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Global burden of osteoarthritis among postmenopausal women in 204 countries and territories: a systematic analysis for the Global Burden of Disease Study 2021

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ABSTRACT

Objectives Our study aimed to provide global burden and temporal trends in the incidence, prevalence, and disability-adjusted life-years (DALYs) of osteoarthritis (OA) among postmenopausal women from 1990 to 2021.

Methods The study employed data from the Global Burden of Disease (GBD) Study 2021. Four subtypes of OA affecting the hip, knee, hand, and other joints among postmenopausal women were included. Age-standardised rates (ASRs) were derived with reference to the global age standard, and temporal patterns were scrutinised through estimated annual percentage change (EAPC) assessments. The impact of age, body mass index (BMI), and Socio-demographic Index (SDI) were all considered.

Results From 1990 to 2021, there were more than 1.3-fold increases in OA incidence, prevalence, and DALYs among postmenopausal women globally, with EAPCs of 0.211, 0.356, and 0.395, respectively. Knee OA carried the heaviest burden, while hip OA bore the least. Higher SDI regions had higher burden, and inequalities linked to SDI among countries had intensified over time. East Asia and high-income Asia Pacific experienced the most substantial increments in OA burden. High BMI significantly influences the burden of OA, especially in countries within high, high-middle, and middle SDI, where DALYs attributed to high BMI exceed 20%.

Conclusions The burden of OA among postmenopausal women continues to escalate, highlighting its significant impact on the global health of postmenopausal women. Necessarily, effective monitoring and management of risk factors, targeted lifestyle adjustments for BMI, and policy interventions accounting for demographic disparities are required to ease OA in postmenopausal women.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Osteoarthritis (OA) is a prevalent, progressively developing joint disorder that notably affects middle-aged and older individuals, substantially impacting their quality of life and ability to perform daily activities. Postmenopausal women are considered a high-risk group for OA due to physiological changes associated with menopause, including hormonal fluctuations, as well as other factors such as age-related joint degeneration and heightened pain sensitivity. This study addressed a critical gap by providing a comprehensive global analysis of the epidemiological characteristics and disease burden of OA in postmenopausal women, an area that has been underexplored to date.

INTRODUCTION

With the acceleration of the ageing demographic shift globally, non-communicable chronic diseases pose an increasingly prominent threat to public health. Osteoarthritis (OA), one of the most common chronic joint diseases, is primarily characterised by the deterioration and damage of joint cartilage, accompanied by bony remodelling, joint dysfunction, and chronic pain.[1–3] Affected individuals commonly grapple with joint discomfort and functional restrictions, which can progressively lead to disability.[4 5] In 2020, an estimated 595 million people worldwide were afflicted with OA, comprising 7.6% of the global population.[6] It ranked among the top 10 causes of years lived with disability (YLD) in adults aged 70 and older, affecting approximately one-third of the adult population in that age bracket, and ranked 14th in terms of age-standardised YLDs across all age groups.[6 7] Moreover, OA typically imposes a considerable strain on healthcare systems and financial resources. Research indicated that the societal costs of OA account for 1% to 2.5% of the gross national product (GDP) in the countries surveyed.[8] OA resulted in wage losses amounting to $65 billion and

WHAT THIS STUDY ADDS

⇒ Globally, the postmenopausal women exhibited 14,258,581 incident cases, 278,568,950 prevalent cases, and 9,944,716 disability-adjusted life-years (DALYs) attributed to osteoarthritis (OA), representing substantial increases of 133.1%, 139.8%, and 141.9% since 1990, respectively.

⇒ The temporal trends of age-standardized rates of incidence, prevalence, and DALYs among postmenopausal women have shown a worldwide rise across all Socio-demographic Index (SDI) categories and most regions (except Central Asia). Higher SDI regions witnessed a greater burden of OA among postmenopausal women, with inequalities related to SDI across countries intensifying over time, particularly as East Asia and high-income Asia Pacific underwent the most significant increases in OA burden among postmenopausal women.

⇒ In nations grouped under the high, high-middle, and middle SDI quintiles, over 20% of DALYs for OA among postmenopausal women are attributed to elevated body mass index (BMI).

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ The burden of OA among postmenopausal women continues to escalate, highlighting its significant impact on the global health of postmenopausal women. There is an urgent need for proactive measures to rigorously monitor and manage risk factors, with a particular emphasis on promoting lifestyle adjustments aimed at controlling BMI. Additionally, policies should be implemented that take into account socio-demographic disparities, to effectively alleviate the burden of OA in postmenopausal women.

direct medical costs exceeded $100 billion in the United States.[5]

The incidence of OA increased with age, and the prevalence of OA was higher in women compared with men.[6] OA incidence rises in women during the menopausal transition,[9 10] making it a highly prevalent condition among postmenopausal women, with 44% of participants in the Women's Health Initiative (WHI) aged 50 to 79 reporting OA.[11] Thus, postmenopausal women constitute a unique population with a heightened risk for OA. Among the modifiable risk factors, high body mass index (BMI) is particularly notable, as it contributes to mechanical stress on weight-bearing joints and systemic inflammation, thereby accelerating OA progression.[12]

Despite these concerns, there remains a dearth of research specifically addressing OA in this particular demographic, especially on a global scale. The Global Burden of Disease (GBD) 2021 study collected and analysed data from 204 countries and territories, comprehensively assessing health conditions globally, covering mortality to various health states.[13 14] Among its analytical tools, the GBD framework incorporates the Socio-Demographic Index (SDI), a composite measure that evaluates levels of development based on income per capita, average years of schooling, and fertility rates for those under 25 years old.[15] SDI values, ranging from 0 to 1 with higher values indicating more advanced development,[13] may provide critical insights into the varying burden of diseases like OA across regions and income levels.

The GBD 2021 incorporates four particular subtypes of OA, including those affecting the hip, knee, hand, and other joints. The GBD 2021 utilised the disability-adjusted life years (DALYs) as a measure, which quantifies the gap between the current health status and the hypothetical ideal of full health over a lifespan.[15] This research framework offers an unprecedented opportunity to deepen the understanding of the distribution patterns, trends, and impacts of OA among postmenopausal women at a global level. Therefore, this study comprehensively evaluated the disease burden of OA among postmenopausal women in 204 countries and territories globally. Our study specifically planned to: (1) comprehensively gather and analyse the global impact of OA on postmenopausal women; (2) discern population groups facing augmented risk, differentiated by OA classifications, varying age groups, and SDI tiers; and (3) assess the attributable proportion of high BMI for the development of OA.

METHODS

Data sources

All data analysed in this study stemmed from the GBD 2021, which supplied the latest epidemiological estimates for health loss due to 371 diseases from 1990 to 2021 across 204 countries and territories, inclusive of prevalence, disease severity, and mortality rates. These metrics collectively form a holistic assessment of the disease burden. All such data is freely accessible via the Global Health Data website, with detailed information on data, methodologies, and statistical models available in prior publications.[14] Against this backdrop, this study outlined the methodologies employed in estimating the health burden of OA among postmenopausal women. Post-menopausal status was approximated using an age cut-off of 55 years and older, consistent with prior epidemiological studies utilising similar data sources.[16–18] This approach offers a pragmatic solution in the absence of direct data on menopausal status in GBD but may underrepresent individuals who experience earlier menopause. When conducting age-specific analyses, this study used men of the same age as postmenopausal women and younger women aged 35–54 years as control groups.

Case definition

The reference definition for OA cases in the GBD framework is based on symptomatic OA radiologically confirmed as meeting Kellgren-Lawrence grading criteria of 2 to 4. In the GBD 2021 study, the main sources of input data for the hip and knee OA models were cross-sectional, population-based surveys conducted worldwide and state-level US insurance claims data. These claims used International Classification of Diseases (ICD)−10 codes M16 (hip) and M17 (knee). GBD 2019 introduced two additional OA sites: the hand (M18) and other joints (M19), retaining these classifications in GBD 2021.[13]

Global/regional socio-demographic profiles

The SDI and regional classifications from GBD 2021 were used to analyse variations in OA burden. SDI categorises 204 countries and territories into five quintiles—high, high-middle, middle, low-middle, and low SDI—based on socioeconomic and demographic factors, providing a standardised framework for comparing health outcomes. For regional analyses, GBD 2021 further divided these countries and territories into 21 regions based on geographic proximity and cultural similarities. This combination of SDI and regional classifications provided a nuanced framework for analysing and interpreting the global distribution of OA burden, highlighting differences attributable to socioeconomic and geographic factors. Additional details regarding SDI and regional definitions can be found in prior publications.[13–15]

Risk factors for OA

High BMI is the sole risk factor for OA investigated in the GBD dataset. In the GBD 2021, high BMI is defined as a measurement exceeding 20 to 23 kg/m² for adults aged 20 and older, which reflects the theoretical minimum risk exposure level (TMREL) as determined by the GBD system.[15] The inclusion of high BMI as an OA risk factor is supported by a rigorous systematic review of longitudinal cohort studies and the application of stringent causal criteria to establish its association with OA. To estimate the relationship between high BMI and OA risk, GBD 2021 employed Mendelian Randomization-Bayesian Regression Trees (MR-BRT), a statistical modelling approach designed to analyse non-linear dose-response associations. Details of this approach are provided in prior GBD publications.[15 19]

Statistical analysis

Each DALY represents the loss of one full year of healthy life, calculated by combining years of life lost (YLL) and YLD within a population in the GBD dataset.[15] Based on the global population age standard delineated within the GBD 2021 report, age-standardised rates (ASRs) for incidence, prevalence, and DALYs of OA among postmenopausal women, along with their corresponding 95% uncertainty intervals (UIs), were calculated using the formula: $ASR=\frac{\sum_{k=1}^{n} I_k T_k}{\sum_{k=1}^{n} T_k}$, where I_k represents the proportion of the population in a specific age group, and T_k represents the quantity or weighting of the comparator standard population within the identical age group.[13 20] This approach ensures comparability across regions and over time, mitigating biases due to differing age structures.

The dynamic trends in OA prevalence, incidence, and DALYs from 1990 to 2021 were assessed using the estimated annual percentage change (EAPC) alongside its 95% confidence interval (CI), which were calculated according to the following formula: $y = \alpha + \beta x + \varepsilon$ and $EAPC=100 \times (e^{\beta} - 1)$, where y and x were ln (ASR) and calendar year, respectively.[21 22] An EAPC>0 indicates an increasing trend in ASRs over the past years, whereas an EAPC<0 suggests a declining trend. Furthermore, if the 95% CI of the EAPC includes 0, no significant change is inferred.[23] We investigated the relationships between the SDI of the 204 countries and territories and ASRs as well as the proportions of DALYs attributed to high BMI according to the methods described in previous studies.[7 13 19] In terms of age strata, we categorised postmenopausal women into specific age groups (55–59, 60–64, 65–69, 70–74, 75–79, 80–84, 85–89, 90–94, and 95+years) to better understand how OA burden varies with age within this demographic. SDI was categorised into five quintiles: high, high-middle, middle, low-middle, and low SDI. We performed stratified analyses to assess the interaction between BMI and SDI on OA risk, allowing us to explore how the relationship between BMI and OA burden differs across regions and income levels.

All ASRs in this study were calculated per 100 000 population. Data cleaning, computations, and graphical representations were performed utilising R programming (v4.4.1).

RESULTS

Global burden of OA among postmenopausal women

This study showed that in postmenopausal women, there were approximately 14 258 581 (95% UI: 12,226,984–16,599,583) incident cases of hip, knee, hand and other OA, with an ASR of 1812.99 (95% UI: 1554.67–2110.65) per 100 000 population in 2021, and the EAPC illustrated an increasing trend from 1990 to 2021 (EAPC=0.211, 95% CI: 0.196 to 0.226) (table 1). Globally, OA prevalence in postmenopausal women was 278 568 950 (95% UI: 246,376,337–309,958,505), with an ASR of 35 420.24 (95% UI: 31 326.92–39 411.44) per 100 000 population, and an EAPC of 0.356 (95% CI: 0.331 to 0.381) from 1990 to 2021. The estimated DALYs attributed to OA were 9 944 716 (95% UI: 4,810,253–20,101,408), with an ASR of 1264.48 (95% UI: 611.63–2555.91) DALYs per 100 000 population, showing an upward trend over time (EAPC=0.395, 95% CI: 0.362 to 0.429) since 1990.

Among the different types of OA in postmenopausal women, knee OA had the highest ASRs for incidence (1192.48, 95% UI: 976.96–1452.71), prevalence (35,420.24, 95% UI: 31 326.92–39 411.44), and DALYs (1264.48, 95% UI: 611.63–2555.91) per 100 000 population (figure 1, online supplemental figure S1, S2), and (online supplemental table S1). In contrast, hip OA had the lowest ASRs for these measures, with incidence (70.19, 95% UI: 50.78–98.09), prevalence (1889.27, 95% UI: 1428.43–2409.34), and DALYs (58.78, 95% UI: 28.01–119.27) per 100 000 population (figure 1, online supplemental figure S1, S2), and (online supplemental table S2). The hand OA and other OA followed as the second and third highest in terms of these rates (figure 1, online supplemental figure S1, S2), and (online supplemental table S3, S4). The EAPC showed a positive association with the age-standardised DALYs for other types of OA

Table 1 Number and age-standardised rates of incidence, prevalence and DALYs in 2021 for osteoarthritis in postmenopausal women, and their temporal trends from 1990, by GBD region

	Incidence (2021)		Prevalence (2021)		DALYs (2021)	
Region	Number (95% UI)	ASR per 100 000 (95% UI)	Number (95% UI)	ASR per 100 000 (95% UI)	Number (95% UI)	ASR per 100 000 (95% UI)
Global	14258581 (12226984–16599583)	1812.99 (1554.67–2110.65)	278568950 (246376337–309958505)	35 420.24 (31 326.92–39 411.44)	9944716 (4810253–20101408)	1264.48 (611.63–2555.91)
Andean Latin America	103530 (88 198–121 120)	2001.47 (1705.06–2341.50)	1941554 (1716197–2165539)	37 534.40 (33 177.76–41 864.52)	70321 (33 840–142 134)	1359.46 (654.20–2747.75)
Australasia	95 173 (82 158–110 076)	2054.27 (1773.34–2375.96)	1908197 (1710663–2112593)	41 187.71 (36 924.02–45 599.52)	70 135 (34 432–141 935)	1513.84 (743.20–3063.62)
Caribbean	91 792 (78 258–107 709)	1869.65 (1593.99–2193.85)	1728354 (1523599–1924277)	35 203.59 (31 033.09–39 194.22)	111 515 (52 890–223 306)	1261.58 (608.07–2554.06)
Central Asia	147 625 (122 538–178 475)	1808.52 (1501.18–2186.45)	3094487 (2606598–3623119)	37 909.73 (31 932.74–44 385.86)	272 189 (132 661–551 943)	1366.14 (647.95–2735.67)
Central Europe	354 564 (303 499–409 287)	1700.90 (1455.93–1963.42)	7558470 (6598113–8566963)	36 259.22 (31 652.23–41 097.13)	295 800 (143 162–595 820)	1305.74 (636.40–2647.76)
Central Latin America	454 037 (384 407–534 246)	1964.78 (1663.46–2311.87)	8256941 (7254874–9233879)	35 730.67 (31 394.38–39 958.23)	47 221 (22 911–95 521)	1280.03 (619.51–2578.32)
Central Sub-Saharan Africa	80 000 (66 591–95 687)	1632.26 (1358.67–1952.34)	1354490 (1183209–1533822)	27 636.05 (24 141.36–31 295.01)	2471 451 (1184881–5005 179)	963.46 (467.46–1948.93)
East Asia	3532229 (3011259–4167264)	1744.92 (1487.56–2058.63)	70442420 (62208902–78631335)	34 798.62 (30 731.25–38 843.95)	535 374 (259 456–1084 514)	1220.90 (585.33–2472.56)
Eastern Europe	694 028 (593 269–810 213)	1818.74 (1554.69–2123.21)	14820169 (12800242–16812266)	38 837.03 (33 543.71–44 057.43)	134 084 (65 324–271 070)	1402.98 (679.92–2842.03)
Eastern Sub-Saharan Africa	228 814 (192 372–269 032)	1616.09 (1358.70–1900.15)	3853457 (3370796–4322543)	27 216.61 (23 807.62–30 529.72)	724 041 (348 297–1470 986)	947.02 (461.38–1914.55)
High-income Asia Pacific	858 690 (753 713–977 149)	2251.08 (1975.88–2561.62)	19029951 (17209871–20877208)	49 887.57 (45 116.18–54 730.21)	940 385 (465 151–1906 076)	1898.09 (913.07–3856.23)
High-income North America	1260970 (1085017–1465692)	2093.11 (1801.04–2432.94)	25590321 (22896908–28280648)	42 477.95 (38 007.09–46 943.69)	394 246 (193 487–797 549)	1560.97 (772.11–3163.94)
North Africa and Middle East	639 609 (532 152–761 951)	1698.87 (1413.45–2023.82)	11306815 (9892436–12646338)	30 032.11 (26 275.36–33 590.02)	5872 (2799–11856)	1047.16 (513.92–2118.37)
Oceania	9360 (7744–11298)	1592.32 (1317.43–1921.93)	169 554 (148 829–190 599)	28 844.21 (25 318.45–32 424.38)	1439101 (700 288–2889 767)	998.92 (476.12–2016.91)
South Asia	2231967 (1877372–2635484)	1762.85 (1482.78–2081.56)	41262218 (36052165–46369973)	32 589.69 (28 474.69–36 623.90)	563 932 (271 080–1132 684)	1136.63 (553.10–2282.39)
Southeast Asia	880 921 (739 646–1038 294)	1436.57 (1206.18–1693.20)	16219042 (14236952–18272339)	26 449.32 (23 217.01–29 797.74)	96 310 (47 275–193 201)	919.64 (442.07–1847.13)
Southern Latin America	162 593 (139 682–188 877)	1998.09 (1716.54–2321.10)	3186105 (2856656–3529123)	39 153.82 (35 105.24–43 369.14)	116 225 (56 795–234 403)	1428.29 (697.95–2880.56)
Southern Sub-Saharan Africa	103 103 (87 097–121 120)	1810.59 (1529.52–2127.00)	1846627 (1601 903–2098 561)	32 428.67 (28 131.07–36 852.91)	64 942 (31 806–130 140)	1140.46 (558.54–2285.39)
Tropical Latin America	491 806 (418 381–576 441)	2021.48 (1719.68–2369.36)	8830129 (7779299–9814910)	36 294.72 (31 975.46–40 342.49)	313 979 (153 393–636 491)	1290.56 (630.50–2616.18)
Western Europe	1547832 (1353204–1768052)	1930.38 (1687.65–2205.03)	31323862 (28147783–34466499)	39 065.65 (35 104.60–42 985.01)	1142890 (560 009–2319 044)	1425.36 (698.42–2892.20)
Western Sub-Saharan Africa	289 938 (239 558–345 766)	1697.01 (1402.13–2023.77)	4845789 (4242396–5451335)	28 362.40 (24 830.74–31 906.66)	169 073 (82 718–340 560)	989.58 (484.15–1993.30)

ASR, age standardised rate; CI, confidence interval; DALYs, disability-adjusted life years; OA, osteoarthritis; UI, uncertainty interval.

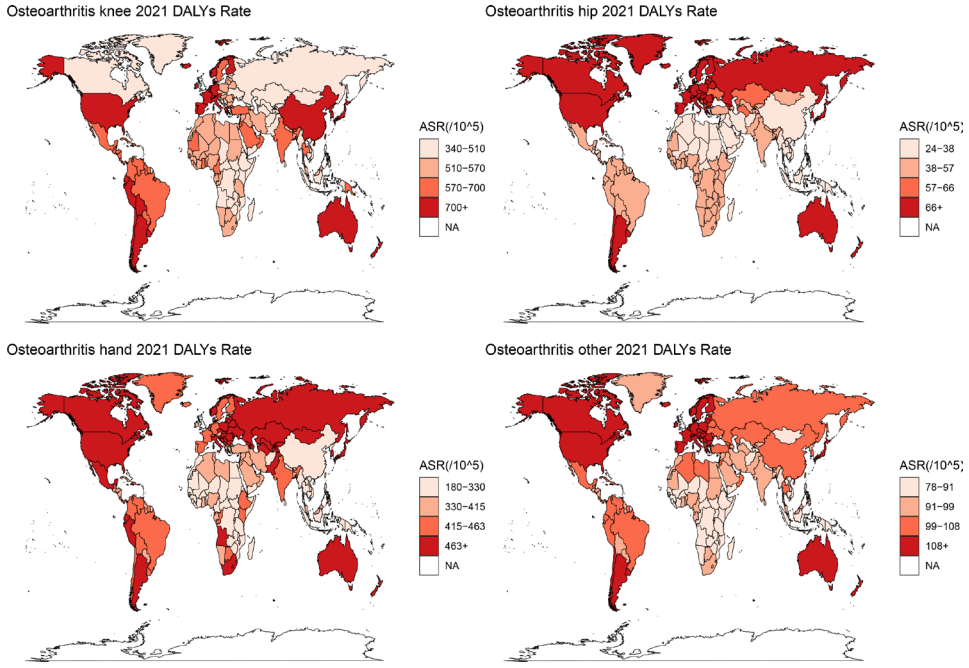

Figure 1 Age-standardised DALY rates for osteoarthritis among postmenopausal women in 204 countries and territories in 2021.

among postmenopausal women (online supplemental figure S3).

Burden of OA in postmenopausal women at the regional and national level

Among the 21 GBD regions, high-income Asia Pacific exhibited the highest age-standardised incidence, prevalence and DALY rates for knee OA of 1572.63 (95% UI: 1325.51–1837.27), 33 944.9 (95% UI: 29 400.83–38 894.33), 1076.45 (95% UI: 525.94–2165.08) per 100 000 population, respectively. Conversely, Central Asia reported the lowest ASRs for incidence (858.74, 95% UI: 699.28–1056.55), prevalence (12,284.43, 95% UI: 10 425.75–14 335.17), and DALYs (390.09, 95% UI: 191.77–768.41) per 100 000 population (figure 1, online supplemental figure S1, S2), and (online supplemental table S1). Southeast Asia saw the fastest increase in the incidence ASR (EAPC=0.374, 95% CI: 0.358 to 0.390), while East Asia had the most rapid rise in prevalence (EAPC=0.505, 95% CI: 0.416 to 0.595) and DALY rates (EAPC=0.494, 95% CI: 0.403 to 0.586) for knee OA. Among 204 countries and territories, the Maldives, Thailand, and Equatorial Guinea had the fastest growing age-standardised prevalence and DALY rates for knee OA from 1990 to 2021, while the United Arab Emirates, Oman, and Saudi Arabia had the most substantial increases in incidence ASRs (online supplemental table S5).

Regarding hip OA in postmenopausal women, East Asia documented the lowest ASRs for incidence (41.82, 95% UI: 30.01–59.39), prevalence (984.29, 95% UI: 744.17–1276.81), and DALYs (30.93, 95% UI: 14.23–62.01) per 100 000 population. High-income North America presented the highest ASRs for incidence (146.48, 95% UI: 98.18–212.86), prevalence (4497.12, 95% UI: 3363.85–5759.40), and DALYs (138.5, 95% UI: 66.84–278.70) per 100 000 population (figure 1, online supplemental figure S1, S2), and (online supplemental table S2). East Asia underwent the swiftest rise in age-standardised incidence (EAPC=1.289, 95% CI: 1.178 to 1.399), prevalence (EAPC=1.187, 95% CI: 1.09 to 1.284) and DALY (EAPC=1.163, 95% CI: 1.067 to 1.259) rates between 1990 and 2021. Across 204 countries and territories, Sweden, Equatorial Guinea, and Greece experienced the biggest rises in knee OA prevalence and DALY rates from 1990 to 2021; and Sweden, China, and Equatorial Guinea experienced the most substantial rises in the age-standardised incidence rates (online supplemental table S6).

For hand OA in postmenopausal women, Central Asia displayed the highest ASRs for incidence (726.66, 95% UI: 489.51–1063.36), prevalence (25,958.61, 95% UI: 19 250.75–33 016.73), and DALYs (823.91, 95% UI: 363.23–1694.17) per 100 000 population, while Oceania presented the lowest ASRs for incidence (308.93, 95% UI: 209.48–454.00), prevalence (7975.52, 95% UI: 5833.17–10 511.51), and DALYs (250.99, 95% UI: 114.07–514.39) per 100 000 population (figure 1, online supplemental figure S1, S2), and (online supplemental table S3). The fastest increases in incidence (EAPC=2.044, 95% CI: 1.676 to 2.412), prevalence (EAPC=2.454, 95% CI: 2.132 to 2.776), and DALYs (EAPC=2.441, 95% CI: 2.118 to 2.764) were observed in East Asia from 1990 to 2021. Among 204 countries and territories, Equatorial Guinea, China, and Timor-Leste showed the largest increases in prevalence and DALYs, while China, Equatorial Guinea, and Mongolia experienced the largest rises in incidence (online supplemental table S7).

For other OA in postmenopausal women, Central Sub-Saharan Africa demonstrated the lowest ASRs for incidence (124.25, 95% UI: 89.95–165.37), prevalence (2645.44, 95% UI: 2020.14–3550.01), and DALYs (83.28, 95% UI: 37.31–177.49) per 100 000 population. In contrast, North Africa and Middle East presented the highest age-standardised incidence rate of 134.96 (95% UI: 98.85–178.79) per 100 000 population, while Australasia recorded the highest ASRs for prevalence 3821.87 (95% UI: 2948.1–4941.86) and DALYs 119.54 (95% UI: 55.99–254.80) per 100 000 population, respectively (figure 1, online supplemental figure S1, S2), and (online supplemental table S4). Moreover, Australasia showed the fastest rise in age-standardised incidence rates (EAPC=0.14, 95% CI: 0.121 to 0.158), while high-income Asia Pacific presented the fastest increases in age-standardised prevalence (EAPC=0.630, 95% CI: 0.614 to 0.646) and DALY (EAPC=0.581, 95% CI: 0.565 to 0.597) rates. Across 204 countries and territories, Maldives, Japan, and Lebanon demonstrated the most rapid increases in age-standardised prevalence and DALY rates from 1990 to 2021, while Oman, United Arab Emirates, and Saudi Arabia presented the fastest increases in age-standardised incidence (online supplemental table S8).

Burden of OA in postmenopausal women by age

Comparisons with younger women aged 35–54 years revealed that, for all four OA subtypes (knee, hip, hand, and other), DALYs in postmenopausal women were consistently higher (figure 2). The global ASRs of OA prevalence and DALYs increased with age (ie, from 55 to 95+years) in postmenopausal women in 2021, except for knee OA (figure 2, online supplemental figure S4). For knee OA, DALYs peaked at 80–84 years before declining in older age groups. In contrast, for hip, hand, and other OA, ASRs for prevalence and DALYs showed steady increases across age groups, with the highest burden observed in the oldest group. The age-standardised incidence rates for both OA knee and other decreased with age, while hip and hand OA showed peak patterns, with OA hip reaching its highest incidence in the 60–64 age group, and hand OA peaking in the 55–59 age group, before both declining in older age groups (75–79 years) among postmenopausal women in 2021 (online supplemental figure S5). The 55–64 age group demonstrated relatively higher incidence for hand OA compared with other subtypes, potentially reflecting earlier onset in this population segment.

Additionally, ASRs of DALYs, incidence, and prevalence were compared between postmenopausal women and age-matched men. The results revealed that for hip and other OA, all ASRs were relatively similar between the two groups, with minimal differences. However, for hand and knee OA, postmenopausal women exhibited significantly higher values across all ASRs compared with men of the same age. Specifically, for hand OA in the 55–59 age group, DALYs among postmenopausal women were 1.8 times higher than those of age-matched men.

Generally, global ASRs of incidence, prevalence, and DALYs for all types of OA steadily increased in postmenopausal women across all age groups from 1990 to 2021 (figure 3, online supplemental figure S6, S7 and). Notably, hand and other OA showed the fastest growth among women aged 55–59 and 60–64 years in the past decade (online supplemental figure S6).

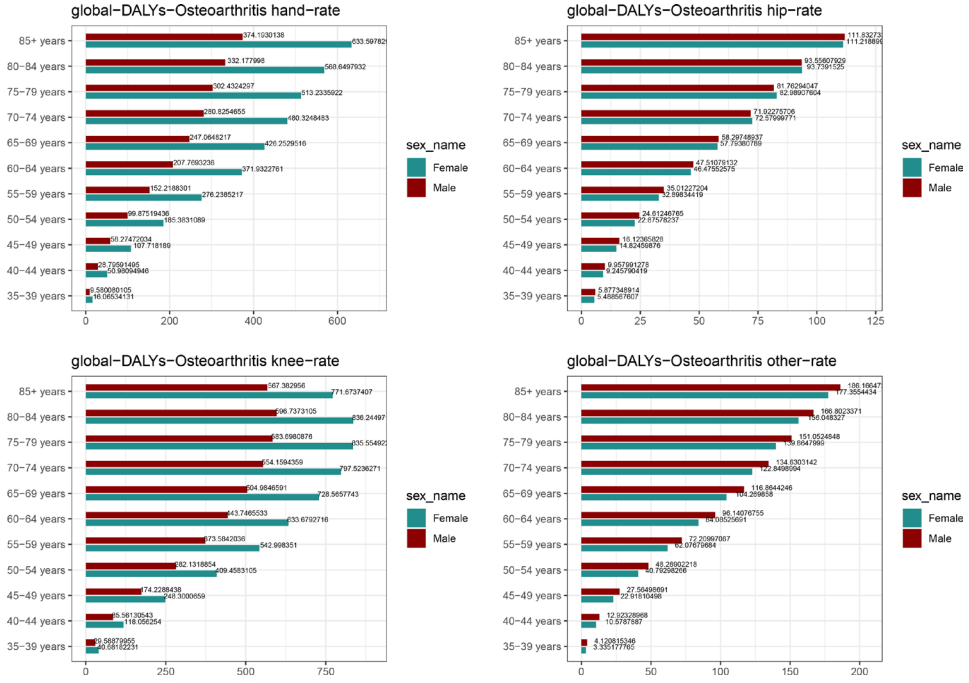

Figure 2 Global age-standardised DALY rates for osteoarthritis between postmenopausal women and age-matched men, as well as younger women (35–54 years), across age groups in 2021.

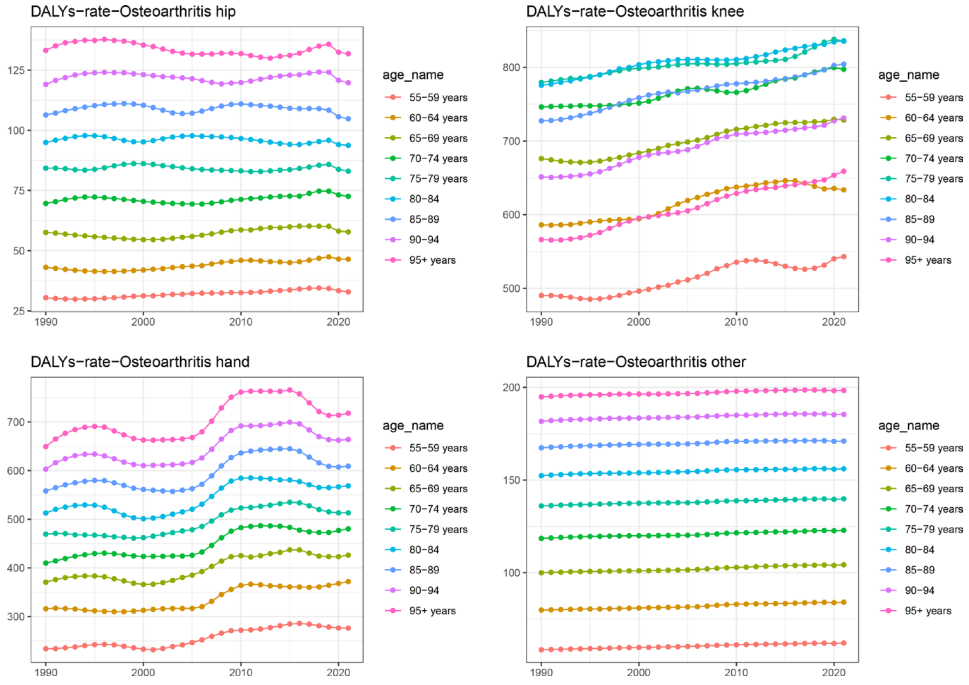

Figure 3 Temporal change in age-standardised DALYs of osteoarthritis among postmenopausal women across age groups from 1990 to 2021.

Burden of OA in postmenopausal women by SDI

There were roughly positive associations of SDI with the ASRs of hip, knee, hand and other OA in postmenopausal women (figure 4, online supplemental figure S8, S9). Regional variations around expected incidence rates increased progressively with increasing SDI. Age-standardised prevalence and DALY rates for high SDI locations clustered tightly around the expected rates based on SDI, suggesting a close association of SDI with prevalence and DALY rates of OA in postmenopausal women. There was some variation in the associations between the ASRs of other OA in postmenopausal women and SDI, with the ASRs of other OA beginning to decrease or maintain stability after the SDI reached 0.65 (figure 4, online supplemental figure S8, S9).

DALYs in OA attributable to high BMI

High BMI is the only risk factor for OA included in GBD, while other factors like age, sex, and socioeconomic status, although known to influence OA risk, were not incorporated as risk factors in GBD. Over the last three decades, DALYs attributable to high BMI among postmenopausal women showed a significant upward trend globally, across SDI gradients, and in most regions, with the exception of Central Asia (figure 5). Globally, DALYs attributed to high BMI among postmenopausal women increased by 1.23-fold globally, rising from 16.86% in 1990 to 20.76% in 2021. Regions with high, high-middle, and middle SDI quintiles had the highest proportions of BMI-related DALYs, exceeding 20%. Middle SDI nations saw the greatest increase in attributable DALYs (from 14.45% to 20.39%), while low-middle SDI nations had the largest percentage change (from 11.22% to 16.24%). By region, East Asia showed the most notable rise in BMI-attributable DALYs (from 14.04% to 22.87%). We further compared BMI-attributable OA DALYs between postmenopausal women and age-matched men. Globally,

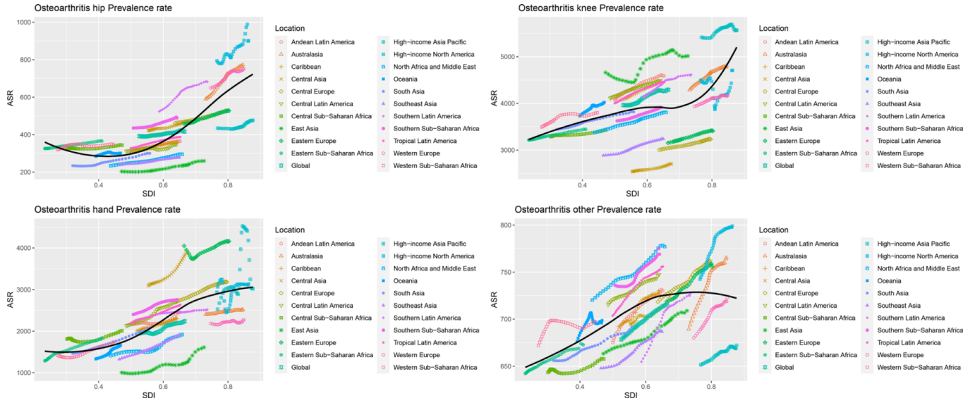

Figure 4 Age-standardised DALYs rates for osteoarthritis among postmenopausal women for 21GBD regions by SDI in 2021.

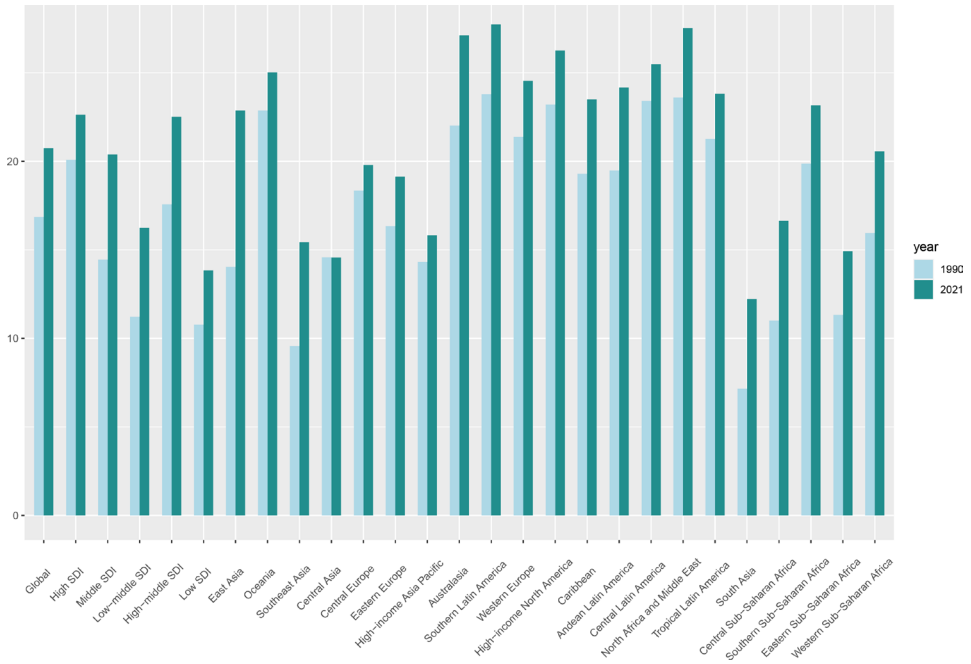

Figure 5 Proportions of DALYs attributable to high BMI for osteoarthritis among postmenopausal women for global, 5 SDI categories and 21 regions in 1990 and 2021.

across all SDI levels, and in most regions, women consistently exhibited higher BMI-related OA burdens than men (online supplemental figure S10).

DISCUSSION

Our study was the first to systematically assess the global burden of OA in postmenopausal women across 204 countries and territories from 1990 to 2021. Our findings revealed a significant increase in the global OA burden among the postmenopausal population, with 14 258 581 incident cases, 278 568 950 prevalent cases, and 9 944 716 DALYs attributed to OA in 2021, marking increases of 133.1%, 139.8%, and 141.9% since 1990, respectively. These findings align with trends observed in the GBD 2021, which reported a rise in OA incidence and prevalence across the entire population.[6] The observed global increase in OA burden underscored the importance of addressing this issue in public health efforts. This study also pioneered the burden of four OA subtypes, finding upward trends in ASRs across SDI regions. Notably, high SDI areas exhibited significantly greater incidence, prevalence, and DALY rates compared with other regions, with the exception of the age-standardised incidence rate of other OA.

As women age through menopause, there is a notable increase in both YLDs and the prevalence of OA, a trend consistently observed globally in the general population.[6] In the current study, the aggregate global DALY count for various forms of OA and the DALY rates spanning all ages showed a considerable rise when contrasted with relatively stable ASRs from 1990 to 2021, implying that the mounting OA burden owes significantly to population expansion and ageing. Menopause marks a pivotal period of physiological transition for women, characterised by a significant decline in oestrogen levels, which not only impacts skeletal health but is also directly linked to the function and stability of the joint system.[24] Although hormonal changes have been shown to be associated with the development of OA, the exact role of sex hormones remains unclear, and other factors, such as heightened pain sensitivity, may also contribute to the increased risk of OA in postmenopausal women. Other studies also showed higher joint pain and stiffness around menopause, doubling the risk compared with premenopausal women.[25 26] However, limited research has quantified OA burden specifically in menopausal populations, underscoring the need for further studies.

Meanwhile, our study revealed distinct patterns of OA burden across specific age groups in postmenopausal women. Basically, OA burden increases with age for all subtypes, likely due to cumulative joint degeneration and aging-related factors. OA knee and hand subtypes showed a disproportionately higher burden in postmenopausal women compared with age-matched men. On the other hand, this study showed a higher incidence of OA, particularly in knee OA, in younger postmenopausal women compared with older postmenopausal women. These relatively younger postmenopausal women, who are exposed to greater joint strain in their daily activities, seem more susceptible to OA symptoms. However, more evidence is needed to confirm their increased susceptibility compared with older cohorts. Interestingly, a peak in hand OA incidence was observed among postmenopausal women, with a notable spike around the age of 55, followed by a decline in later decades, which was consistent with prior research showing that hand OA risk peaks after

the typical menopausal age (55–60 years), stabilises, and then declines in older age groups.[27] Additionally, women aged 50–60 are 3.5 times more likely to develop hand OA compared with men of the same age in a country specific study,[27] highlighting a significant gender disparity. These findings suggest that interventions should be tailored to address the specific needs of different age groups within the postmenopausal population.

BMI is a leading risk factor for OA,[28 29] and our study highlighted its significant role in postmenopausal women. High BMI is the only modifiable risk factor for OA included in the GBD analysis.[6] Over the past three decades, there has been a consistent rise worldwide and each of the five SDI categories in DALYs attributed to high BMI among postmenopausal women with OA. In numerous regions, the DALYs resulting from high BMI exceed 20%, paralleling the global surge in obesity over the same period, particularly among women and their rising BMIs, which may partly account for the escalating OA burden.[13 30] Geographically, regions with high or high-middle SDI status, such as Latin America, Australia, Northern Africa, and the Middle East, had observed relatively higher DALYs from OA in postmenopausal women attributable to high BMI, consistent with higher obesity prevalence among women aged 55 and over in these locales.[30] Thus, weight management programmes tailored for postmenopausal women, such as community-based lifestyle interventions or clinical obesity management services, should be prioritised. Promoting regular physical activity can help reduce joint stress and improve overall health. These screenings could be complemented by educational initiatives to raise awareness among postmenopausal women about maintaining joint health, particularly through diet, exercise, and regular health check-ups. National health programmes should integrate these strategies to address the growing OA burden and improve quality of life in this vulnerable population. Meanwhile, low-middle SDI countries saw the fastest growth in BMI-related OA burden,[31] especially in East Asia,[32 33] due to rapid obesity increases. Some of these regions also face malnutrition challenges,[34] reflecting the multifaceted health issues present.

In this study, across 204 countries and territories, ASRs for OA among postmenopausal women were positively correlated with the SDI, aligning with earlier observations in the general population in 2020.[6] Across all SDI quintiles, with the exception of the incidence rate for other OA, ASRs for all OA subtypes increased with rising SDI. In high-income countries, postmenopausal women predominantly experienced the highest age-standardised incidence, prevalence, and DALY rates for various OA types, including knee OA in high-income Asia Pacific, hip OA in North America and Western Europe, and other OA in Australia. This may be attributed to the presence of ageing populations and robust healthcare infrastructure in these developed regions.[14 35] Positive EAPC-ASR correlations for other OA suggested faster ASR growth in some high-income nations, highlighting the need for targeted interventions.

Emphasis should not be limited to regions currently enduring the heaviest OA burden but also extended to those that have seen the most substantial increases over recent decades. Regions like East Asia and Asia-Pacific experienced the steepest OA burden increases from 1990 to 2021. Specifically, the analysis revealed that ASRs for hand OA in East Asia more than doubled, while hip OA rates surpassed a doubling, and ASRs of prevalence and DALYs for knee OA rose approximately by half. This trend in East Asia may be linked to rapid population ageing, increased workforce participation, and a surge in obesity rates due to urbanisation and changing lifestyles.[36 37] Conversely, the high burden observed in high-income Asia Pacific could be attributed to advanced healthcare systems with better diagnostic capabilities,[38] facilitating comprehensive identification and reporting of OA cases. Cultural differences, such as varying levels of physical activity and traditional dietary patterns, may also influence regional OA prevalence and progression. Nationally, in the context of large, middle-SDI countries, China has emerged as the nation with the highest OA incidence, particularly with hand OA increasing 2.5-fold over the past three decades. This escalation is potentially linked to population ageing, workforce participation, and imbalanced healthcare resources as a representative of East Asian countries.[35 39]

Our study was subject to several limitations. First, there were regional variations in data quality, and data from low-income countries were often scarce, which affected the precision of global OA burden estimates. Underreporting of OA cases, particularly in regions with limited healthcare infrastructure, may lead to underestimation of the true disease burden. The reliance on ICD-10 codes to identify OA cases primarily captured diagnosed, severe cases and will miss milder or undiagnosed cases. Furthermore, the use of a 55 year cut-off to define menopause will reduce sensitivity, particularly for women who experience menopause at younger ages, and will not fully account for variations in menopausal timing across different populations and ethnic groups. By using a 55 year threshold, this definition will miss a significant number of postmenopausal women, including those in the 45–54 age group, many of whom are already postmenopausal. Additionally, while this study provided valuable insights into the global burden of OA, the observed trends may reflect the ability of healthcare system to diagnose and report OA, which varies across countries. Finally, the GBD methodology relies on statistical modelling and data synthesis, which, despite improvements, may introduce uncertainties due to variability in healthcare access, diagnostic practices, and study designs. These factors might affect the interpretation and generalisability of the results across diverse populations.

CONCLUSIONS

In summary, this study provided a comprehensive analysis of global OA incidence, prevalence, and DALYs in

postmenopausal women, revealing substantial increases in incidence, prevalence, and DALYs from 1990 to 2021. An interesting pattern observed in this study was the higher incidence of hand OA in younger postmenopausal women, particularly around the age of 55, which emphasised the need for targeted interventions during early menopause to address this unique trend. In addition, our findings highlight the significant role of BMI as a modifiable risk factor, with rising obesity rates contributing to the increased OA burden. High SDI countries face a disproportionate OA burden, with widening SDI-related inequalities among nations over time. This underscores the urgent need for targeted interventions and rigorous health strategies to control and manage OA, focusing on modifiable risk factor reduction.

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