27)	8.65(3.46,16.90)	
Eastern Europe	114551.57(69938.76,164999.08)	133753.21(80315.99,193438.53)	91.84(55.50,133.48)	57.59(35.03,82.04)	
Eastern Sub-Saharan Africa	8830.04(4255.85,15040.17)	7001.44(3674.15,11258.08)	11.17(5.15,19.44)	8.77(4.45,14.52)	
High-income Asia Pacific	721000(2615.63,13691.50)	6011.13(2103.22,12460.64)	3.87(1.45,7.17)	1.77(0.68,3.44)	
High-income North America	86534.88(53491.20,121639.69)	64056.18(38169.68,93223.04)	30.99(19.27,43.39)	16.69(10.48,23.29)	
North Africa and Middle East	130579.94(81488.38,187071.51)	102085.76(68263.11,139652.11)	59.15(36.01,85.64)	52.33(34.21,72.97)	
Oceania	1763.32(932.23,2888.26)	920.15(503.50,1526.53)	41.27(21.01,69.37)	26.20(13.69,43.93)	
South Asia	161214.51(88240.51,249111.62)	114382.03(65228.09,170328.27)	22.17(12.04,34.83)	16.21(9.28,24.48)	
Southeast Asia	48984.89(25907.13,75678.15)	36743.31(21350.02,55591.20)	16.37(8.44,25.97)	11.44(6.54,17.65)	
Southern Latin America	7176.79(3953.44,10789.66)	5556.93(3112.46,8542.86)	19.85(10.81,29.89)	11.07(6.36,16.83)	
Southern sub-Saharan Africa	5307.09(3422.23,7435.13)	6487.00(4415.98,8734.04)	22.90(14.32,32.89)	21.51(14.40,29.42)	
Tropical Latin America	26683.33(16636.49,37586.73)	19615.57(13091.63,27474.90)	24.08(14.80,34.32)	14.72(9.80,20.63)	
Western Europe	62395.40(33747.95,96735.42)	51761.93(27565.45,83217.81)	15.70(8.63,24.13)	7.90(4.53,12.15)	
Western sub-Saharan Africa	13638.76(7128.02,21943.83)	15426.73(8979.99,23316.61)	15.52(7.93,25.32)	17.24(9.71,26.60)	

Table 2 (continued)

		DALYs			
	Counts (M)	Counts (F)	Age-standardized Rate (M) (per 100,000)	Age-standardized Rate (F) (per 100,000)	
Global	25115164.73(15479700.20,36014335.13)	16254608.01(10491739.23,23036695.94)	626.10(386.23,903.54)	375.05(242.15,530.66)	
Sex	-	-	-	-	
Male	25115164.73(15479700.20,36014335.13)	25115164.73(15479700.20,36014335.13)	626.10(386.23,903.54)	626.10(386.23,903.54)	
Female	16254608.01(10491739.23,23036695.94)	16254608.01(10491739.23,23036695.94)	375.05(242.15,530.66)	375.05(242.15,530.66)	
Sociodemographic index	-	-	-	-	
High-middle SDI	7173984.21(4448716.99,10194405.43)	4746677.51(3016364.47,6736787.31)	767.24(475.70,1090.91)	425.27(273.01,597.68)	
High SDI	3947828.52(2486175.08,5470668.80)	2082349.47(1366652.47,2894780.54)	509.28(325.69,697.09)	218.27(149.94,290.19)	
Low-middle SDI	4320346.97(2470219.83,6503441.88)	2982785.92(1819396.85,4366356.11)	581.52(328.77,874.63)	395.49(240.11,581.14)	
Low SDI	1265860.10(632209.51,2041434.01)	991917.83(565829.55,1486116.42)	409.13(203.24,666.74)	332.00(187.52,501.06)	
Middle SDI	8390715.71(5127623.71,12008173.22)	5440221.18(3550625.14,7678742.95)	650.95(392.93,948.31)	410.54(266.95,585.80)	
Region	-	-	-	-	
Andean Latin America	119390.83(71231.29,173887.13)	77701.70(49636.66,109960.76)	422.00(250.14,614.88)	262.10(167.18,371.54)	
Australasia	84295.63(52929.78,117706.68)	41144.39(26040.35,58328.55)	401.06(253.79,556.73)	153.31(101.99,210.57)	
Caribbean	180383.39(105308.49,270710.79)	132906.81(83769.15,192623.98)	728.24(423.26,1089.15)	489.13(308.12,710.06)	
Central Asia	764249.92(476409.42,1068487.69)	530296.95(351170.33,718205.03)	2103.87(1297.21,2975.10)	1312.66(860.75,1795.39)	
Central Europe	986935.31(629662.14,1378208.98)	614633.23(395805.76,872032.97)	1120.90(716.35,1559.44)	489.25(322.54,684.13)	
Central Latin America	740077.27(438187.32,1086355.69)	463452.03(285980.12,652628.20)	645.74(381.82,952.18)	360.92(222.14,509.75)	
Central sub-Saharan Africa	107109.55(50670.95,181190.18)	84714.86(41194.23,149171.06)	354.00(166.02,598.34)	269.56(130.44,477.23)	
East Asia	3277956.34(1436360.87,5741967.39)	1899792.76(816144.01,3374873.55)	331.11(143.12,581.42)	178.27(75.73,320.08)	
Eastern Europe	2894937.45(1791418.44,4118461.95)	2300149.91(1493376.18,3167026.23)	2193.49(1366.61,3123.68)	1059.10(698.94,1442.79)	
Eastern Sub-Saharan Africa	282272.47(140506.38,472125.21)	195887.38(107000.48,304399.80)	295.29(143.44,497.81)	206.63(111.13,326.62)	
High-income Asia Pacific	161233.59(64025.48,288376.02)	81035.90(32046.08,153091.20)	99.51(40.61,172.62)	32.69(13.46,57.99)	
High-income North America	2019867.53(1297074.11,2712615.38)	1117217.88(750956.86,1485724.01)	756.96(490.63,1007.81)	347.17(238.22,448.64)	
North Africa and Middle East	3809984.05(2439255.77,5324544.49)	2572389.12(1765147.79,3432790.21)	1504.97(950.34,2124.20)	1149.92(783.28,1543.73)	
Oceania	62316.82(33374.95,100155.54)	29438.54(16698.59,48129.18)	1272.33(671.53,2083.91)	704.92(389.52,1161.80)	
South Asia	5211318.87(2883048.22,7985134.08)	3264670.11(1887369.71,4813523.24)	653.67(361.72,1002.45)	424.60(245.02,626.68)	
Southeast Asia	1610458.11(889085.39,2435797.60)	1033753.83(626566.65,1516091.43)	481.32(260.23,739.43)	297.07(178.76,441.03)	
Southern Latin America	177678.51(101417.23,261849.67)	97829.58(59996.23,141238.52)	482.53(276.38,711.28)	212.10(132.26,300.47)	
Southern sub-Saharan Africa	158284.20(104762.24,217437.16)	151116.39(107262.22,197227.96)	582.39(376.11,812.15)	457.23(322.31,601.42)	
Tropical Latin America	771328.17(498778.96,1067002.58)	459995.84(316196.36,615819.96)	659.73(423.94,916.14)	344.14(236.34,460.92)	
Western Europe	1287409.53(730415.44,1908926.67)	700523.30(420595.04,1051711.89)	353.52(204.04,519.95)	136.08(86.21,196.39)	
Western sub-Saharan Africa	407677.21(218855.97,648489.17)	405957.51(244721.91,606144.68)	387.80(204.99,617.57)	385.11(226.71,579.77)	

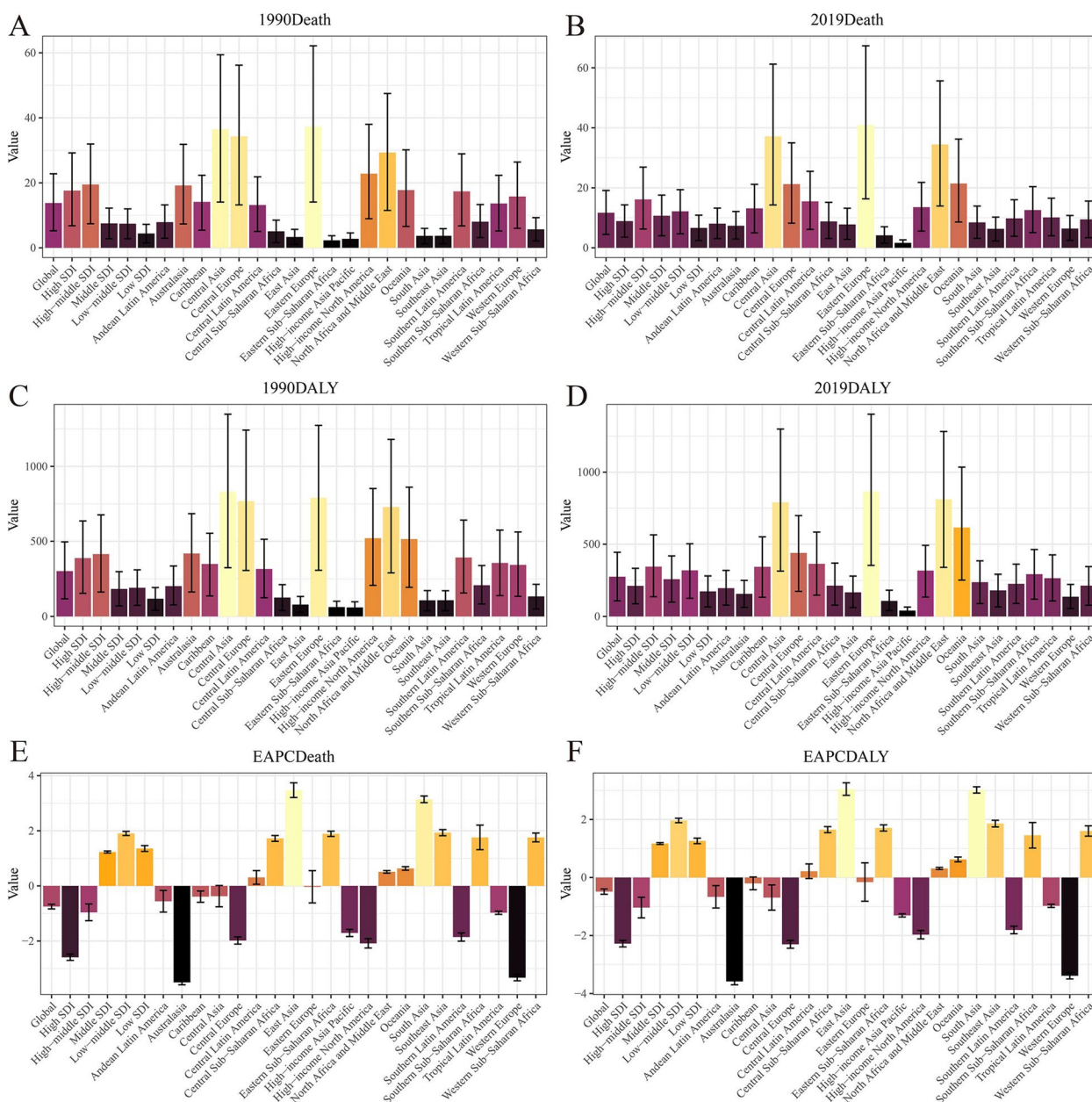


Fig. 1 The Global Burden of ischemic heart disease attributable to high body-mass index: age-standardized DALY rate and ASDR in 1990 and 2019: **(A)** ASDR in 1990; **(B)** age-standardized DALY rate in 1990; **(C)** ASDR in 2019; **(D)** age-standardized DALY rate in 2019; **(E)** EAPCs of ASDR; **(F)** EAPCs of age-standardized DALY rate. ASRs= age-standardized rates. ASDR=age-standardized Death rate. DALY=disability adjusted life-year. EAPCs=Estimated Annual Percentage Changes

successful in addressing IHD. The data affirms the existence of notable regional disparities in the burden of IHD. High-income regions have achieved a reduction in IHD death rates by virtue of their superior healthcare systems, reduction in modifiable risk factors [16]. In contrast, regions such as Sub-Saharan Africa, Southeast Asia, East Asia, Oceania, and South Asia have experienced increased death rates, potentially influenced by factors

like evolving economies leading to lifestyle changes, escalating urbanization, and potentially limited accessibility and quality of healthcare [16, 17]. Despite some improvements, Central Europe, Eastern Europe, and Central Asia continue to bear relatively high death rates from IHD, indicative of ongoing public health challenges [18, 19]. The disparate trends observed across regions underscore the necessity for region-specific approaches in combating

Table 3 Deaths and DALYs of ischemic heart disease attributable to high body-mass index in counts and age-standardized rate for both sexes combined in 1990 and 2019, with EAPC between 1990 and 2019 by nation

Countries	Deaths				EAPC in age-standardized rates between 1990 and 2019 (%)
	1990		2019		
	Counts	Age-standardized Rate (per 100,000)	Counts	Age-standardized Rate (per 100,000)	
Afghanistan	3662.92(1693.32,6313.64)	50.14(22.71,87.82)	8120.81(4562.71,12627.03)	61.74(34.76,95.40)	1.09(0.59,1.59)
Albania	503.71(265.51,785.38)	26.62(13.66,42.08)	1300.58(698.76,2090.87)	31.17(16.66,49.97)	1.07(0.80,1.34)
Algeria	6528.89(3687.47,10391.55)	59.03(31.61,97.57)	15641.69(9272.77,23265.17)	53.31(30.69,81.39)	-0.44(-0.51,-0.37)
American Samoa	11.64(7.98,15.25)	47.22(30.87,63.33)	23.80(16.10,32.04)	48.73(32.07,66.85)	0.03(-0.07,0.12)
Andorra	7.15(3.69,11.70)	14.68(7.42,24.44)	14.18(7.31,23.09)	9.41(4.95,15.25)	-1.65(-1.88,-1.43)
Angola	204.04(42.01,505.94)	5.21(1.04,13.10)	1341.88(632.90,2251.55)	12.10(5.55,21.02)	3.01(2.88,3.14)
Antigua and Barbuda	9.05(4.25,15.40)	17.27(8.35,28.99)	15.28(8.73,23.00)	15.72(8.80,24.03)	-0.61(-0.80,-0.43)
Argentina	7293.36(3487.52,12029.78)	23.65(11.13,39.37)	9115.62(5026.27,13850.94)	16.82(9.33,25.49)	-1.27(-1.38,-1.16)
Armenia	1116.85(606.07,1739.09)	45.65(23.80,72.74)	2117.02(1301.11,3158.72)	53.36(32.69,79.42)	0.25(0.06,0.43)
Australia	6392.96(3635.36,9644.47)	33.31(18.83,50.18)	5497.81(3211.26,8216.50)	12.52(7.57,18.33)	-3.80(-4.00,-3.59)
Austria	3114.11(1646.36,4975.14)	26.35(14.02,41.77)	2929.92(1516.10,4717.59)	14.67(7.85,23.17)	-2.57(-2.78,-2.35)
Azerbaijan	2834.78(1579.21,4334.47)	58.34(32.26,89.99)	7132.13(4304.13,10212.45)	94.98(55.26,141.38)	1.58(1.34,1.83)
Bahamas	45.49(27.33,66.28)	29.63(17.32,43.78)	89.48(53.14,130.82)	22.83(13.52,33.73)	-0.97(-1.13,-0.80)
Bahrain	184.30(116.52,255.04)	108.26(64.89,155.60)	333.22(208.87,469.46)	42.07(25.43,61.37)	-3.77(-4.04,-3.51)
Bangladesh	1451.99(70.26,3695.30)	2.92(0.52,7.61)	12401.25(5470.30,21778.48)	9.22(4.00,16.35)	5.14(4.65,5.64)
Barbados	67.78(35.30,105.36)	23.68(12.53,36.39)	74.96(42.90,112.91)	15.36(8.82,23.15)	-1.88(-2.11,-1.65)
Belarus	7294.93(4159.51,11381.47)	58.52(33.31,90.70)	12644.76(7302.90,19037.08)	79.22(46.34,118.52)	0.83(0.43,1.23)
Belgium	3323.28(1784.15,5199.42)	21.89(11.77,34.19)	2429.07(1289.92,3872.02)	9.83(5.42,15.04)	-3.07(-3.21,-2.93)
Belize	19.30(8.91,31.90)	21.04(9.60,35.01)	57.93(36.05,83.34)	21.17(12.85,30.72)	-0.69(-1.31,-0.07)
Benin	203.74(84.54,370.76)	10.35(4.16,19.29)	898.19(489.17,1391.15)	18.61(9.82,29.55)	2.11(1.95,2.28)
Bermuda	32.96(18.99,47.76)	54.65(30.95,80.56)	25.19(14.49,38.97)	18.96(10.94,29.01)	-3.79(-4.23,-3.35)
Bhutan	21.84(6.37,47.16)	8.21(2.33,18.20)	102.84(49.81,171.26)	18.04(8.64,29.96)	2.84(2.62,3.07)
Bolivia (Plurinational State of)	568.27(261.49,1000.57)	17.97(7.92,32.11)	1794.56(995.41,2887.27)	21.37(11.42,34.94)	0.52(0.36,0.69)
Bosnia and Herzegovina	1329.76(733.16,2050.20)	36.37(19.53,57.00)	1948.48(1096.24,3014.30)	34.80(19.50,54.41)	-0.39(-0.54,-0.25)
Botswana	69.29(30.33,126.05)	12.71(5.50,23.15)	398.27(225.19,619.66)	30.76(17.45,48.06)	2.92(2.54,3.30)
Brazil	21732.46(11703.78,34207.73)	25.05(13.23,40.18)	45210.07(29102.45,63084.10)	19.11(12.24,27.04)	-0.81(-0.86,-0.75)
Brunei Darussalam	13.88(4.00,28.85)	14.47(4.01,30.98)	43.56(21.92,69.78)	15.75(7.34,26.15)	0.62(0.44,0.80)
Bulgaria	8558.38(5103.77,12286.76)	78.07(45.59,115.51)	7580.11(4275.76,11798.97)	54.26(30.88,83.54)	-2.36(-2.78,-1.93)
Burkina Faso	223.80(62.17,500.19)	5.36(1.44,12.28)	1341.40(648.03,2239.98)	15.53(7.34,26.86)	4.14(3.85,4.42)
Burundi	149.95(43.41,325.46)	6.39(1.82,14.05)	345.54(130.12,664.78)	7.55(2.76,14.92)	0.41(0.33,0.50)

Table 3 (continued)

Countries	Deaths				EAPC in age-standardized rates between 1990 and 2019 (%)
	1990		2019		
	Counts	Age-standardized Rate (per 100,000)	Counts	Age-standardized Rate (per 100,000)	
Cabo Verde	23.91(9.08,44.14)	10.43(4.04,19.06)	98.67(58.43,148.07)	23.88(14.19,35.67)	2.40(2.17,2.63)
Cambodia	200.11(46.05,482.97)	4.30(0.95,10.73)	1053.61(469.37,1883.98)	8.99(3.87,16.41)	2.79(2.60,2.99)
Cameroon	653.28(336.67,1076.79)	16.30(8.25,27.43)	2821.57(1591.65,4375.94)	25.66(14.53,40.23)	1.71(1.54,1.89)
Canada	9254.45(5199.00,14215.74)	28.92(16.23,44.59)	10317.65(6098.99,15544.26)	14.50(8.76,21.31)	-2.90(-3.11,-2.69)
Central African Republic	93.81(27.86,201.42)	7.80(2.31,17.10)	239.99(92.67,480.68)	10.67(3.98,21.62)	1.41(1.31,1.51)
Chad	120.47(34.63,269.20)	4.43(1.25,10.05)	539.71(245.31,946.91)	9.88(4.44,17.48)	2.83(2.72,2.95)
Chile	1991.68(1059.36,3103.61)	21.98(11.34,35.04)	2848.82(1646.54,4156.64)	11.94(6.89,17.44)	-2.05(-2.13,-1.97)
China	39406.17(9213.83,89039.24)	5.14(1.18,12.02)	203608.68(84285.47,367441.47)	11.20(4.53,20.83)	3.39(3.11,3.66)
Colombia	3573.92(1900.43,5667.69)	21.00(10.85,33.98)	8103.84(4447.58,13098.83)	15.00(8.23,24.17)	-1.37(-1.48,-1.26)
Comoros	18.70(5.90,36.08)	8.73(2.78,17.23)	61.30(29.42,106.34)	12.78(5.97,22.49)	1.19(1.05,1.33)
Congo	208.24(91.61,367.37)	19.27(8.21,34.85)	653.58(365.41,1025.12)	25.52(13.81,40.32)	0.85(0.73,0.97)
Cook Islands	4.73(2.85,6.88)	36.32(21.32,54.01)	7.62(4.77,10.79)	32.00(19.88,45.56)	-0.50(-0.65,-0.34)
Costa Rica	363.01(193.71,566.11)	21.28(11.16,33.68)	830.54(462.65,1322.24)	15.96(8.87,25.46)	-1.45(-1.70,-1.20)
Croatia	3021.62(1761.65,4526.93)	51.26(29.46,77.95)	2915.73(1602.73,4514.98)	32.97(18.52,50.67)	-1.24(-1.37,-1.12)
Cuba	3138.60(1837.02,4738.06)	31.29(18.25,47.72)	4381.64(2505.16,6670.82)	22.60(13.04,34.21)	-1.26(-1.57,-0.95)
Cyprus	180.98(89.26,300.26)	25.20(11.80,43.24)	251.38(136.18,400.93)	14.26(7.72,23.10)	-2.64(-2.95,-2.34)
Czechia	9690.48(5799.59,14129.94)	72.21(42.40,106.38)	7938.08(4555.44,11972.84)	36.58(21.14,54.94)	-2.54(-2.63,-2.45)
Côte d'Ivoire	563.43(270.77,951.71)	14.54(6.53,25.59)	1870.58(1000.60,2938.45)	17.86(9.17,29.15)	0.64(0.50,0.78)
Democratic People's Republic of Korea	755.09(145.60,1817.46)	5.05(0.97,12.33)	1924.95(395.87,4634.71)	6.32(1.29,15.40)	0.92(0.74,1.09)
Democratic Republic of the Congo	2044.75(950.33,3491.83)	13.17(6.00,22.96)	3887.81(1724.94,6953.83)	11.12(4.83,20.15)	-1.31(-1.75,-0.86)
Denmark	2435.94(1297.89,3906.06)	29.91(16.07,47.54)	1107.12(599.51,1784.56)	9.13(5.03,14.49)	-4.79(-5.06,-4.52)
Djibouti	5.29(1.16,12.66)	3.91(0.82,9.73)	72.96(32.19,131.64)	12.42(5.32,22.36)	4.65(4.38,4.92)
Dominica	17.68(9.70,27.91)	24.78(13.79,38.98)	18.60(10.67,28.45)	20.76(11.95,31.55)	-0.76(-0.89,-0.63)
Dominican Republic	583.92(251.38,1020.00)	15.56(6.39,27.97)	3247.95(1733.04,5258.45)	34.60(18.24,56.36)	3.89(3.45,4.34)
Ecuador	991.24(591.33,1460.36)	18.47(10.51,27.79)	2780.91(1639.74,4096.48)	19.22(11.18,28.83)	0.12(-0.14,0.38)
Egypt	24083.70(14180.30,35411.09)	85.03(48.19,127.74)	64466.52(40104.38,93842.16)	105.34(64.19,155.97)	0.76(0.67,0.85)
El Salvador	560.87(281.12,906.78)	18.52(9.21,30.39)	1314.30(697.06,2136.56)	21.32(11.48,34.45)	0.41(0.23,0.59)
Equatorial Guinea	13.98(3.25,32.59)	7.04(1.61,16.72)	90.92(50.32,145.48)	20.98(11.63,33.59)	4.49(4.13,4.84)
Eritrea	36.14(10.88,83.29)	3.81(1.20,8.62)	262.23(123.31,467.61)	10.81(5.00,18.75)	3.68(3.30,4.05)
Estonia	1357.87(823.13,2009.94)	69.18(41.84,103.03)	1015.52(561.74,1583.22)	35.46(20.33,54.53)	-3.09(-3.48,-2.71)
Eswatini	68.32(41.10,99.94)	25.71(15.41,38.19)	187.20(110.38,283.87)	35.57(21.33,54.27)	1.41(0.94,1.88)

Table 3 (continued)

Countries	Deaths				EAPC in age-standardized rates between 1990 and 2019 (%)
	1990		2019		
	Counts	Age-standardized Rate (per 100,000)	Counts	Age-standardized Rate (per 100,000)	
Ethiopia	944,302(13,96,2353.79)	4.46(0.96,11.58)	2808,36(1,204,67,5174.92)	6.85(2.76,12.84)	1.38(1.02,1.75)
Fiji	261,881(38,76,405.23)	64.99(33.70,102.54)	543,18(340.73,789.14)	71.11(42.97,104.55)	-0.04(-0.29,0.21)
Finland	2730,82(1481.20,4177.68)	38.74(21.01,59.14)	2347,78(1187.58,3781.41)	17.44(9.23,27.15)	-2.90(-3.00,-2.80)
France	10731.17(5676.92,17315.11)	12.95(6.91,20.65)	10507,97(5551.35,16824.90)	6.84(3.85,10.39)	-2.38(-2.52,-2.25)
Gabon	77,89(33.90,137.85)	14.07(5.97,25.44)	246,91(139.53,374.58)	24.91(13.95,38.47)	1.89(1.53,2.24)
Gambia	35,00(13.76,65.24)	10.51(4.01,20.10)	212,22(117.85,328.55)	22.84(12.43,36.13)	2.80(2.63,2.97)
Georgia	4922.12(3047.43,7060.35)	88.22(53.39,129.51)	2898,58(1709.35,4368.75)	47.40(28.30,69.92)	-2.79(-3.07,-2.51)
Germany	47310,83(26075.58,73155.87)	37.29(20.64,57.57)	32620,37(17523.59,50826.04)	15.94(8.99,23.99)	-3.26(-3.50,-3.02)
Ghana	566,69(224.46,1039.02)	9.08(3.41,17.13)	4003,97(2526.11,5798.92)	27.03(16.69,39.51)	4.11(3.90,4.31)
Greece	3587,26(1879.40,5540.50)	24.48(12.83,38.06)	4557,23(2376.44,7203.44)	18.86(10.45,28.53)	-1.14(-1.36,-0.91)
Greenland	1,350(7.80,19.95)	41.11(23.13,62.23)	15,52(8.84,23.18)	23.25(12.96,35.22)	-2.45(-2.68,-2.22)
Grenada	1,582(7.07,27.53)	22.37(10.39,38.19)	22,99(13.96,33.46)	20.86(12.47,30.88)	-0.42(-0.65,-0.19)
Guam	31,34(17.26,45.82)	42.53(22.57,64.91)	93,98(56.76,136.90)	49.46(29.88,71.95)	0.68(0.43,0.93)
Guatemala	502,38(183.86,929.62)	14.16(4.93,27.31)	1521,23(781.12,2466.01)	14.92(7.37,24.77)	0.02(-0.32,0.36)
Guinea	257,82(105.46,488.56)	8.11(3.23,15.57)	793,60(404.07,1311.56)	14.73(7.33,24.59)	2.44(2.30,2.58)
Guinea-Bissau	44,76(14.73,93.63)	11.17(3.67,23.56)	138,07(64.53,237.04)	18.96(8.82,32.96)	1.92(1.78,2.06)
Guyana	151,05(75.52,243.55)	39.31(19.35,64.87)	258,21(142.78,404.05)	41.19(22.42,65.28)	0.26(0.11,0.40)
Haiti	570,28(204.95,1070.15)	17.24(6.08,32.79)	1292,73(544.28,2398.20)	18.44(7.56,34.29)	0.58(0.39,0.76)
Honduras	287,51(120.68,507.22)	14.18(5.90,25.39)	1484,46(798.71,2283.99)	26.70(14.16,41.95)	2.26(1.98,2.54)
Hungary	9616.10(6213.51,13370.86)	69.04(44.34,96.53)	8654,27(5164.93,12977.88)	44.05(26.92,64.99)	-1.79(-1.90,-1.68)
Iceland	92,55(49.58,142.96)	31.97(17.17,49.05)	79,34(41.95,124.63)	13.13(7.22,20.28)	-3.36(-3.52,-3.21)
India	40243,86(15924.28,77980.01)	8.60(3.30,16.71)	226415.13(130247.80,338562.39)	19.57(11.18,29.87)	2.96(2.84,3.08)
Indonesia	6419,62(2028.40,13284.54)	5.94(1.74,12.77)	38670,34(21818.50,60289.95)	16.69(8.91,26.73)	4.02(3.86,4.18)
Iran (Islamic Republic of)	10179,38(5890.44,15145.18)	41.01(23.17,63.26)	23913,04(15585.52,33270.99)	34.84(22.34,49.28)	-1.11(-1.43,-0.80)
Iraq	6050.14(3533.84,8745.57)	79.20(44.69,116.60)	14395,04(8832.88,21069.50)	67.69(40.82,99.21)	-0.80(-0.88,-0.71)
Ireland	1623,89(869.07,2534.43)	40.64(21.58,63.47)	1105,33(612.21,1707.09)	14.59(8.19,22.47)	-4.15(-4.40,-3.90)
Israel	1437,94(789.56,2220.23)	30.66(16.57,47.79)	1088,43(579.59,1708.37)	8.93(4.84,13.80)	-5.03(-5.34,-4.72)
Italy	15823,90(8416.88,25233.94)	18.29(9.61,29.25)	15017,96(7742.22,24828.46)	9.20(5.00,14.63)	-2.72(-2.85,-2.59)
Jamaica	213,18(112.31,343.66)	12.05(6.37,19.28)	459,63(273.49,707.01)	14.77(8.82,22.64)	0.83(0.52,1.14)
Japan	8804,54(2879.85,17461.70)	5.50(1.74,11.09)	9665,91(3164.06,19997.79)	2.58(0.92,4.94)	-2.69(-2.79,-2.60)

Table 3 (continued)

Countries	Deaths			EAPC in age-standardized rates between 1990 and 2019 (%)		
	1990		2019		Age-standardized Rate (per 100,000)	Age-standardized Rate (per 100,000)
	Counts	Age-standardized Rate (per 100,000)	Counts	Age-standardized Rate (per 100,000)		
Jordan	696.20(425.06,993.67)	54.46(31.93,79.93)	2322.39(1519.97,3195.54)	38.31(24.41,53.89)	-1.86(-2.16,-1.56)	
Kazakhstan	7671.56(4725.70,11061.34)	66.01(40.65,96.63)	9167.00(5580.30,13097.95)	62.45(36.94,90.89)	-1.09(-1.84,-0.32)	
Kenya	363.12(143.22,692.01)	4.68(1.72,9.09)	2593.42(1464.20,4126.19)	11.93(6.38,19.63)	3.82(3.56,4.08)	
Kiribati	28.21(15.61,43.55)	63.41(34.01,99.43)	49.76(27.73,75.30)	59.14(31.80,91.98)	-0.52(-0.68,-0.36)	
Kuwait	369.44(246.15,490.93)	54.68(34.95,76.06)	1089.07(721.78,1458.15)	37.32(23.75,51.37)	-0.95(-1.31,-0.58)	
Kyrgyzstan	1155.84(655.00,1781.09)	39.38(22.08,61.00)	2225.23(1293.22,3352.50)	55.60(31.43,85.64)	1.28(0.88,1.69)	
Lao People's Democratic Republic	152.60(38.62,364.43)	7.29(1.77,17.47)	776.40(382.95,1241.02)	17.24(8.17,28.44)	3.28(3.14,3.42)	
Latvia	2422.19(1376.30,3630.77)	69.72(39.58,104.56)	2120.09(1225.85,3217.68)	50.64(29.95,75.30)	-1.58(-1.94,-1.23)	
Lebanon	1573.93(909.19,2359.50)	71.36(40.41,109.14)	3316.42(1964.18,4777.73)	64.48(38.14,93.54)	-0.05(-0.35,0.24)	
Lesotho	83.77(38.29,147.40)	9.10(4.08,15.99)	316.15(178.35,483.51)	26.37(14.96,41.41)	4.50(4.05,4.95)	
Liberia	169.74(82.06,290.47)	15.55(7.30,27.00)	414.93(239.02,647.15)	19.74(10.85,31.43)	1.69(1.07,2.31)	
Libya	835.84(504.33,1248.16)	44.32(26.18,67.72)	2622.89(1591.80,3886.35)	51.61(31.22,76.47)	0.53(0.39,0.67)	
Lithuania	2960.26(1693.02,4517.14)	67.48(38.64,103.12)	3323.26(1864.89,5052.92)	54.09(31.03,80.78)	-0.80(-1.09,-0.51)	
Luxembourg	146.04(81.77,224.91)	27.46(15.36,42.29)	102.64(54.97,161.43)	9.61(5.26,14.92)	-3.91(-4.03,-3.79)	
Madagascar	325.02(117.81,627.84)	6.46(2.32,12.85)	1374.98(630.73,2351.81)	12.44(5.60,21.64)	2.68(2.47,2.89)	
Malawi	221.43(59.62,487.37)	5.60(1.40,12.96)	811.01(377.34,1365.88)	11.31(5.18,19.28)	2.78(2.40,3.16)	
Malaysia	1569.32(757.82,2591.17)	16.99(7.92,28.70)	7297.61(4224.67,10872.96)	27.33(15.76,41.25)	1.19(0.84,1.53)	
Maldives	11.06(2.81,24.47)	11.80(2.77,27.69)	37.96(18.99,62.63)	11.86(5.57,20.48)	-0.58(-0.79,-0.37)	
Mali	268.72(90.63,549.70)	7.18(2.32,15.02)	1046.21(523.88,1776.57)	13.05(6.29,22.61)	2.18(2.10,2.26)	
Malta	122.13(63.77,195.89)	29.43(15.21,47.60)	144.47(76.07,231.27)	15.12(8.07,23.83)	-2.44(-2.61,-2.28)	
Marshall Islands	6.41(2.46,11.63)	36.30(13.05,67.42)	21.33(10.42,36.06)	53.18(24.26,92.34)	1.22(1.00,1.44)	
Mauritania	201.49(108.98,319.67)	21.05(11.20,33.84)	429.33(263.69,643.49)	22.47(13.61,33.88)	0.16(0.08,0.25)	
Mauritius	249.81(133.54,383.49)	32.99(17.31,51.47)	326.05(187.74,492.87)	19.11(10.91,29.02)	-2.88(-3.37,-2.38)	
Mexico	8245.58(4693.24,12415.65)	20.41(11.23,31.78)	25969.48(15244.31,37980.44)	22.94(13.33,33.89)	0.38(0.23,0.53)	
Micronesia (Federated States of)	30.54(16.47,49.11)	58.83(31.18,96.78)	58.01(31.47,90.83)	71.17(37.84,112.41)	0.54(0.41,0.67)	
Monaco	19.13(9.57,31.04)	26.16(13.51,41.23)	15.55(7.83,25.18)	14.71(8.00,22.98)	-2.11(-2.37,-1.85)	
Mongolia	574.72(298.35,912.58)	58.50(29.55,94.96)	1151.68(654.60,1769.68)	55.78(30.48,87.64)	-0.89(-1.28,-0.50)	
Montenegro	240.07(145.02,341.66)	40.12(24.04,57.32)	418.49(259.48,610.54)	44.35(27.21,65.02)	0.58(0.45,0.71)	
Morocco	6611.40(3683.92,10303.42)	48.92(26.66,77.35)	18899.80(10755.62,28434.37)	64.00(36.18,97.59)	0.81(0.66,0.95)	

Table 3 (continued)

Countries	Deaths			EAPC in age-standardized rates between 1990 and 2019 (%)
	1990		2019	
	Counts	Age-standardized Rate (per 100,000)	Counts	
Mozambique	184,43(41.93,445.88)	3.19(0.68,7.98)	1133.31(507.79,1979.15)	10.17(4.41,18.45)
Myanmar	1346.18(281.94,3372.59)	5.56(1.12,14.04)	4499.40(2149.06,7633.13)	9.75(4.53,17.02)
Namibia	105.58(58.37,166.51)	15.52(8.55,24.88)	285.45(170.32,427.61)	21.54(12.81,32.54)
Nauru	3.93(2.31,5.89)	82.34(46.80,125.88)	5.03(3.15,7.37)	91.86(53.45,139.38)
Nepal	393.15(100.67,917.51)	3.89(0.98,9.17)	2892.92(1310.88,4972.29)	1.27(0.57,2.24)
Netherlands	4621.98(2377.16,7359.29)	23.25(11.97,37.01)	2841.62(1475.90,4561.07)	8.09(4.28,12.68)
New Zealand	1334.43(747.00,2028.97)	34.42(19.12,52.30)	1266.83(714.47,1925.52)	15.59(8.99,23.23)
Nicaragua	187.29(84.19,322.37)	12.66(5.55,22.19)	1016.96(572.49,1536.36)	26.16(14.55,40.66)
Niger	195.60(71.40,386.80)	7.51(2.56,15.18)	784.38(351.80,1388.57)	10.63(4.65,19.13)
Nigeria	3888.58(1408.58,7861.73)	9.31(3.30,19.18)	11314.78(5639.66,18693.99)	13.97(6.64,23.11)
Niue	1.08(0.60,1.67)	50.78(28.36,78.01)	1.24(0.74,1.82)	57.87(34.48,85.08)
North Macedonia	853.25(502.91,1261.35)	48.39(27.72,72.76)	1360.74(801.85,2055.37)	48.89(27.89,74.48)
Northern Mariana Islands	8.28(5.45,11.33)	38.34(24.16,54.02)	24.08(15.18,32.98)	44.30(27.16,62.32)
Norway	1753.78(923.84,2764.41)	25.69(13.65,39.77)	868.83(446.44,1426.86)	8.31(4.43,13.33)
Oman	411.45(215.50,662.30)	60.95(30.53,101.61)	1219.99(805.70,1665.31)	86.35(54.25,122.86)
Pakistan	5877.31(1530.05,12697.36)	10.18(2.60,22.41)	33784.40(17656.89,54112.91)	29.03(15.04,46.87)
Palau	6.39(3.74,9.77)	61.43(35.83,94.15)	14.87(9.09,21.30)	66.24(39.72,96.12)
Palestine	398.67(197.84,650.50)	45.91(22.50,76.53)	965.37(579.89,1419.96)	42.24(24.11,63.88)
Panama	154.86(50.15,300.11)	10.60(3.39,20.93)	470.81(252.98,771.54)	11.12(6.01,18.24)
Papua New Guinea	290.54(96.73,600.03)	13.93(4.40,29.51)	1156.08(466.19,2216.14)	20.60(7.24,40.35)
Paraguay	375.82(200.47,591.98)	17.05(8.91,27.26)	1088.83(599.48,1727.86)	19.57(10.67,31.14)
Peru	1696.96(795.12,2811.14)	14.47(6.69,24.43)	3237.71(1645.00,5319.42)	9.91(5.06,16.34)
Philippines	1626.05(657.51,2953.71)	6.02(2.30,11.38)	15828.16(8320.94,24229.67)	19.87(10.31,30.87)
Poland	28593.99(17172.45,41907.10)	68.44(40.80,101.19)	23018.64(13170.51,34009.66)	32.09(18.64,47.05)
Portugal	2225.47(1088.60,3641.86)	16.86(8.16,28.16)	2029.02(1042.87,3343.51)	8.05(4.28,12.76)
Puerto Rico	1229.26(707.20,1792.79)	34.76(19.99,50.73)	1231.58(716.37,1864.34)	17.11(10.38,25.62)
Qatar	100.93(63.69,141.22)	105.83(63.21,151.50)	397.99(256.50,558.16)	75.19(44.59,109.86)
Republic of Korea	3026.51(992.33,5898.48)	11.43(3.64,23.17)	2942.97(1220.60,5234.04)	3.53(1.45,6.42)
Republic of Moldova	2577.59(1464.40,3894.47)	66.02(36.09,103.03)	3495.29(2085.34,5073.65)	60.38(36.06,87.47)
Romania	14150.87(8909.67,20164.15)	56.02(33.90,82.75)	16324.08(10217.57,23865.21)	43.63(27.75,63.16)

Table 3 (continued)

Countries	Deaths				EAPC in age-standardized rates between 1990 and 2019 (%)
	1990		2019		
	Counts	Age-standardized Rate (per 100,000)	Counts	Age-standardized Rate (per 100,000)	
Russian Federation	103484.06(62642.36,149989.44)	61.68(37.43,90.66)	146434.52(88939.05,210231.59)	63.25(38.62,90.71)	-0.31(-0.87,0.26)
Rwanda	175.57(46.81,380.96)	6.25(1.60,14.25)	467.84(183.88,858.83)	8.56(3.22,15.75)	0.84(0.43,1.26)
Saint Kitts and Nevis	15.34(8.65,23.52)	42.51(23.83,65.22)	14.08(8.30,20.99)	22.52(13.15,34.29)	-2.58(-2.89,-2.27)
Saint Lucia	16.97(8.39,27.55)	20.63(9.98,34.50)	27.69(16.02,42.34)	13.19(7.55,20.30)	-2.12(-2.48,-1.76)
Saint Vincent and the Grenadines	15.87(7.37,27.00)	22.78(10.37,39.14)	32.48(18.50,49.77)	25.27(14.21,39.23)	0.38(0.15,0.62)
Samoa	50.05(28.55,72.98)	55.53(30.78,82.30)	83.43(49.63,124.02)	55.30(32.13,82.99)	-0.12(-0.22,-0.03)
San Marino	4.51(2.37,7.10)	13.86(7.26,22.00)	6.66(3.03,11.80)	9.32(4.38,16.42)	-1.39(-1.55,-1.22)
Sao Tome and Principe	7.51(3.38,13.35)	12.45(5.33,22.87)	26.51(15.22,40.62)	27.23(15.30,42.97)	2.74(2.58,2.91)
Saudi Arabia	2901.56(1674.67,4349.00)	49.16(27.84,74.59)	13472.33(8790.39,18334.34)	71.36(45.63,96.76)	1.20(0.82,1.58)
Senegal	369.96(169.91,639.70)	12.12(5.36,21.42)	1188.44(652.04,1884.70)	16.94(9.05,27.20)	1.23(1.11,1.36)
Serbia	5420.58(3128.99,7959.91)	52.39(29.85,78.33)	6748.27(3890.04,10266.99)	46.10(26.27,70.16)	-0.82(-1.04,-0.59)
Seychelles	10.05(5.01,16.81)	17.95(8.95,30.23)	20.48(12.20,30.71)	18.02(10.40,27.60)	-0.53(-0.77,-0.29)
Sierra Leone	157.37(43.17,339.34)	8.56(2.35,18.72)	508.07(224.16,893.75)	14.34(6.09,25.66)	2.04(1.93,2.15)
Singapore	268.35(86.12,518.45)	12.34(3.87,24.40)	568.69(309.81,883.00)	7.28(3.89,11.50)	-2.18(-2.45,-1.90)
Slovakia	4505.89(2742.04,6529.70)	77.78(47.42,113.87)	4274.51(2474.81,6527.56)	47.09(27.22,71.96)	-2.00(-2.24,-1.75)
Slovenia	723.25(399.88,1132.60)	30.75(17.01,47.78)	680.86(384.63,1060.08)	14.63(8.45,22.31)	-3.19(-3.41,-2.97)
Solomon Islands	99.27(39.78,180.38)	59.77(22.82,110.45)	331.55(178.42,520.42)	84.54(42.78,135.31)	1.01(0.72,1.29)
Somalia	111.41(22.67,290.29)	4.33(0.82,11.34)	355.46(78.63,878.07)	5.22(1.10,13.15)	1.09(0.93,1.25)
South Africa	3758.66(2434.08,5305.72)	18.01(11.32,25.68)	8987.44(6063.68,12065.42)	21.64(14.21,29.55)	0.80(0.29,1.31)
South Sudan	166.80(65.08,298.83)	7.31(2.78,13.41)	420.10(204.70,728.90)	11.53(5.50,20.14)	1.93(1.77,2.08)
Spain	10096.08(5579.40,15768.57)	19.24(10.66,30.27)	9815.28(5239.67,15718.29)	9.36(5.41,14.34)	-2.90(-3.16,-2.65)
Sri Lanka	1360.06(606.76,2361.86)	12.53(5.39,22.46)	3435.07(1729.12,5683.14)	14.20(7.03,23.64)	0.60(0.43,0.77)
Sudan	3900.80(1853.00,6674.14)	40.86(18.85,70.57)	10927.67(6144.04,17300.12)	58.85(32.86,94.05)	1.33(1.21,1.46)
Suriname	75.74(40.15,120.71)	28.95(15.15,46.68)	146.25(82.56,219.68)	24.17(13.60,36.62)	-0.74(-1.19,-0.29)
Sweden	4383.64(2208.05,7231.12)	28.22(14.39,46.21)	2961.93(1547.60,4740.36)	12.65(6.83,19.82)	-3.08(-3.20,-2.95)
Switzerland	2268.88(1198.39,3565.37)	21.44(11.39,33.44)	1770.71(900.56,2926.62)	8.73(4.68,13.92)	-3.52(-3.69,-3.35)
Syrian Arab Republic	4030.92(2226.74,6214.17)	75.34(40.92,118.52)	9538.71(5512.36,14536.74)	84.42(48.65,129.20)	0.02(-0.16,0.20)
Taiwan (Province of China)	1162.43(512.02,1971.58)	8.22(3.51,14.48)	2164.51(1016.77,3705.45)	5.50(2.60,9.30)	-1.36(-1.51,-1.21)
Tajikistan	627.35(258.55,1128.85)	22.90(9.43,41.32)	1919.04(953.99,3130.72)	46.32(21.33,79.92)	2.45(2.10,2.79)

Table 3 (continued)

Countries	Deaths				EAPC in age-standardized rates between 1990 and 2019 (%)
	1990		2019		
	Counts	Age-standardized Rate (per 100,000)	Counts	Age-standardized Rate (per 100,000)	
Thailand	1918.21(674.24,3699.90)	5.31(1.74,10.74)	7588.38(3808.55,12642.07)	7.60(3.84,12.66)	0.58(0.24,0.93)
Timor-Leste	9.48(2.05,23.78)	3.33(0.66,8.62)	60.18(19.00,124.59)	7.52(2.34,15.92)	3.42(2.85,3.98)
Togo	119.21(44.79,225.29)	10.16(3.76,19.45)	634.46(340.54,1034.07)	18.12(9.53,30.14)	2.01(1.91,2.12)
Tokelau	0.43(0.19,0.72)	32.92(14.73,56.30)	0.58(0.32,0.90)	44.08(24.04,68.96)	0.97(0.79,1.15)
Tonga	16.23(9.29,23.58)	27.77(15.47,41.51)	26.41(15.68,39.49)	32.90(19.38,49.35)	0.36(0.09,0.64)
Trinidad and Tobago	384.92(232.02,550.18)	47.32(28.24,68.74)	585.35(341.49,900.70)	31.56(18.22,49.04)	-1.97(-2.22,-1.71)
Tunisia	1890.47(1065.33,2919.62)	39.79(21.84,63.53)	5319.08(2943.98,8493.09)	44.47(24.32,70.71)	0.25(0.17,0.32)
Turkey	1828.20(1065.24,2662.84)	51.54(29.74,75.76)	2772.60(1577.34,4641.48)	32.47(18.38,48.80)	-2.05(-2.40,-1.71)
Turkmenistan	1275.85(739.14,1911.66)	72.10(40.99,111.00)	3283.17(1982.17,4735.77)	91.63(53.91,133.80)	-0.04(-0.49,0.41)
Tuvalu	2.63(1.09,4.59)	37.02(14.75,66.70)	5.48(2.87,8.91)	52.57(27.00,86.49)	1.02(0.81,1.24)
Uganda	222.58(56.35,507.34)	3.66(0.87,8.53)	1341.01(618.88,2295.41)	9.75(4.28,16.99)	3.60(3.38,3.81)
Ukraine	48401.04(30494.06,68957.40)	71.63(44.31,103.59)	79271.34(49998.41,113452.30)	104.78(66.27,149.27)	0.81(0.41,1.20)
United Arab Emirates	316.21(195.76,476.88)	71.96(44.21,108.19)	2667.15(1675.33,3863.24)	61.34(37.79,86.93)	-0.62(-1.11,-0.14)
United Kingdom	34932.94(19014.60,53576.95)	38.96(21.23,59.69)	19445.00(10978.77,29352.30)	15.17(8.73,22.32)	-3.87(-4.13,-3.61)
United Republic of Tanzania	691.27(279.09,1257.99)	6.90(2.65,12.96)	2896.64(1541.12,4728.32)	12.51(6.37,20.61)	2.13(1.99,2.28)
United States of America	11965.62(6693.41,180364.92)	37.55(21.21,56.19)	140255.50(85924.03,199014.35)	24.57(15.38,34.18)	-1.82(-1.98,-1.67)
United States Virgin Islands	34.89(20.05,51.24)	44.23(24.48,66.68)	87.63(55.00,123.29)	49.08(30.51,68.99)	0.59(0.42,0.75)
Uruguay	851.00(420.02,1386.78)	22.18(10.90,36.32)	768.64(423.83,1183.77)	13.89(7.76,21.02)	-1.80(-1.92,-1.68)
Uzbekistan	5292.31(2884.94,8264.49)	49.30(26.36,78.22)	20489.02(12579.34,29209.57)	133.42(76.93,200.73)	3.53(2.97,4.09)
Vanuatu	26.77(11.19,48.33)	37.95(15.20,68.83)	110.30(56.10,180.06)	59.49(29.59,98.60)	1.39(1.23,1.55)
Venezuela (Bolivarian Republic of)	2900.93(1592.17,4506.97)	30.03(16.01,47.72)	8179.43(4390.96,13294.34)	28.03(14.98,45.73)	-0.57(-0.76,-0.37)
Viet Nam	1007.92(209.69,2619.50)	2.60(0.53,6.87)	6022.24(2598.77,11060.44)	6.87(2.96,12.67)	3.93(3.60,4.26)
Yemen	1371.02(499.97,2627.15)	27.01(9.66,53.43)	5074.05(2522.89,8452.46)	37.04(17.93,61.59)	1.40(1.23,1.57)
Zambia	254.74(98.57,473.48)	8.47(3.01,16.18)	874.66(461.82,1399.38)	12.58(6.46,20.42)	1.00(0.87,1.14)
Zimbabwe	563.20(312.53,876.89)	15.00(7.95,24.18)	1619.59(935.11,2523.63)	24.63(13.75,39.45)	2.14(1.88,2.40)

Table 3 (continued)

Countries	DALYs			
	1990		2019	
	Counts	Age-standardized Rate (per 100,000)	Counts	Age-standardized Rate (per 100,000)
Alghanistan	109465.57(50347.78,190494.06)	141.42(64.77,247.16)	263091.23(144879.31,415316.42)	1632.93(919.71,2528.69)
Albania	12043.72(6563.87,18422.09)	563.56(305.43,864.51)	26643.46(14813.66,41838.08)	652.98(359.47,1022.09)
Algeria	187977.64(108793.97,296581.50)	1407.66(804.62,2219.12)	397895.69(24282.463,582416.56)	1129.68(690.71,1663.41)
American Samoa	388.91(27983.501,01)	1366.32(952.59,1776.53)	727.87(512.30,965.27)	1388.90(967.38,1860.41)
Andorra	177.80(95.91,284.01)	316.38(168.83,507.02)	277.10(153.87,428.51)	198.27(111.03,304.45)
Angola	6343.37(1331.78,15827.05)	135.54(28.08,335.03)	40971.92(19495.86,68031.60)	306.04(145.66,512.58)
Antigua and Barbuda	217.60(109.94,350.06)	434.67(221.57,693.42)	374.28(224.25,542.37)	356.99(212.84,523.06)
Argentina	170238.05(82980.64,274117.64)	529.12(257.60,857.21)	195691.43(112758.46,283858.94)	373.70(215.82,539.93)
Armenia	27622.04(15690.58,41813.72)	1000.98(556.22,1549.54)	46429.00(30029.62,64455.69)	1149.61(746.21,1594.05)
Australia	140406.75(81772.64,204442.83)	728.13(424.48,1063.19)	101852.10(65158.58,141636.56)	264.11(174.86,360.40)
Austria	62576.42(34004.29,95925.75)	557.05(305.06,846.38)	47411.88(26350.25,71422.77)	276.45(155.51,409.76)
Azerbaijan	75043.46(42503.21,111563.57)	1419.67(801.20,2120.88)	179773.47(107719.97,255212.70)	1907.19(1148.45,2730.58)
Bahamas	1314.67(813.06,1875.18)	769.07(469.80,1105.72)	2540.82(1525.94,3684.78)	600.00(362.56,867.57)
Bahrain	5795.80(3707.65,7923.94)	2513.05(1582.72,3532.53)	10290.98(6559.51,14093.73)	871.32(530.31,1229.86)
Bangladesh	48148.59(9050.01,120886.07)	83.83(15.67,211.00)	38791.73(178969.07,664663.60)	271.03(123.93,466.73)
Barbados	1442.52(799.82,2139.52)	536.67(301.19,786.43)	1688.25(1013.32,2489.66)	356.30(214.37,523.56)
Belarus	159153.73(94122.08,236922.01)	1249.80(736.87,1868.51)	256969.36(153169.42,377593.40)	1660.22(989.20,2432.81)
Belgium	69061.05(38194.84,105238.54)	475.38(264.68,718.78)	43495.44(24850.50,64776.52)	208.55(122.56,306.03)
Belize	483.77(233.39,783.53)	505.24(244.50,817.69)	1618.07(1031.83,2238.75)	530.73(337.92,743.44)
Benin	5633.21(2497.56,9918.66)	264.28(114.44,470.52)	26223.85(14539.27,40393.60)	472.17(258.72,735.38)
Bermuda	789.55(472.08,1100.75)	1242.70(739.94,1733.54)	507.26(312.72,735.90)	416.41(260.44,596.78)
Bhutan	728.86(217.27,1549.85)	234.66(68.87,504.24)	3002.66(1468.42,4944.75)	479.78(235.71,789.14)
Bolivia (Plurinational State of)	16225.61(7624.99,28448.32)	457.59(215.87,792.80)	45132.78(25622.82,70389.01)	488.95(279.25,773.59)
Bosnia and Herzegovina	34234.58(19166.97,51819.84)	811.12(454.28,1237.32)	39898.78(23481.34,60226.55)	701.52(413.79,1062.77)
Botswana	1929.14(845.44,3477.27)	310.91(135.90,561.71)	11499.61(6418.21,17983.14)	738.82(416.57,1151.13)
Brazil	624240.12(341587.1,2962608.57)	632.73(343.22,989.03)	1202620.29(798542.65,1637214.69)	493.36(326.60,673.25)
Brunei Darussalam	445.07(128.02,916.25)	343.56(99.32,719.16)	1344.10(684.42,2135.19)	363.42(181.26,583.15)
Bulgaria	196086.08(121564.01,272987.26)	1643.53(1011.65,2332.78)	157370.95(94795.39,235392.40)	1221.84(736.39,1799.35)
Burkina Faso	6288.76(1792.44,13850.72)	132.18(37.30,294.68)	37342.54(18347.57,61346.52)	367.45(178.82,607.58)
Burundi	4510.97(1371.51,9768.61)	171.24(50.35,368.54)	10780.30(4093.50,20300.78)	195.59(74.88,373.68)
Cabo Verde	528.63(214.14,935.83)	239.41(99.59,420.07)	2321.52(1441.03,3343.48)	531.96(328.98,770.23)
Cambodia	6381.83(1493.38,15489.41)	119.71(27.76,288.89)	30666.63(13925.68,53887.47)	230.90(104.06,405.22)
Cameroon	17334.99(9174.61,28146.06)	366.58(189.35,602.78)	78852.09(44831.16,121875.66)	593.02(334.92,918.67)
				1.80(1.56,2.04)

Table 3 (continued)

Countries	DALYs			
	1990		2019	
	Counts	Age-standardized Rate (per 100,000)	Counts	Age-standardized Rate (per 100,000)
Canada	207289.74(120086.86,308560.90)	651.18(379.36,973.36)	202183.14(126297.71,282138.30)	317.05(201.87,438.11)
Central African Republic	2895.04(878.15,6253.78)	209.23(62.66,450.19)	7676.96(2947.38,15194.67)	286.00(109.62,575.02)
Chad	3131.29(923.06,6768.86)	106.43(31.46,231.53)	15554.32(7195.95,26815.70)	246.02(113.10,427.00)
Chile	44789.82(24139.23,68002.69)	447.55(240.18,686.45)	64129.14(39004.97,90262.02)	270.58(165.24,381.10)
China	1183843.99(283867.90,2643151.93)	127.54(30.11,286.07)	5073254.14(2233964.46,8744122.41)	257.69(112.34,447.18)
Colombia	97705.34(52899.59,150865.50)	507.66(273.73,795.03)	182345.59(103632.21,285708.70)	344.64(196.70,539.68)
Comoros	519.51(159.48,996.22)	217.50(68.69,414.41)	1725.57(849.04,2923.54)	325.25(158.24,555.18)
Congo	6092.51(2691.65,10654.07)	504.22(222.85,896.46)	19382.44(10927.24,30291.13)	633.39(355.08,991.03)
Cook Islands	148.78(92.56,216.20)	1051.55(642.38,1513.55)	209.28(135.69,289.32)	900.87(585.16,1252.85)
Costa Rica	9061.98(5104.20,13513.67)	493.13(274.26,740.66)	19702.35(11399.95,30325.66)	376.94(217.48,582.25)
Croatia	68000.74(40558.75,98082.85)	1080.47(641.35,1568.36)	52155.80(31206.42,77397.68)	634.76(380.96,939.35)
Cuba	76436.81(47126.44,110217.22)	743.09(457.91,1073.50)	95112.31(56214.72,138992.75)	518.83(311.29,758.66)
Cyprus	4267.68(2144.38,6793.99)	538.55(267.27,871.39)	5650.22(3197.65,8559.36)	309.48(175.67,469.88)
Czechia	216722.19(132239.02,307626.49)	1607.61(976.08,2281.55)	140724.23(87619.34,203908.99)	691.31(432.71,998.39)
Côte d'Ivoire	17606.40(8727.74,29508.96)	359.48(172.74,607.85)	57699.54(31667.22,88923.04)	445.66(239.82,699.09)
Democratic People's Republic of Korea	22873.29(4424.90,55700.17)	128.93(25.27,312.83)	50912.20(10525.93,122454.38)	158.04(32.79,381.60)
Democratic Republic of the Congo	59363.56(27820.39,101056.72)	329.64(154.81,566.38)	114525.38(51625.10,201014.29)	278.97(124.44,493.49)
Denmark	48695.45(26480.90,75109.61)	641.11(351.23,981.55)	19469.40(11234.42,29254.00)	180.89(105.01,269.56)
Djibouti	173.40(39.19,412.21)	96.74(21.33,230.34)	2291.49(1013.96,4127.38)	312.41(138.25,560.29)
Dominica	379.90(218.37,565.88)	563.18(327.86,834.56)	406.12(243.42,607.90)	461.48(276.99,686.85)
Dominican Republic	17991.51(8104.92,30213.89)	416.89(187.34,704.00)	94160.59(53130.87,148863.03)	947.35(531.70,1506.27)
Ecuador	29891.50(19015.28,41519.39)	487.34(306.51,681.72)	74581.27(45663.55,106778.68)	473.69(288.17,684.82)
Egypt	699885.51(419645.29,1015554.56)	2115.12(1252.01,3077.41)	1825285.68(1156241.98,2644114.93)	2554.83(1612.68,3709.44)
El Salvador	16234.87(8490.76,25263.92)	495.08(258.71,775.23)	30144.54(16864.16,47368.60)	507.67(284.44,799.07)
Equatorial Guinea	414.55(97.30,964.28)	184.93(43.18,425.89)	2491.54(1398.54,4004.45)	460.93(256.56,734.96)
Eritrea	1155.13(338.33,2765.78)	96.83(29.69,220.28)	7761.06(3651.32,14261.85)	255.91(120.33,454.15)
Estonia	29603.40(18513.33,42581.40)	1477.39(922.39,2121.57)	16976.17(10158.62,25543.98)	671.36(409.20,1009.05)
Eswatini	1871.43(1151.87,2764.57)	593.81(358.03,867.64)	5274.21(3067.96,8128.39)	837.93(489.87,1272.44)
Ethiopia	31356.10(7494.09,7036.48)	126.32(29.01,312.63)	84265.14(37697.65,150776.11)	172.01(76.09,312.45)
Fiji	8915.05(4798.00,13659.59)	1891.31(1007.17,2919.70)	16920.38(10889.01,24407.97)	1967.58(1256.43,2845.84)
Finland	59814.22(33210.69,90284.30)	870.23(488.42,1308.31)	38268.53(21035.18,58030.61)	333.92(189.48,495.61)

Table 3 (continued)

Countries	DALYs			
	1990		2019	
	Counts	Age-standardized Rate (per 100,000)	Counts	Age-standardized Rate (per 100,000)
France	219426.30(12009.35,339826.25)	283.03(156.88,434.19)	179767.06(105420.47,268413.68)	148.95(89.45,217.29)
Gabon	2160.48(966.92,3808.56)	360.00(160.27,634.12)	6776.16(3839.86,10303.75)	589.52(332.64,890.37)
Gambia	996.30(397.81,1819.47)	253.11(101.79,470.34)	5939.07(3294.14,9223.73)	565.84(316.65,873.15)
Georgia	120079.73(76691.45,168599.90)	198.243(126.29,2791.49)	61110.32(37728.89,88156.23)	1099.88(687.60,1575.64)
Germany	943893.91(532301.60,1418812.96)	777.59(441.08,1160.07)	547495.95(316475.82,813476.45)	314.22(187.57,454.58)
Ghana	17285.04(7191.71,31484.60)	235.31(94.76,431.11)	109447.92(68303.89,158877.06)	619.96(388.86,901.28)
Greece	79643.20(42988.98,120924.22)	550.96(300.20,830.96)	85143.94(47714.28,127101.61)	442.24(254.11,637.46)
Greenland	395.26(227.38,583.50)	997.21(578.17,1467.14)	400.25(231.33,584.53)	539.66(312.33,794.77)
Grenada	375.00(181.87,619.21)	571.56(284.49,930.22)	597.29(373.33,839.56)	509.02(316.96,721.89)
Guam	961.07(547.60,1381.98)	1060.31(584.82,1543.81)	2639.77(1679.39,3699.56)	1388.06(888.34,1941.47)
Guatemala	15883.97(5806.52,28469.83)	358.63(133.06,658.26)	41485.84(22309.84,65649.66)	342.58(184.59,549.41)
Guinea	6690.73(2812.01,12516.09)	192.49(80.26,361.06)	21943.04(11503.15,35066.64)	363.17(190.39,590.89)
Guinea-Bissau	1321.49(433.03,2750.40)	289.73(95.27,603.52)	4265.32(2022.48,7289.43)	493.18(233.64,847.45)
Guyana	4495.20(2280.46,7113.66)	1042.91(528.79,1663.61)	7363.63(4148.64,11470.71)	1062.60(597.17,1654.55)
Haiti	17153.99(6294.99,32190.28)	461.33(167.05,867.19)	38404.40(16367.21,70206.76)	477.15(201.31,879.73)
Honduras	8123.93(3364.48,14259.95)	353.23(149.94,620.45)	36237.51(19653.86,55930.34)	579.48(315.05,893.30)
Hungary	230100.45(152984.59,312907.20)	1638.69(1093.82,2225.71)	166059.30(105890.79,235298.51)	922.56(599.39,1295.49)
Iceland	1914.09(1066.76,2841.78)	692.66(387.75,1023.84)	1442.95(836.14,2160.26)	273.83(162.09,400.60)
India	1321241.85(523425.35,2552028.87)	237.08(93.70,456.05)	6898797.04(4058493.07,10155583.87)	547.20(319.02,812.38)
Indonesia	226410.02(75334.53,456546.04)	178.04(56.86,364.78)	1272493.62(743551.77,1951436.91)	488.15(280.72,757.77)
Iran (Islamic Republic of)	297735.12(174499.54,435725.98)	998.73(581.95,1483.43)	603614.57(408858.57,821249.15)	776.67(519.47,1066.83)
Iraq	168844.90(101827.92,240465.45)	1989.77(1193.51,2849.89)	390935.93(240096.16,575339.66)	1553.15(958.37,2275.75)
Ireland	35531.16(19272.83,53853.09)	899.75(485.89,1368.99)	21117.46(12408.88,31168.07)	292.60(172.98,429.41)
Israel	30926.71(17163.26,46432.70)	651.89(361.38,980.54)	19923.70(11227.96,29705.79)	177.97(101.26,262.75)
Italy	326208.24(176605.26,503751.69)	384.80(207.31,594.66)	238908.72(132427.06,369982.27)	182.21(102.72,275.00)
Jamaica	4932.79(2803.56,7542.57)	285.43(162.07,433.93)	11060.42(6933.01,16346.49)	368.68(231.24,542.27)
Japan	193719.49(66189.95,368568.66)	116.01(39.29,221.68)	166639.00(59948.71,313802.32)	61.71(23.28,112.01)
Jordan	20432.81(12722.88,28550.81)	1321.26(810.46,1897.55)	65978.51(44183.53,88687.46)	886.40(583.36,1213.19)
Kazakhstan	188352.89(117267.09,267045.45)	1457.47(904.48,2089.17)	21301.40(137227.95,299645.87)	1241.36(788.36,1740.51)
Kenya	10697.32(4488.28,19256.25)	116.67(47.71,216.13)	80551.49(47683.08,123796.56)	308.35(177.94,481.22)
Kiribati	1050.07(595.56,1590.37)	2167.04(1205.15,3333.88)	1837.28(1052.26,2759.92)	1965.17(1105.34,2992.16)
Kuwait	12587.17(8623.64,16497.93)	1410.29(930.02,1884.82)	36169.02(24876.74,47503.00)	963.95(643.36,1284.21)
				-2.35(-2.46,-2.24)
				1.60(1.23,1.98)
				2.87(2.66,3.08)
				-2.83(-3.14,-2.51)
				-3.45(-3.69,-3.21)
				3.60(3.34,3.86)
				-0.93(-1.14,-0.72)
				-2.49(-2.67,-2.32)
				-0.52(-0.77,-0.27)
				1.14(0.95,1.33)
				-0.34(-0.72,0.05)
				2.59(2.46,2.72)
				1.93(1.77,2.10)
				0.16(0.04,0.28)
				0.49(0.29,0.70)
				1.79(1.56,2.01)
				-2.28(-2.42,-2.15)
				-3.51(-3.72,-3.30)
				3.07(2.96,3.18)
				3.99(3.81,4.16)
				-1.41(-1.72,-1.11)
				-1.21(-1.33,-1.08)
				-4.46(-4.69,-4.22)
				-5.25(-5.59,-4.90)
				-2.95(-3.09,-2.81)
				1.00(0.67,1.32)
				-2.20(-2.26,-2.15)
				-2.05(-2.35,-1.74)
				-1.61(-2.47,-0.74)
				3.94(3.63,4.26)
				-0.62(-0.79,-0.46)
				-0.98(-1.37,-0.59)

Table 3 (continued)

Countries	DALYs				EAPC in age-standardized rates between 1990 and 2019 (%)
	1990		2019		
	Counts	Age-standardized Rate (per 100,000)	Counts	Age-standardized Rate (per 100,000)	
Kyrgyzstan	28895.35(16721.43,42722.79)	938.87(541.62,1393.92)	52514.90(31194.96,76092.88)	1137.17(670.47,1670.62)	0.55(0.16,0.95)
Lao People's Democratic Republic	4677.30(1194.60,11140.71)	197.71(50.44,477.06)	24298.66(12115.37,38558.28)	463.15(231.61,737.48)	3.33(3.15,3.51)
Latvia	53896.52(32240.76,77552.54)	1548.11(932.70,22225.50)	38346.07(23516.80,55347.55)	1031.88(647.14,1473.11)	-2.10(-2.55,-1.65)
Lebanon	43521.73(25393.19,64145.06)	1782.61(1038.74,2635.34)	79596.54(48712.23,111945.43)	1523.21(932.76,2146.10)	-0.23(-0.59,0.12)
Lesotho	2165.82(1002.61,3833.12)	211.97(97.85,375.04)	8974.33(5042.24,13792.71)	648.46(363.90,995.08)	4.78(4.28,5.28)
Liberia	4685.35(2361.18,7728.29)	399.34(199.17,659.54)	12837.21(7433.37,19807.07)	518.74(302.61,805.74)	1.78(1.17,2.40)
Libya	24627.75(15480.94,35807.98)	1137.76(697.84,1660.64)	76092.30(46925.08,112251.69)	1290.85(793.85,1899.14)	0.40(0.26,0.54)
Lithuania	62510.62(37003.12,92215.76)	1415.93(842.75,2078.49)	56535.24(33403.81,82686.69)	1038.53(619.94,1499.04)	-1.17(-1.54,-0.79)
Luxembourg	3147.06(1832.22,4676.02)	597.72(348.53,885.82)	1902.99(1098.83,2878.73)	195.47(114.23,295.26)	-4.18(-4.32,-4.05)
Madagascar	9946.59(3616.39,19094.75)	166.83(62.18,321.33)	44340.71(20052.70,76838.81)	323.35(148.69,550.71)	2.71(2.48,2.93)
Malawi	7148.92(2050.84,15044.61)	153.23(42.85,333.53)	24329.82(11334.08,40757.67)	287.32(134.35,483.35)	2.39(2.01,2.76)
Malaysia	45965.73(22947.40,73656.80)	445.17(218.65,718.22)	207316.55(125377.93,306585.47)	709.29(423.37,1052.84)	1.33(1.06,1.61)
Maldives	352.93(91.94,768.22)	320.36(80.85,708.77)	1190.25(626.54,1895.62)	304.34(155.90,491.98)	-0.76(-0.98,-0.54)
Mali	7016.90(2399.88,14452.60)	161.50(54.55,331.84)	28236.44(14726.56,47850.28)	302.16(153.81,509.16)	2.29(2.22,2.37)
Malta	2677.64(1428.88,4179.67)	626.74(333.93,980.57)	2654.67(1467.91,4101.21)	312.73(174.18,478.98)	-2.55(-2.70,-2.41)
Marshall Islands	218.78(86.75,393.51)	1079.03(420.90,1935.58)	766.93(387.00,1289.83)	1642.00(804.09,2790.94)	1.29(1.03,1.56)
Mauritania	5276.07(2918.51,8287.44)	499.83(274.57,785.54)	10527.19(6475.41,16014.23)	486.43(299.63,735.66)	-0.11(-0.20,-0.03)
Mauritius	7392.48(4055.43,11208.81)	892.84(484.86,1355.09)	8554.60(5071.11,12775.04)	490.48(292.08,727.94)	-3.05(-3.54,-2.57)
Mexico	224060.23(132070.23,322907.41)	479.97(280.62,706.12)	648479.80(398860.31,915336.17)	534.91(328.85,756.08)	0.33(0.18,0.49)
Micronesia (Federated States of)	1083.74(606.13,1733.41)	1908.05(1041.90,3034.39)	2007.73(1081.91,3157.35)	2231.27(1192.98,3500.11)	0.44(0.31,0.58)
Monaco	348.65(185.55,539.31)	553.55(301.43,862.44)	255.96(142.99,392.18)	302.55(172.09,455.76)	-2.21(-2.48,-1.93)
Mongolia	15588.88(8189.45,24303.68)	1399.21(733.60,2202.58)	34673.62(20235.08,52479.95)	1292.61(729.19,1965.67)	-1.07(-1.47,-0.67)
Montenegro	5975.75(3777.90,8228.64)	942.35(588.51,1302.61)	9133.39(5853.04,12898.36)	950.31(609.78,1340.95)	0.14(-0.04,0.32)
Morocco	188980.69(106339.70,291354.02)	1247.38(702.99,1935.73)	493709.81(284000.61,745895.07)	1486.35(852.52,2279.21)	0.47(0.37,0.58)
Mozambique	5512.19(1322.33,12846.44)	81.01(18.78,194.13)	35619.47(16681.38,60474.40)	269.68(122.72,465.61)	5.33(4.92,5.74)
Myanmar	44166.49(9588.88,111397.62)	160.76(34.83,400.54)	132066.90(64172.55,217432.95)	258.46(125.55,429.87)	1.92(1.78,2.06)
Namibia	2780.89(1565.96,4356.78)	371.01(207.40,581.31)	7395.97(4345.35,11039.78)	499.23(298.48,740.20)	0.73(0.34,1.13)
Nauru	148.79(88.23,219.83)	2548.08(1496.47,3798.48)	194.85(121.64,285.09)	2824.67(1744.96,4169.23)	0.05(-0.22,0.31)
Nepal	13144.60(3432.01,30372.30)	113.24(29.22,263.31)	87188.08(40952.95,145876.86)	352.95(163.79,591.99)	4.51(4.32,4.70)
Netherlands	99112.64(52088.56,154308.85)	515.84(270.92,804.71)	53462.65(29354.49,81570.09)	169.79(94.60,256.36)	-4.59(-4.91,-4.26)
New Zealand	30104.82(17166.79,44686.47)	787.61(449.50,1164.38)	23587.91(14185.95,33839.33)	323.65(200.10,458.46)	-3.52(-3.75,-3.29)

Table 3 (continued)

Countries	DALYs				EAPC in age-standardized rates between 1990 and 2019 (%)
	1990		2019		
	Counts	Age-standardized Rate (per 100,000)	Counts	Age-standardized Rate (per 100,000)	
Saudi Arabia	87846.24(52190.81,132514.69)	1237.60(717.94,1851.26)	450563.90(294761.84,614267.29)	1783.05(1166.89,2406.36)	1.28(0.89,1.66)
Senegal	10065.12(4785.10,17080.63)	289.20(135.40,493.54)	31482.53(17507.97,49499.33)	391.15(216.72,612.96)	1.09(0.94,1.24)
Serbia	128521.09(75625.46,182624.80)	1134.75(663.86,1621.55)	132371.16(80134.63,194999.91)	884.94(540.04,1298.79)	-1.33(-1.60,-1.06)
Seychelles	294.18(154.60,466.37)	522.82(274.60,827.82)	616.26(380.38,899.15)	506.53(312.04,741.31)	-0.71(-0.98,-0.45)
Sierra Leone	4104.20(1170.83,8626.21)	205.48(58.07,431.67)	14693.06(6752.56,25719.98)	363.47(164.35,635.49)	2.24(2.13,2.35)
Singapore	7315.81(2422.45,13830.61)	301.15(99.09,576.53)	14126.89(8320.61,20873.15)	173.49(101.47,257.47)	-2.22(-2.48,-1.96)
Slovakia	102185.67(63233.88,145210.79)	1726.93(1067.24,2462.43)	81332.63(49093.95,120864.45)	899.27(545.87,1339.60)	-2.58(-2.84,-2.33)
Slovenia	16297.10(9588.99,24670.84)	674.92(396.73,1027.03)	12620.11(7559.67,18730.84)	309.43(187.77,455.45)	-3.30(-3.53,-3.06)
Solomon Islands	3664.92(1527.14,6578.37)	1979.71(804.17,3585.66)	12543.68(6878.15,19588.29)	2794.24(1498.26,4375.12)	1.01(0.71,1.31)
Somalia	3661.29(774.57,9462.65)	114.57(23.36,298.21)	11734.15(2731.52,28789.17)	138.72(30.57,343.86)	1.09(0.93,1.24)
South Africa	112387.78(74575.23,154550.29)	479.02(317.01,665.52)	231532.14(162173.60,303832.78)	492.25(340.60,647.83)	0.24(-0.27,0.75)
South Sudan	4717.44(1898.19,8388.68)	179.99(71.12,321.28)	12328.08(6178.20,21498.63)	281.70(140.76,487.79)	1.85(1.71,2.00)
Spain	212036.09(119664.54,317653.29)	411.72(233.59,615.69)	175692.48(103873.39,261919.91)	204.57(125.14,294.91)	-2.83(-3.09,-2.57)
Sri Lanka	41429.64(18952.43,71013.30)	330.88(149.47,571.29)	85974.85(44000.27,141452.10)	335.34(171.58,552.79)	-0.01(-0.21,0.20)
Sudan	117887.44(56160.30,202241.33)	1117.20(537.20,1916.91)	321374.41(181608.95,515989.78)	1464.19(831.94,2313.37)	0.98(0.89,1.07)
Suriname	2096.34(1161.20,3210.84)	751.08(409.98,1159.77)	4053.69(2365.45,5958.82)	641.60(371.81,946.33)	-0.73(-1.15,-0.31)
Sweden	82297.61(43203.12,130734.72)	581.01(306.93,909.40)	49226.53(27434.41,74884.59)	249.86(141.70,374.74)	-3.19(-3.33,-3.05)
Switzerland	44002.43(24296.22,67125.91)	444.58(246.91,675.21)	27288.40(15155.29,41834.43)	161.53(91.56,244.25)	-3.88(-4.07,-3.69)
Syrian Arab Republic	122292.70(69195.81,186265.33)	1965.19(1099.53,3009.82)	259203.64(150856.50,391158.46)	1966.89(1149.71,2982.02)	-0.35(-0.53,-0.17)
Taiwan (Province of China)	30280.92(13267.73,50814.48)	183.54(80.90,311.23)	53582.76(26390.06,87457.49)	143.10(71.51,231.88)	-0.71(-0.84,-0.59)
Tajikistan	16118.15(6749.10,28102.07)	559.46(237.59,975.82)	52118.92(26179.66,85540.07)	989.08(483.34,1619.72)	1.83(1.42,2.23)
Thailand	61576.90(30200.48,114571.71)	144.54(52.10,274.58)	210397.21(113743.54,340873.24)	212.96(115.85,345.26)	0.53(0.12,0.93)
Timor-Leste	309.89(68.63,772.44)	85.31(18.24,133.34)	1713.33(531.97,3448.05)	194.86(62.26,395.04)	3.51(2.89,4.14)
Togo	3398.83(1310.61,6381.63)	242.83(92.70,455.32)	18573.47(9947.92,30347.85)	440.11(236.61,714.52)	2.04(1.92,2.16)
Tokelau	1.225(5.80,20.49)	964.77(466.71,1594.31)	16.83(9.68,26.11)	1250.98(714.65,1938.71)	0.84(0.65,1.04)
Tonga	522.48(322.15,740.14)	841.50(511.13,1204.87)	798.74(505.89,1140.84)	964.55(610.61,1382.69)	0.27(0.01,0.52)
Trinidad and Tobago	10462.69(6535.37,14653.83)	1199.73(745.83,1682.08)	14747.44(8955.44,22591.61)	789.12(478.46,1210.21)	-2.03(-2.28,-1.77)
Tunisia	51045.25(30041.38,76704.14)	946.68(547.04,1437.25)	127192.01(72648.79,198189.22)	990.07(567.56,1542.43)	-0.04(-0.13,0.05)
Turkey	51142.186(302636.29,744064.42)	1306.64(772.95,1899.26)	642605.42(382449.80,937113.49)	714.36(420.99,1044.61)	-2.73(-3.09,-2.37)
Turkmenistan	33255.03(19869.44,48392.87)	1658.47(976.16,2446.60)	86046.90(53055.81,123145.28)	2083.17(1273.87,2978.18)	-0.10(-0.59,0.40)
Tuvalu	85.24(36.79,147.35)	1117.35(479.53,1934.36)	176.39(96.17,280.57)	1604.08(864.85,2563.22)	1.08(0.87,1.30)
Uganda	6230.96(1617.16,13819.47)	87.90(22.63,198.62)	39783.85(18577.74,68010.63)	242.19(114.35,411.45)	3.67(3.38,3.95)

Table 3 (continued)

Countries	DALYs						EAPC in age-standardized rates between 1990 and 2019 (%)
	1990			2019			
	Counts	Age-standardized Rate (per 100,000)	Counts	Age-standardized Rate (per 100,000)	Counts	Age-standardized Rate (per 100,000)	
Ukraine	1022989.49(652708.02,1416851.71)	1454.35(931.19,2022.70)	1635214.34(1052615.82,2278974.13)	2235.17(1460.48,3107.95)	2235.17(1460.48,3107.95)	0.88(0.42,1.34)	
United Arab Emirates	11367.74(6901.59,17244.49)	1694.26(1053.52,2493.75)	100788.05(63824.01,144927.21)	1454.18(944.68,2049.15)	1454.18(944.68,2049.15)	-0.65(-0.99,-0.31)	
United Kingdom	738345.75(410581.39,1107634.90)	874.28(491.44,1302.04)	375082.18(223280.09,535179.10)	333.34(203.44,469.65)	333.34(203.44,469.65)	-3.88(-4.14,-3.63)	
United Republic of Tanzania	19171.06(8002.46,34135.53)	161.55(65.66,291.03)	80998.67(43723.19,131417.36)	296.69(160.23,477.63)	296.69(160.23,477.63)	2.15(2.03,2.28)	
United States of America	2628029.91(1547401.23,3778277.33)	872.32(517.40,1247.32)	2934452.18(19222069.40,3904357.77)	571.72(385.46,748.68)	571.72(385.46,748.68)	-1.76(-1.90,-1.62)	
United States Virgin Islands	929.15(554.60,1356.53)	1019.72(598.72,1487.55)	1954.02(1255.87,2681.06)	1096.48(710.06,1506.61)	1096.48(710.06,1506.61)	0.45(0.27,0.63)	
Uruguay	18899.20(9682.06,29739.90)	500.80(257.48,786.68)	15673.66(8954.13,22984.02)	317.20(185.12,461.85)	317.20(185.12,461.85)	-1.75(-1.87,-1.63)	
Uzbekistan	131849.42(75400.86,198068.10)	1129.51(643.55,1719.86)	568868.34(356744.77,804451.99)	2684.01(1640.95,3883.79)	2684.01(1640.95,3883.79)	2.97(2.44,3.51)	
Vanuatu	904.00(386.15,1620.12)	1111.71(469.14,1997.38)	3728.95(1955.61,6021.91)	1807.23(937.75,2931.64)	1807.23(937.75,2931.64)	1.49(1.31,1.67)	
Venezuela (Bolivarian Republic of)	82542.54(45949.92,125537.91)	763.26(424.55,1177.97)	210443.55(117495.49,335577.29)	695.49(386.12,1107.98)	695.49(386.12,1107.98)	-0.66(-0.85,-0.47)	
Viet Nam	26916.52(5639.51,68317.41)	63.96(13.47,162.04)	157435.58(66954.25,287258.22)	160.03(68.88,291.15)	160.03(68.88,291.15)	3.76(3.38,4.14)	
Yemen	42312.23(15680.75,81733.96)	728.70(268.85,1400.31)	155671.14(78389.27,264354.43)	974.78(489.68,1618.82)	974.78(489.68,1618.82)	1.27(1.12,1.42)	
Zambia	8242.90(3313.58,15134.37)	234.73(91.24,435.28)	28390.74(15284.11,45318.94)	336.91(179.49,533.29)	336.91(179.49,533.29)	0.78(0.61,0.96)	
Zimbabwe	15000.61(8483.81,23082.90)	347.71(195.14,537.56)	44724.33(25699.14,68761.18)	594.61(343.41,919.02)	594.61(343.41,919.02)	2.35(2.04,2.65)	

Table 4 Deaths and DALYs of ischemic heart disease attributable to high body-mass index in 2019 in global for male, female, and both sexes combined, for each age groups in counts and age-standardize rates

	Deaths			DALYs (Disability-Adjusted Life Years)			
	male		both	female		both	
	Counts	Age-standardized Rate (per 100,000)	Counts	Age-standardized Rate (per 100,000)	Counts	Age-standardized Rate (per 100,000)	
20-24 years	3692,297(11,007,268.54)	1.21(0.23,2.39)	2068,45(410,49,4056.23)	0.70(0.14,1.37)	5760,74(1118,07,11254.56)	0.96(0.19,1.88)	
25-29 years	8134,68(1831.73,14682.74)	2.67(0.60,4.82)	3688,42(827.7,66584.71)	1.23(0.28,2.19)	11823.10(2704.44,21233.54)	1.95(0.45,3.51)	
30-34 years	16788,19(5202.30,30016.33)	5.54(1.72,9.90)	6898,75(2185.68,11754.49)	2.31(0.73,3.94)	23686,94(7386.06,41403.74)	3.94(1.23,6.88)	
35-39 years	24240,31(114572.31,35751.79)	8.89(5.35,13.12)	9559,56(6117.92,13598.60)	3.56(2.28,5.07)	33799,87(20871.15,49550.76)	6.25(3.86,9.16)	
40-44 years	35173,97(20294.43,52792.21)	14.14(8.16,21.22)	14802,13(8720.35,21728.21)	6.05(3.56,8.88)	49976.10(29415.88,73760.43)	10.13(5.96,14.95)	
45-49 years	57288,06(34330.92,82264.60)	24.03(14.40,34.51)	24355,47(15308.74,34053.52)	10.35(6.50,14.46)	81643,53(49181.77,115253.65)	17.23(10.38,24.33)	
50-54 years	84120,18(50475.35,121090.66)	38.66(23.20,55.65)	38590,25(24611.08,54174.87)	17.60(11.23,24.71)	12271,043(75388.14,174278.16)	28.09(17.26,39.90)	
55-59 years	107468,78(65304.55,154848.89)	58.80(35.73,84.73)	53174,77(34650.78,74446.79)	28.25(18.41,39.55)	160643,55(100003.68,227816.72)	43.30(26.95,61.40)	
60-64 years	122942,81(72494.21,181602.10)	80.80(47.65,119.35)	73553,84(46859.62,105691.58)	45.86(29.22,65.90)	196496,65(120045.25,286684.58)	62.87(38.41,91.73)	
65-69 years	122479,00(68790.18,186115.28)	99.08(55.65,150.56)	90386,94(55265.77,131955.63)	66.97(40.95,97.77)	212865,94(124145.74,316495.17)	82.32(48.01,122.40)	
70-74 years	102725,24(58993.65,168119.43)	121.76(66.96,190.82)	95568,58(56707.88,142106.44)	96.55(57.29,143.57)	202843,82(115680.34,311884.36)	108.42(61.83,166.71)	
75-79 years	89153,41(43634.74,148448.03)	155.85(76.28,259.50)	100774,58(55712.47,157927.97)	144.28(79.76,226.10)	189927,99(993400.3,306927.54)	149.49(78.19,241.57)	
80-84	55007,27(21219.53,109798.34)	156.10(60.22,311.59)	80029,26(35019.61,145453.22)	162.71(71.20,295.73)	135036,53(55357.46,255673.45)	159.95(65.57,302.85)	
85-89	43796,30(17294.01,87111.93)	268.96(106.21,534.98)	74877,33(32650.28,138135.98)	275.31(120.05,507.90)	118673,63(49808.40,226289.42)	272.93(114.55,520.43)	
90-94	23446,56(9362.50,46051.14)	441.73(176.39,867.60)	55566,75(23327.51,101278.56)	481.11(201.98,876.89)	79013,31(32428.37,148039.41)	468.71(192.37,878.18)	
95+ years	8944,18(3459.99,17177.19)	700.77(271.09,1345.81)	28492,24(12004.65,51635.59)	814.79(343.30,1476.62)	37436,42(15393.95,68897.07)	784.30(322.51,1443.41)	
DALYs (Disability-Adjusted Life Years)							
		female		both		both	
	Counts	Age-standardized Rate (per 100,000)	Counts	Age-standardized Rate (per 100,000)	Counts	Age-standardized Rate (per 100,000)	Age-standardized Rate (per 100,000)
20-24 years	246765.61(47589.08,485767.39)	81.07(15.64,159.60)	138526.87(27478.53,271979.24)	46.84(9.29,91.95)	385292.49(74690.21,752847.22)	64.20(12.45,125.44)	
25-29 years	506121.30(114183.18,914178.19)	166.06(37.46,299.95)	230627.49(51970.06,412789.23)	76.70(17.28,137.28)	736748.79(169488.98,1322432.16)	121.68(27.99,218.41)	
30-34 years	961109.31(297662.30,171331.05)	317.02(98.18,565.13)	397594.47(126454.82,676797.73)	133.17(42.36,226.69)	1358703.78(424510.09,2370845.97)	225.80(70.55,394.00)	
35-39 years	1268484.65(759764.72,1869278.54)	465.43(278.77,685.87)	504064.31(322972.26,720774.21)	187.78(120.32,268.51)	1772548.96(1091886.32,2596086.54)	327.66(201.84,479.89)	
40-44 years	1669835.36(962611.92,25000370.28)	671.31(386.99,1005.20)	708951.67(420064.34,1044293.25)	289.72(171.67,426.77)	2378787.02(1410470.70,3507722.39)	482.08(285.84,710.87)	
45-49 years	2444370,72(1466513.91,3515253.70)	1025.44(615.22,1474.69)	1049968,00(662875.90,1470325.29)	445.98(281.56,624.53)	3494339,52(2108290.12,4932739.07)	737.51(444.97,1041.10)	
50-54 years	3187211,69(1916807.81,4585480.59)	1464.81(880.94,2107.43)	1479202,69(945004.91,2069323.59)	674.72(431.05,943.90)	4666414,38(2873606.40,6637337.22)	1068.28(657.85,1519.48)	
55-59 years	3562415,79(2160099.21,5150392.26)	1949.21(1181.92,2818.09)	1782809,60(1157953.30,2501681.27)	947.04(615.11,1328.91)	5345225,39(3328299.83,7609710.91)	1440.71(897.09,2051.07)	
60-64 years	3509779,31(2068296.82,5189207.65)	2306.72(1359.34,3410.48)	2117072,18(1344831.62,3035898.65)	1320.03(838.52,1892.93)	5626851,49(3428659.44,8182552.67)	1800.39(1097.05,2618.12)	
65-69 years	2956777,92(1669384.60,4486544.85)	2391.89(1350.45,3629.40)	2194380,05(1347654.79,3225674.70)	1625.87(998.51,2389.97)	5151157,97(3005105.37,7687314.67)	1992.07(1162.14,2972.85)	
70-74 years	2127332,70(1165515.02,3312376.16)	2414.58(1322.89,3759.64)	1898229,65(1127383.78,2814997.26)	1917.72(1138.96,2843.91)	4025562,35(2280475.47,6144127.74)	2151.70(1218.94,3284.10)	
75-79 years	1400334,13(688597.72,2339817.82)	2447.92(1203.74,4090.23)	1576978,28(869833.37,2472266.34)	2257.71(1245.31,3539.46)	2977312,41(1549811.90,4814993.43)	2343.35(1219.81,3789.73)	

Table 4 (continued)

	DALYs (Disability-Adjusted Life Years)					
	male		female		both	
	Counts	Age-standardized Rate (per 100,000)	Counts	Age-standardized Rate (per 100,000)	Counts	Age-standardized Rate (per 100,000)
80-84	661080.93(254692.71,1309184.57)	1876.06(722.78,3715.29)	956275.60(413752.78,1734018.46)	1944.26(841.22,3525.53)	1617356.53(661584.34,3055248.24)	1915.79(783.66,3619.01)
85-89	400267.04(158394.77,790029.43)	2458.14(972.74,4851.78)	680310.69(297478.63,1252521.00)	2501.36(1093.77,4605.26)	1080577.73(448504.50,2048983.92)	2485.18(1031.50,4712.38)
90-94	165698.46(66514.35,323851.35)	3121.74(1253.12,6101.33)	389570.20(166234.89,707076.73)	3372.99(1439.30,6122.04)	555268.66(226671.47,1036708.63)	3293.88(1344.63,6149.81)
95+ years	47579.80(18447.96,90775.44)	3727.83(1445.38,7112.16)	150045.46(63180.72,271793.53)	4290.85(1806.78,7772.49)	197625.26(81429.09,362201.58)	4140.30(1705.96,7588.22)

IHD, which take into account local health systems, socio-economic circumstances, and lifestyle patterns [20]. Furthermore, the escalating trends in low- and middle-income regions emphasize the need for targeted focus on preventive healthcare, public awareness, and more effective management of risk factors such as diet, physical activity, and tobacco use [21].

Our analysis of the burden of IHD in relation to HBMI shows notable age-related differences, with a substantial increase in both deaths and DALYs with increasing age. This is similar to a previous study [22]. The most significant burden is observed in the 60–69 age group, and it sharply escalates in individuals over the age of 95. This pattern highlights the importance of age as a key determinant of the prevalence and severity of IHD, while also emphasizing the need for healthcare strategies that are tailored to specific age groups, especially older populations [23].

Men of all ages bear a higher burden of IHD than women, as reflected in both mortality and DALYs. This is similar to previous studies [24, 25]. This gender difference is further highlighted by the distinct trends seen in age-standardized rates, as indicated by the EAPC. The EAPC for male age-standardized death rates stand at -0.36, suggesting a slower decline compared to females (-0.97). Similarly, the EAPC for male age-standardized DALY rates is -0.11, contrasting with -0.65 for females. These disparities in IHD burden between genders are likely influenced by a complex interplay of biological, lifestyle, and socio-economic factors, as well as differential access to healthcare and health-seeking behaviors [23].

Our study highlights the urgent need for comprehensive public health strategies and medical interventions tailored to the specific challenges of IHD in different age groups and genders [26]. The findings highlight an important avenue for future research aimed at understanding the factors contributing to gender differences in IHD [27]. Such knowledge is essential for the development of more precise, targeted prevention and treatment approaches, particularly those designed to address the challenges posed by ageing demographics and the specific health needs of different sexes.

Our analysis revealed differences in deaths and DALYs from IHD attributable to HBMI between SDI regions. In particular, a decrease in these indicators was observed in high and high-middle SDI regions, with significantly lower values in high SDI regions. This finding is similar to previous studies [28]. This trend suggests that regions with higher socio-economic status are increasingly prioritizing health issues related to HBMI and implementing effective strategies to prevent

and control IHD. In contrast, middle and low-middle SDI regions experienced a worsening trend in IHD burden due to HBMI, exacerbated by limited resources and inadequate healthcare infrastructure for widespread prevention and treatment of the disease. This disparity is particularly evident in rapidly growing and aging populations in these regions, emphasizing the urgent need for improved primary preventive efforts on a global scale [1].

Great efforts should be made to promote the prevention of obesity and its progression to IHD. Intake of simple sugars, complex carbohydrates and total calories should be reduced. Community prevention programmes should be implemented to improve relevant knowledge among the population in countries with a high IHD burden. Countries with a low SDI and an ageing population should promote healthcare. Possible government interventions could include mandatory calorie/nutrient menu labelling and regulation of food ingredients, as well as control of advertising and certain forms of taxation on beverages and foods [1].

In this study, we employed BMI as the primary indicator of body size [29]. Due to the change in the definition of obesity, there are limitations to the use of BMI as a measure of body size. In addition, BMI is a straightforward measure, it does have certain limitations, such as its inability to differentiate between lean body mass and adipose tissue. Nevertheless, BMI continues to be a valuable predictor of CVD and has demonstrated a non-linear association with mortality risk [30]. Other anthropometric measurements have also been investigated in relation to obesity-related outcomes, each offering distinct advantages and limitations.

The disparities in disease burden between developing and developed countries necessitate additional investigation. For the purposes of this paper, the geographical breakdown of the data is primarily based on the SDI classification of countries, and urban-rural and race data are missing, so it is not possible to explore further the differences in disease burden between factors such as urban-rural and race. Our study, which encompasses the largest epidemiological dataset on IHD to date, sought to accurately measure the burden of IHD caused by HBMI. Despite encountering challenges related to limited availability of high-quality epidemiological data and substantial regional variation, we employed standardized methodological criteria over a span of three decades to mitigate the impact of these limitations. We are confident that this approach has ensured a uniform quality of data across the included studies, thus offering a dependable overview of the global burden of IHD associated with HBMI.

Conclusion

Our findings showed that, globally, from 1990 to 2019, the disease burden of IHD in both deaths and DALYs attributable to HBMI have more than doubled in both sexes. However, after age-standardizing the HBMI-related DALY rates and Deaths rate, a decrease trend were noted in both sexes. This increasing trend emphasizes the utmost importance of prioritizing efforts to prevent overweight and obesity in all age groups, highlighting a significant global challenge in identifying the underlying causes of disparities and changing patterns in IHD burden. This is particularly pertinent when considering countries with different income levels. The insights gained from this study play a crucial role in guiding the development, implementation, and assessment of effective strategies aimed at preventing, managing, and rehabilitating IHD across diverse national contexts and population groups. Not only do these findings contribute to a broader understanding of IHD epidemiology, but they also provide a valuable framework for tailoring public health initiatives to mitigate the global impact of HBMI on IHD.

Abbreviations

IHD	ischemic heart disease
GBD	Global Burden of Disease
DALYs	disability-adjusted life years
EAPCs	estimated annual percentage changes
SDI	Socio-Demographic Index
CVD	Cardiovascular diseases
HBMI	high body mass index
ASRs	age-standardized rates
ICD	International Classification of Diseases

Supplementary Information

The online version contains supplementary material available at <https://doi.org/10.1186/s12872-024-04136-y>.

Supplementary Material 1.

Supplementary Material 2.

Acknowledgements

We thank all authors for their contributions to the article and the GBD collaborators.

Authors' contributions

W.Y.: Conceptualization, Methodology, and Data curation. W.Y. and Y.H.: Writing-Original draft preparation; Y.H.: Writing- Reviewing and Editing. All authors read and approved the final manuscript.

Funding

This study was funded by the Yuyao Science and Technology Bureau (grant number 2023YYB05).

Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

This study was based on a publicly available databases and does not require ethical approval. All of the participants or their legal representatives provided written informed consent during recruitment.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

Received: 7 March 2024 Accepted: 20 August 2024

Published online: 11 September 2024

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