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Burden of Osteoarthritis in Iran: A National and Subnational Perspective, 1990–2019 Global Burden of Disease Study

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ABSTRACT

Background and Aims: Osteoarthritis (OA) is a chronic degenerative joint disease caused by pro-inflammatory factors and protease activity, leading to progressive joint destruction. The data on a global scale indicate a substantial rise in OA. This study evaluates the burden of OA in Iran, given its high impact and the limited number of epidemiological studies on the condition.

Methods: The data pertaining to the prevalence, years lived with disability (YLD), and incidence and age-standardized rates of OA in Iran and its subnational regions were retrieved using the Global Burden of Disease Study (GBD) Results Tool.

Results: Age-standardized prevalence rate (ASPR) of OA in Iran was 5224.14 (4699.54–5821.43) and 5588.22 (5041.17–6228.61) in 1990 and 2019, which was lower than the global level. The knee was the most prevalent OA in both 1990 and 2019 in Iran, 3326.63 (2862.19–3841.62) and 3660.61 (3151.81–4228.27) respectively, followed by hand OA (1432.43 (1078.03–1922.21) in 1990 and 1476.24 (1107.91–1979.80) in 2019) and hip OA (239.08 (184.05–300.68) in 1990 and 277.65 (213.24–351.43) in 2019). The age-standardized YLD rate of OA in Iran was 180.96 (91.76–355.00) in 1990 and 195.27 (98.67–381.01) in 2019. The age-standardized YLD rate of site-specific OA followed the same trend as ASPR. Tehran province, followed by Alborz and Yazd provinces, had the highest ASPR of OA in 1990. In 2019, Tehran province (6144.94 (5526.53–6862.14)) remained at the first rank, followed by Mazandaran (5536.591 (4974.13–6165.62)) and Alborz (5512.88 (4946.79–6138.54)) provinces. Our findings show that the OA incidence rate peaked in the 55–59 age group in both males and females in 1990 and 2019.

Conclusion: Despite being lower than global averages, the prevalence, incidence, and YLD due to OA in Iran have significantly increased over the past three decades. This highlights the need for healthcare policymakers to implement comprehensive strategies to manage OA burden and costs.

Abbreviations: ASPR, age-standardized prevalence rate; GBD, Global Burden of Disease; OA, osteoarthritis; YLD, years lived with disabilities.

1 | Introduction

Osteoarthritis (OA) is a chronic degenerative joint disease caused by pro-inflammatory factors and protease activity, leading to progressive joint destruction, pain, disability, and reduced physical function in affected individuals [1, 2]. While OA can develop at any age, it is most commonly observed in individuals over 65 [3]. Additionally, OA is almost twice as common in women as in men, particularly in the knee and hip [4]. OA most commonly affects the hands and weight-bearing joints, such as the hips and knees, often leading to disability and joint-specific comorbidities [5]. Prior research indicates that having OA in the hip and knee may increase the chance of experiencing cardiovascular events. In contrast, OA in the hand does not show this same association [6]. Different pathological mechanisms contribute to site-specific OA: systemic inflammation is more associated with hand OA, while excessive joint loading is linked to knee OA [7]. Therefore, considering the prevalence and burden of each site-specific OA is essential for health policymakers and healthcare providers.

Global data indicate a 114.5% increase in OA-related disability from 1990 to 2019 [8]. Additionally, the global age-standardized prevalence rate (ASPR) for OA was recorded as 6173.38/100,000 individuals in 1990 and increased to 6348.25/100,000 individuals in 2019 [9]. By 2050, the burden of OA will rise significantly. Projections show that by 2050, cases of knee, hand, hip, and other types of OA will increase by 74.9%, 48.6%, 78.6%, and 95.1%, respectively, compared to 2020 [10].

In Iran, the targeted country of this study, the reported prevalence of OA was ~16.9%, and knee, hand, and hip OA were 15.5%, 2.9%, and 0.3%, respectively [11–13]. In rural areas of Iran, the prevalence was higher [14]. It is notable that Iran has one of the highest years lived with disability (YLD) due to OA in the Middle East and North Africa region. YLD quantifies the impact of a disease on quality of life before recovery or death [15].

Due to the substantial burden of OA and limited studies on the epidemiology of OA in Iran, this study aimed to evaluate the burden of OA at the subnational level. We evaluated the prevalence, incidence and YLD of knee, hip, and hand OA in Iran from 1990 to 2019 across different age groups and sexes at the subnational level. This analysis was conducted using data from the Global Burden of Disease (GBD) 2019 study [16].

2 | Methods

2.1 | Overview

This study used GBD 2019 data on OA incidence, prevalence and YLD in Iran, covering both national and subnational levels from 1990 to 2019. The GBD study is an extensive endeavor aimed at quantifying the impact of injuries, as well as communicable and noncommunicable diseases, on population health. The GBD Study 2019 provides a comprehensive and systematic evaluation of age- and sex-specific rates of incidence, prevalence, death, years of life lost (YLL), YLD, and disability-adjusted life years (DALYs) on 369 injuries and diseases, as well as 87 risk factors, across 204 countries and territories. The data spanned the period from 1990 to 2019 [17].

2.2 | Case Definition and Data Source

The Global Health Data Exchange (GHDx) query tool was utilized to gather data on the prevalence, incidence and YLD of OA between 1990 and 2019 [18]. These data were categorized based on various factors, including age group, sex, location—Iran and its 31 provinces—and the specific anatomical sites affected—the knee, hip, hand, and other joints, excluding the spine.

The GBD Study 2019 provided a reference definition for OA that expressly referred to symptomatic OA, further confirmed radiologically as Kellgren/Lawrence Grades 2–4 [19]. Additionally, this definition needed the presence of pain for a minimum duration of 1 month within the past 12 months. The International Classification of Diseases 10th Revision (ICD-10) codes for subtypes of OA evaluated in this study are as follows: M16 for hip OA, M17 for knee OA, M19.04 for hand OA, and M19 for other types [20]. It is important to note that Spine OA was not included in the GBD data set and was instead classified under “low back pain” and “neck pain.”

2.3 | Statistical Analysis

YLDs were computed by multiplying the prevalence in each severity category by the severity-specific disability weights. No fatalities or YLLs occurred due to OA; hence, the DALYs equated to the YLDs. Further information regarding the computation of YLDs is available elsewhere [21].

Age-standardized rates were computed for prevalence, incidence and YLDs for the period spanning from 1990 to 2019. Additionally, estimated percentage changes were determined for these rates. The age-standardized rates have been reported using a per 100,000 population metric. The age-standardized rate was calculated by aggregating the product of the age-specific rate (β_i, where i represents the ith age group) and the corresponding number of cases (or weight; ω_i) within the same age subgroup i of the chosen reference standard population. This sum was then divided by the total sum of the weights of the standard population. The 95% uncertainty interval (95% UI) has also been provided for each point estimate. The uncertainty intervals (UIs) were established by identifying the 25th and 975th values from the ordered draws. Statistical analyses were conducted using R (version 4.2.0, R Foundation for Statistical Computing, Vienna, Austria). Python was used to generate maps and figures.

3 | Results

3.1 | National Level

The ASPR of OA in Iran was 5224.14 (4699.54–5821.43) in 1990 and 5588.22 (5041.17–6228.61) in 2019, both lower than the global rates (6173.38 (5607.26–6848.06) in 1990 and 6348.25 (5776.34–7023.04) in 2019). Among site-specific OA types, knee OA was the most prevalent in both 1990 and 2019 in Iran, with 3326.63 (2862.19–3841.62) and 3660.61 (3151.81–4228.27), respectively, followed by hand OA (1432.43 (1078.03–1922.21) in 1990 and 1476.24 (1107.91–1979.80) in 2019) and hip OA (239.08 (184.05–300.68) in

TABLE 1 | Comparison of global and Iran age-standardized prevalence, YLD, and incidence rate of site-specific osteoarthritis in 1990 and 2019, based on genders.

OA location	Gender	Years											
		1990						2019					
		Prevalence		YLD		Incidence		Prevalence		YLD		Incidence	
		Iran	Global	Iran	Global	Iran	Global	Iran	Global	Iran	Global	Iran	Global
Total OA	Both	5224.14 (4699.54–-5821.43)	6173.38 (5607.26–-6848.06)	180.96 (91.76–3-55.00)	220.68 (112.47–-433.46)	414.65 (369.17–-466.74)	473.61 (422.03–-531.37)	5588.22 (5041.17–-6228.61)	6348.25 (5776.34–-7023.04)	195.27 (98.67–3-81.01)	227.97 (115.31–-452.70)	445.04 (395.92–-501.86)	492.21 (438.66–-551.50)
	Male	4575.00 (4118.28–-5069.34)	5137.57 (4655.86–-5712.79)	156.98 (78.85–3-10.71)	179.65 (91.08–3-54.83)	366.97 (327.51–-411.66)	397.66 (354.22–-446.14)	4836.23 (4354.15–-5353.04)	5324.02 (4827.01–-5885.21)	167.11 (83.68–3-31.99)	186.96 (94.45–3-69.80)	388.48 (346.55–-435.05)	415.20 (370.29–-464.53)
	Female	5916.39 (5303.05–-6656.70)	7082.18 (6424.61–-7850.82)	206.55 (104.88–-405.15)	256.18 (130.81–-505.04)	466.16 (411.63–-529.43)	548.29 (488.03–-617.58)	6337.48 (5706.85–-7098.66)	7277.97 (6613.61–-8038.62)	223.26 (113.50–-439.59)	264.89 (134.04–-523.45)	502.28 (444.05–-570.12)	567.24 (504.88–-636.29)
Knee OA	Both	3326.63 (2862.19–-3841.62)	4070.49 (3523.03–-4661.88)	104.59 (51.72–2-11.61)	128.22 (63.56–2-61.05)	284.28 (246.42–-325.67)	329.99 (285.50–-376.71)	3660.61 (3151.81–-4228.27)	4375.95 (3793.04–-5004.90)	115.26 (57.29–2-33.25)	138.23 (68.47–2-81.32)	309.74 (268.33–-354.35)	350.34 (303.42–-398.92)
	Male	3089.63 (2652.00–-3574.84)	3280.36 (2828.63–-3769.72)	97.69 (48.42–1-98.07)	103.94 (51.52–2-12.36)	265.24 (229.70–-304.57)	274.71 (237.29–-315.00)	3327.47 (2858.09–-3841.12)	3510.19 (3032.61–-4036.95)	105.46 (52.06–2-12.53)	111.53 (55.32–2-27.31)	283.88 (245.74–-325.69)	291.19 (251.39–-333.51)
	Female	3580.72 (3080.27–-4135.59)	4762.26 (4121.80–-5436.41)	112.03 (55.11–2-27.55)	149.58 (74.08–3-03.36)	305.04 (264.18–-349.15)	384.17 (334.08–-437.98)	3991.15 (3438.90–-4607.28)	5161.36 (4470.91–-5889.68)	124.97 (61.94–2-54.07)	162.53 (80.49–3-30.61)	335.79 (290.69–-384.46)	407.91 (354.69–-464.58)
Hip OA	Both	239.08 (184.05–3-00.68)	368.91 (285.67-462.32)	7.53 (3.50–15.-59)	11.54 (5.41–23.-64)	11.68 (8.67–15.-05)	17.02 (12.67–2-2.04)	277.65 (213.24–3-51.43)	400.95 (312.77–4-99.41)	8.75 (4.07–18.-12)	12.57 (5.91–25.-79)	13.57 (10.04–1-7.47)	18.70 (13.98–2-4.19)
	Male	278.07 (213.55–3-50.38)	356.51 (275.80–4-46.89)	8.79 (4.09–18.-05)	11.22 (5.28–23.-11)	13.50 (10.01–1-7.41)	16.50 (12.33–2-1.35)	312.36 (241.11–3-93.66)	395.01 (306.75–4-92.35)	9.90 (4.57–20.-45)	12.46 (5.89–25.-72)	15.19 (11.35–1-9.59)	18.35 (13.73–2-3.77)
	Female	197.96 (151.77–2-48.79)	376.75 (291.89–4-72.42)	6.20 (2.89–12.-66)	11.73 (5.49–24.-15)	9.68 (7.17–12.-52)	17.48 (12.96–2-2.67)	243.07 (186.60–3-07.00)	405.13 (316.68–5-04.36)	7.61 (3.58–15.-63)	12.63 (5.91–25.-84)	11.93 (8.82–15.-41)	19.03 (14.27–2-4.48)
Hand OA	Both	1432.43 (1078.03–-1922.21)	1887.31 (1433.62–-2471.45)	44.69 (21.99–9-3.74)	58.85 (29.16–1-22.38)	73.95 (56.12–9-7.61)	85.41 (65.91–1-11.44)	1476.24 (1107.91–-1979.80)	1726.38 (1319.91–-2254.85)	46.17 (22.73–9-6.78)	53.87 (26.59–1-11.49)	75.64 (57.34–1-00.02)	80.14 (61.79–1-04.84)
	Male	736.05 (538.13–9-92.67)	1311.60 (997.91–1-732.48)	23.16 (11.32–4-8.45)	41.08 (20.14–8-6.60)	38.73 (29.34–5-1.86)	63.29 (48.60–8-3.25)	749.77 (549.35–1-014.23)	1208.76 (925.04–1-587.52)	23.66 (11.50–4-9.32)	37.93 (18.81–7-9.01)	38.97 (29.45–5-2.04)	60.04 (46.08–7-9.19)

(Continues)

TABLE 1 | (Continued)

OA location	Gender	1990 Prevalence Iran	1990 Prevalence Global	1990 YLD Iran	1990 YLD Global	1990 Incidence Iran	1990 Incidence Global	2019 Prevalence Iran	2019 Prevalence Global	2019 YLD Iran	2019 YLD Global	2019 Incidence Iran	2019 Incidence Global
	Female	2169.74 (1621.86–2886.99)	2375.54 (1804.04–3096.28)	67.58 (33.44–141.40)	74.02 (36.81–153.10)	111.88 (83.78–149.33)	107.45 (82.48–139.53)	2200.07 (1643.57–2919.52)	2183.17 (1663.68–2842.01)	68.60 (33.73–143.06)	68.00 (33.93–140.24)	112.93 (84.64–150.48)	99.83 (76.72–129.40)
Other OA	Both	774.80 (584.68–992.03)	707.57 (542.70–888.01)	24.15 (11.85–49.81)	22.06 (10.83–45.81)	44.73 (35.13–55.51)	41.19 (32.90–50.46)	803.26 (603.17–1027.56)	745.62 (570.16–939.80)	25.08 (12.22–51.99)	23.31 (11.40–48.47)	46.09 (36.04–57.12)	43.04 (34.03–52.86)
	Male	872.22 (654.50–1119.49)	746.93 (572.09–940.39)	27.33 (13.35–56.77)	23.41 (11.45–48.52)	49.50 (38.61–61.83)	43.17 (34.20–52.98)	894.23 (666.04–1147.54)	796.24 (607.27–1007.50)	28.09 (13.69–58.36)	25.03 (12.24–52.51)	50.45 (39.33–62.93)	45.62 (36.02–56.26)
	Female	670.56 (509.82–848.67)	672.35 (516.07–841.77)	20.74 (10.19–42.46)	20.86 (10.28–43.39)	39.56 (31.36–48.72)	39.19 (31.43–47.92)	712.74 (537.33–900.16)	699.12 (534.58–876.44)	22.08 (10.80–45.63)	21.72 (10.70–45.30)	41.63 (32.80–51.21)	40.47 (32.29–49.55)

Abbreviations: OA, osteoarthritis; YLD, years lived with disability.

1990 and 277.65 (213.24–351.43) in 2019), which were all lower than the global level (Table 1 and Figure 1).

The age-standardized YLD rate of OA in Iran slightly increased from 180.96 (91.76–355.00) in 1990 to 195.27 (98.67–381.01) in 2019. Age-standardized YLD rate of site-specific OA followed an ASPR trend. The age-standardized YLD rates of the knee, hand, and hip were as follows: in 1990, 104.59 (51.72–211.61), 44.69 (21.99–93.74), and 7.53 (3.50-15.59) and 2019, 115.26 (57.29–233.25), 46.17 (22.73–96.78), and 8.75 (4.07–18.12), respectively. The global age-standardized YLD rate of hand OA declined from 1990 to 2019 (58.85 (29.16–122.38) and 53.87 (26.59–111.49)), whereas Iran observed an increase during this period (Table 1 and Figure 2).

The age-standardized incidence rate of OA in Iran has increased from 1990 (414.65 (369.17–466.74)) to 2019 (445.04 (395.92–501.86)), which was lower than the global level (473.61 (422.03–531.37) in 1990 and 492.21 (438.66–551.50) in 2019). Knee, hand, and hip had the highest age-standardized incidence rates of OA, respectively, as prevalence and YLD rates; the age-standardized incidence rates of knee OA were 284.28 (246.42–325.67) in 1990 and 309.74 (268.33–354.35) in 2019, the age-standardized incidence rates of hand OA were 73.95 (56.12–97.61) in 1990 and 75.64 (57.34–100.02) in 2019, and the age-standardized incidence rates of hip OA were 11.68 (8.67–15.05) and 13.57 (10.04–17.47) in 1990 and 2019, respectively. Notably, the age-standardized incidence rate of hand OA in Iran increased, in contrast to the declining global trend (Table 1 and Figure 3).

3.2 | Subnational Level

At the subnational level, Tehran province (5865.48 (5269.67–6575.06)), followed by Alborz (5221.21 (4680.89–5806.77)) and Yazd (5184.65 (4641.52–5757.74)) provinces, had the highest ASPR of OA in 1990. In 2019, Tehran province (6144.94 (5526.53–6862.14)) remained at the first rank, followed by Mazandaran (5536.591 (4974.13–6165.62)) and Alborz (5512.88 (4946.79–6138.54)) provinces, respectively. Notably, Tehran's ASPR of OA exceeded the national average in both years. In 1990 and 2019, the Sistan and Baluchistan provinces had the lowest ASPR of OA (Table 2 and Figure 4). The age-standardized YLD rate of OA was the highest in Tehran (206.01 (105.35–404.80) in 1990 and 216.95 (110.82–427.83 in 2019)), followed by Alborz province (181.47 (91.97–355.54) in 1990 and 192.57 (97.18–377.24) in 2019). The third highest age-standardized YLD rate was in the provinces of Isfahan in 1990 (179.76 (90.41–349.88)) and Mazandaran in 2019 (192.20 (96.81–378.03)). Sistan and Baluchistan province still had the lowest age-standardized YLD rate of OA in 1990 and 2019 (Table 2 and Figure 5). Tehran, Alborz, and Mazandaran provinces had the highest age-standardized incidence rates of OA in both 1990 and 2019; Tehran 453.26 (402.44–511.17) in 1990 and 480.68 (426.01–543.65) in 2019; Alborz 415.50 (368.69–468.02) in 1990 and 442.21 (392.50–499.42) in 2019; and Mazandaran (412.23 (367.47–463.75)) in 1990 and 443.26 (393.67–500.22) in 2019. Tehran province had the highest age-standardized prevalence, YLD, and incidence rate of OA, while Sistan and Baluchistan possessed the lowest burden in 1990 and

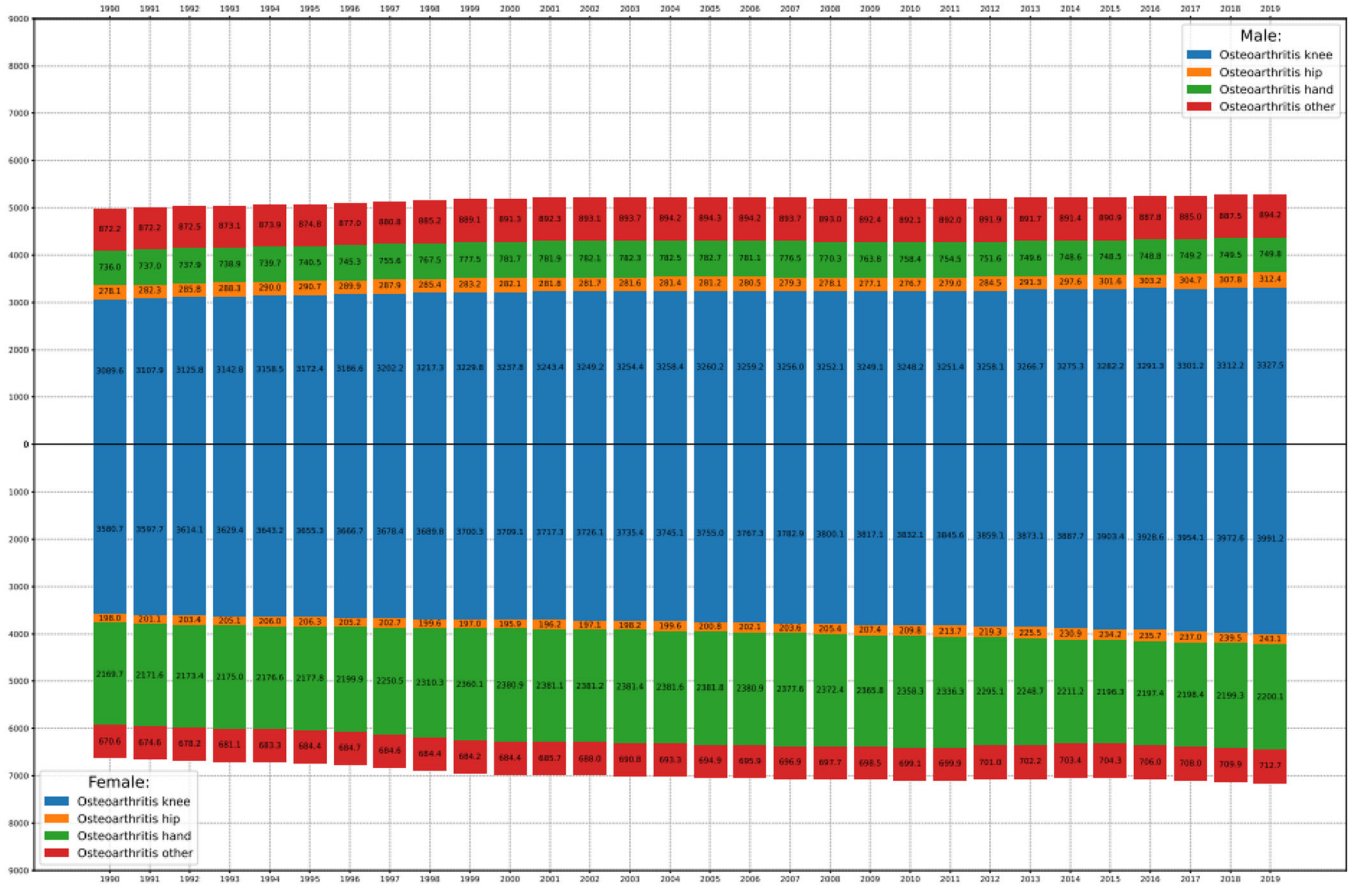

FIGURE 1 | Bar charts of the age-standardized prevalence rate of site-specific OAs in males and females from 1990 to 2019.

2019 (Table 2). Refer to Figures S1–S16 for national maps showing trends in site-specific OA incidence, prevalence, and YLD rates. For detailed data on rates, see Tables S1–S9.

3.3 | Age and Gender Disparity

The findings of our study show that the OA incidence rate reached the highest level in the age group of 55–59 years in both males and females in 1990 and 2019 (males: 1276.74 (970.28–1606.76) in 1990 and 1355.00 (1034.79–1700.06) in 2019. Females: 1623.01 (1218.92–2084.64) in 1990 and 1773.90 (1331.59–2279.23) in 2019). Incidence rates increased with age, peaking at 55–59 years, followed by a gradual decline (Figure 6). The assessment of site-specific OA in 1990 and 2019 revealed that knee and hip OA exhibited the highest incidence rate within the age range of 55–64 years, irrespective of sex. In 2019, the incidence rate for males peaked at 55–59 years, while the peak age group for females remained consistent with previous years. The age distribution of the OA incidence rate in Iran closely resembles the global pattern. Figure 7 provides additional information about the age-specific prevalence rate of OA in both genders; 1990 and 2019 (Figure 7).

In 1990, the ASPR of OA in Iran was 4575.00 (4118.27–5069.33) in males and 5916.39 (5303.04–6656.70) in females. By 2019, these rates had increased to 4836.22 (4354.14–5353.03) in males and 6337.48 (5706.85–7098.65) in females. The gender disparity ratio (female-to-male) in ASPR increased slightly from 1.29 in 1990 to 1.31 in 2019. The age-standardized YLD rate for OA exhibited changes from 1990 to 2019. In males, the rate increased from 156.98 (78.85–310.71) to 167.11 (83.67–331.99). Similarly, in females, the rate increased from 206.54 (104.88–405.15) to 223.26 (113.50–439.59). These changes suggest that the YLD gender disparity ratio shifted from 1.31 to 1.33. Additionally, a slight change in the age-standardized incidence rate of OA was observed from 1990 to 2019. The gender disparity in incidence increased marginally from 1.27 to 1.29. Table 1 provides additional information on the gender disparity of site-specific OA (Table 1). To see the age and gender-adjusted site-specific OA's age-standardized incidence, prevalence, and YLD rates in 1990 and 2019, refer to Figures S17–S24.

4 | Discussion

The current study found that the ASPR of OA in Iran was lower than the global level in both 1990 and 2019. In 1990 and 2019, the ASPR trend of site-specific OAs in Iran was the same as the global trend, which included knee, hand, and hip OA, respectively. Also, in Iran, the ASPR of OA was higher in females than in males, following global trends, in 1990 and 2019 in total and all site-specific types, except in hip OA in 1990, in which males had a slightly higher rate than females. Notably, the age-standardized YLD and incidence rates for OA and its subtypes followed a similar trend to the ASPR, except the age-standardized YLD and incidence rate of hip OA were higher in

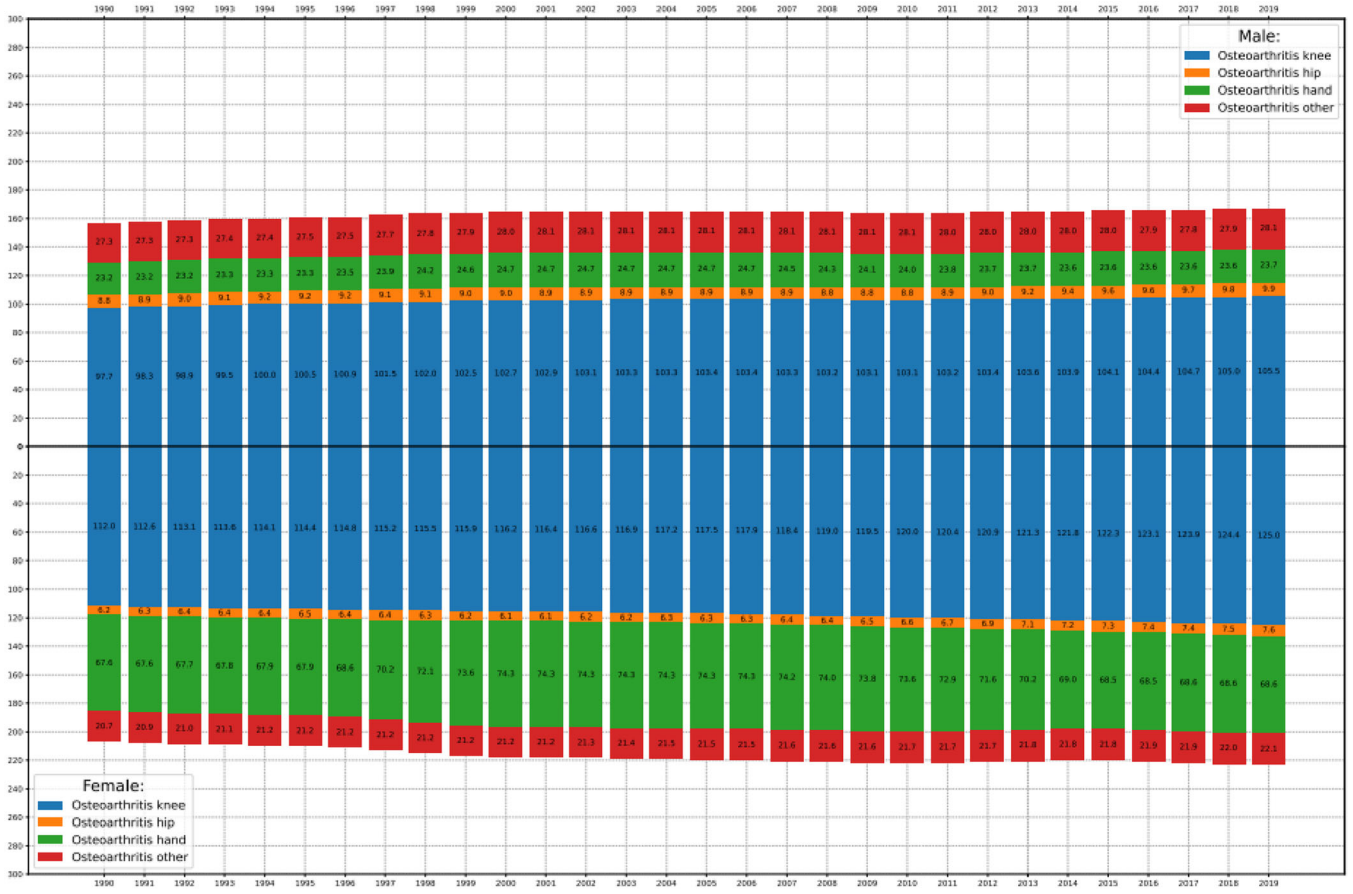

FIGURE 2 | Bar charts of the age-standardized YLD rate of site-specific OAs in males and females from 1990 to 2019.

males than in females in both 1990 and 2019 in Iran, unlike global trends. Moreover, the YLD rate for OA in Iran peaked among the elderly, particularly males aged 85–89 and females aged 80–84, in 2019. Unlike global trends, Iran experienced an increase in age-standardized YLD and hand OA incidence between 1990 and 2019. The age-specific incidence rate of OA exhibited its highest levels globally and in Iran among individuals aged 55–59 years, regardless of sex, in both 1990 and 2019. The only exception was the global age-standardized incidence rate of OA in females in 2019, which peaked in the age group of 50–54 years.

Tehran province had the highest ASPR of OA in 1990 and 2019, while Sistan and Baluchistan consistently had the lowest rates. In 1990, Alborz, Yazd, and Gilan followed Tehran, with Mazandaran replacing Yazd in 2019. This regional pattern remained relatively stable between 1990 and 2019. It is also noteworthy that the age-standardized YLD and incidence rate of OA were highest in Tehran, Alborz, and Mazandaran provinces in both 1990 and 2019.

Tehrani-Banihashemi and colleagues performed a study showing that OA was more prevalent in rural areas of Iran than in urban regions [14]. Other studies also showed the same outcome [22]. A rural lifestyle depends more on physical activities, long walking, and heavy load carrying, which places more consistent stress on joints. Mazandaran was one of the top three provinces with age-standardized prevalence, incidence, and YLD rates of OA. Tehran Province, the capital of Iran, had the highest age-standardized prevalence, YLD, and incidence rates of OA in 1990 and 2019. Despite Tehran being a densely populated urban city with a relatively low rural population, our findings align with previous research indicating a higher prevalence of OA in large cities than in rural regions [23].

A previous GBD 2019 study showed a global increase in ASPR of OA and site-specific OA from 1990 to 2019, with knee OA being the most common [9], consistent with our findings in Iran. Previous studies have reported similar findings [2, 24]. Also, OA was responsible for 303.1 million prevalent cases, 14.9 million incident cases, and 9.6 million YLDs globally in 2017 [25]. OA was more prevalent in females than males globally; our results in Iran's OA trend also conformed to the global trend [26]. OA is expected to become one of the leading causes of disability worldwide, particularly among women.

Age, female sex, obesity, repeated stress on the joints, and joint injuries are common risk factors for OA [27]. Our findings and previous studies showed that the incidence rate of OA was higher in older age groups and more prevalent in females than males. It is noteworthy that obesity is more prevalent in females than males in Iran [28], so it may be considered an associative factor in the higher prevalence of OA in Iranian females. Also, the dispersion of obesity in Iran is almost similar to the subnational spread of OA. Therefore, the elderly, individuals with overweight or obesity, and women should be prioritized in both preventive and treatment programs. Then, health policymakers should consider these groups as a priority. With limited curative

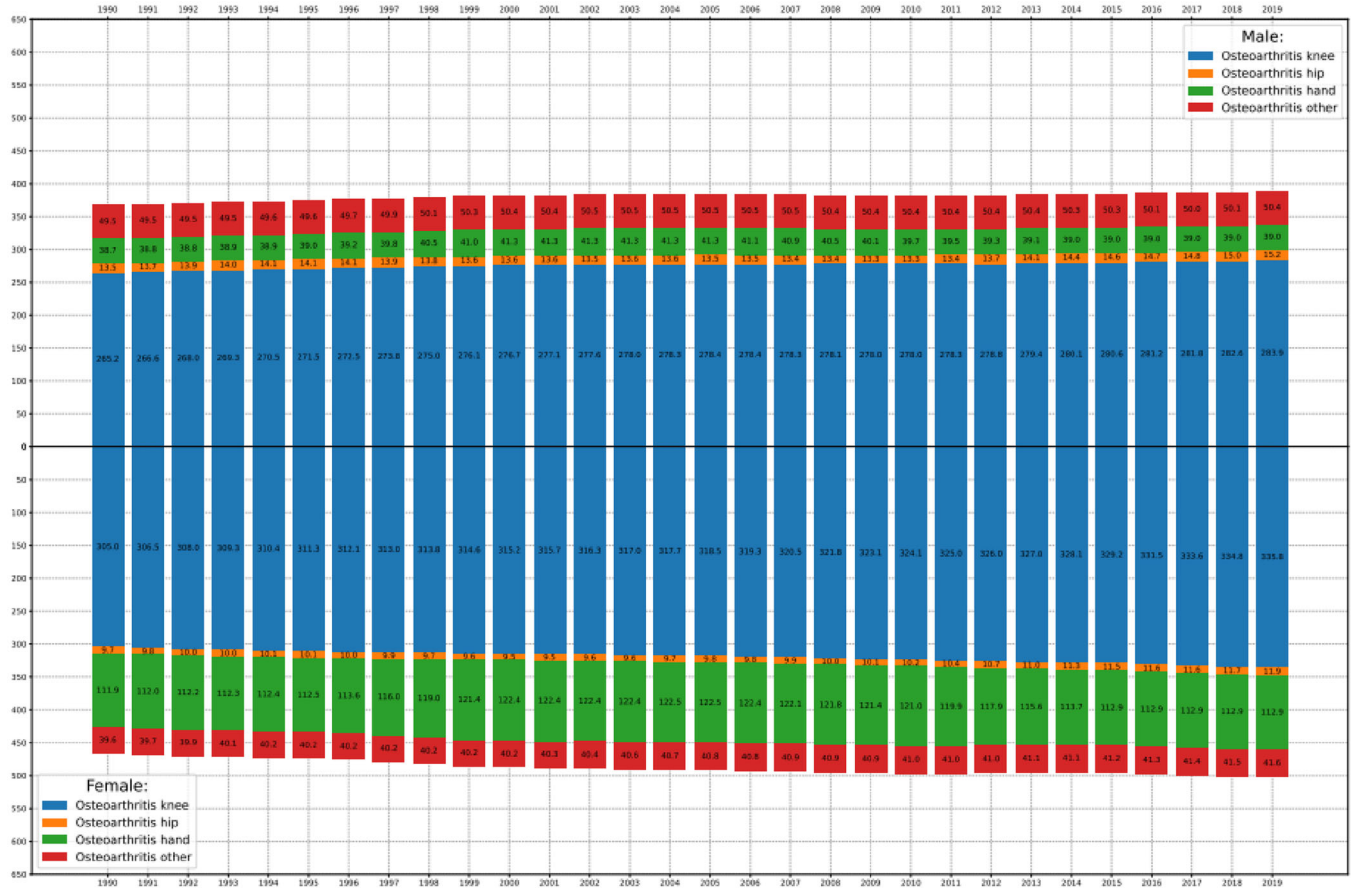

FIGURE 3 | Bar charts of the age-standardized incidence rate of site-specific OAs in males and females from 1990 to 2019.

options beyond joint replacement [29], paying attention to preventive methods such as national healthy regimen education and promoting regular exercise through national media campaigns is essential for reducing weight and mitigating a major risk factor, such as the Canadian obesity program [30].

Iran's population is undergoing substantial demographic changes, characterized by a swiftly rising percentage of elderly population [31]. The elderly demographic is a recognized risk factor for OA, as the probability of having the ailment escalates with advancing age [32]. Also, the ongoing urbanization in Iran, characterized by a transition from rural to urban living [33], has resulted in lifestyle modifications, notably diminished physical activity and heightened sedentary behavior [34]. This trend correlates with elevated obesity rates, a recognized risk factor for the onset and advancement of OA, especially in the knee and hip joints [35]. Urbanization has been associated with dietary alterations, particularly the heightened intake of processed foods, which has contributed to escalating obesity rates [36]. These factors, combined with a potential lack of public health infrastructure for early detection and prevention, underscore the need for targeted public health interventions to reduce the burden of OA in the country. Addressing these risk factors through national health initiatives, including promoting physical activity and healthy eating, is critical to curbing the rising incidence of OA in Iran.

The escalating prevalence of OA in Iran seems to be affected by various interconnected demographic and lifestyle factors, many of which are more notable in Iran than the global averages. For example, Iran possesses one of the most rapidly aging populations, with forecasts indicating that over 20% of its populace will exceed 60 years of age by 2050—surpassing the global average for that year [31, 37]. In 2021, the nationwide prevalence of obesity and overweight/obesity among Iranian adults aged 18 and older was estimated at 24.96% and 63.02%, respectively [38], in contrast to the global figures of 43% for overweight and 16% for obesity among adults [39]. Excess body weight imposes heightened mechanical stress on weight-bearing joints and expedites the progression of OA. Urbanization is a significant accelerating factor: Iran's urban population increased from 57% in 1990 to over 75% in 2020, surpassing other countries within the same income category. Urban living can foster sedentary behavior and diminished physical activity; both recognized risk factors for OA. Unlike nations where aging and obesity are increasing yet are well treated by early screening and preventative measures, Iran's healthcare system may continue to have difficulties in proactive musculoskeletal care. The disparities elucidate why the percentage rise in OA prevalence and burden in Iran exceeds global averages despite the marginally lower absolute rates.

Policies at the national level that prioritize prevention and early intervention are desperately needed, especially in light of Iran's growing OA burden. Priority should be given to public health initiatives that encourage healthy eating, regular exercise, and weight control, particularly for high-risk populations, including the elderly, women, and obese people. Expanding community-

TABLE 2 | The age-standardized prevalence, incidence, and YLD rates of OA in Iran at the national and subnational levels, and the percentage change and beta-coefficient of age-standardized rate between 1990 and 2019.

	Prevalence				Incidence				YLDs			
	Age-standardized rate estimates (1990)	Age-standardized rate estimates (2019)	Percentage change in age-standardized rates between 1990 and 2019	Beta for age-standardized rates trends through 1990–2019	Age-standardized rate estimates (1990)	Age-standardized rate estimates (2019)	Percentage change in age-standardized rates between 1990 and 2019	Beta for age-standardized rates trends through 1990–2019	Age-standardized rate estimates (1990)	Age-standardized rate estimates (2019)	Percentage change in age-standardized rates between 1990 and 2019	Beta for age-standardized rates trends through 1990–2019
Global	6173.38	6348.25	2.83	7.59	473.61	492.21	3.93	0.78	220.68	227.97	3.30	0.31
Iran	5224.14	5588.22	6.96	11.19	414.65	445.04	7.33	0.91	180.96	195.27	7.91	0.44
Alborz	5221.22	5512.88	5.59	8.81	415.50	442.22	6.43	0.82	181.48	192.58	6.12	0.33
Ardebil	5036.76	5455.14	8.31	13.66	403.02	436.04	8.19	1.04	173.79	190.39	9.55	0.54
Bushehr	5129.55	5474.29	6.72	10.11	408.97	437.27	6.92	0.80	177.70	191.12	7.55	0.39
Chaharmahaal and Bathtiari	5051.04	5413.04	7.17	11.37	403.21	432.42	7.24	0.89	174.67	189.57	8.53	0.47
East Azarbayejan	5073.74	5441.81	7.25	11.28	405.38	435.63	7.46	0.89	175.84	189.95	8.03	0.43
Fars	5138.02	5487.44	6.80	10.95	409.10	439.57	7.45	0.93	177.21	191.48	8.06	0.44
Gilan	5182.84	5501.62	6.15	9.58	411.84	440.88	7.05	0.85	179.51	191.79	6.84	0.38
Golestan	5119.49	5474.80	6.94	10.97	407.99	438.33	7.44	0.91	177.45	190.89	7.57	0.41
Hamadan	5096.91	5465.86	7.24	11.96	407.11	437.32	7.42	0.95	176.07	191.30	8.65	0.49
Hormozgan	5036.03	5441.84	8.06	13.19	401.51	435.13	8.37	1.07	174.15	190.14	9.18	0.52
Ilam	5033.70	5475.18	8.77	14.80	403.22	438.94	8.86	1.18	174.52	191.45	9.70	0.57
Isfahan	5175.20	5469.55	5.69	8.93	411.25	438.46	6.61	0.82	179.77	190.94	6.22	0.33
Kerman	5143.88	5435.70	5.67	9.28	410.33	435.32	6.09	0.78	177.23	188.56	6.40	0.34
Kermanshah	5046.55	5443.50	7.87	12.97	404.21	436.37	7.95	1.02	174.59	190.02	8.84	0.50
Khorasan-e-Razavi	5090.08	5437.71	6.83	10.78	406.26	435.46	7.19	0.86	175.29	188.23	7.38	0.40
Khuzestan	5098.39	5450.42	6.90	11.14	406.04	436.11	7.40	0.93	175.40	189.37	7.96	0.43
Kohgiluyeh and Boyer-Ahmad	5035.38	5416.99	7.58	13.12	400.30	435.59	8.82	1.20	173.53	189.39	9.14	0.54
Kurdistan	4986.43	5398.82	8.27	13.55	399.52	432.50	8.25	1.06	172.47	188.62	9.36	0.53
Lorestan	5051.29	5463.14	8.15	13.31	403.63	437.18	8.31	1.05	174.29	191.16	9.68	0.54
Markazi	5118.93	5450.50	6.48	10.41	408.95	436.17	6.66	0.80	176.32	190.24	7.90	0.43
Mazandaran	5179.08	5536.59	6.90	10.65	412.24	443.27	7.53	0.91	177.92	192.21	8.03	0.42

(Continues)

TABLE 2 | (Continued)

	Prevalence				Incidence				YLDs			
	Age-standardized rate estimates (1990)	Age-standardized rate estimates (2019)	Percentage change in age-standardized rates between 1990 and 2019	Beta for age-standardized rates trends through 1990–2019	Age-standardized rate estimates (1990)	Age-standardized rate estimates (2019)	Percentage change in age-standardized rates between 1990 and 2019	Beta for age-standardized rates trends through 1990–2019	Age-standardized rate estimates (1990)	Age-standardized rate estimates (2019)	Percentage change in age-standardized rates between 1990 and 2019	Beta for age-standardized rates trends through 1990–2019
North Khorasan	5025.91	5444.26	8.32	13.70	401.72	436.71	8.71	1.10	173.02	189.31	9.42	0.54
Qazvin	5127.54	5468.95	6.66	10.95	408.26	436.70	6.97	0.88	177.40	191.24	7.80	0.44
Qom	5105.45	5422.66	6.21	9.44	406.30	434.83	7.02	0.85	175.26	188.95	7.81	0.41
Semnan	5152.15	5484.10	6.44	10.82	409.71	438.56	7.04	0.91	177.51	191.43	7.84	0.45
Sistan and Baluchistan	4914.12	5312.87	8.11	13.05	392.70	425.90	8.46	1.06	169.42	185.02	9.21	0.51
South Khorasan	5024.33	5440.72	8.29	13.22	401.35	435.53	8.52	1.06	173.05	188.77	9.08	0.50
Tehran	5865.48	6144.95	4.76	7.55	453.26	480.68	6.05	0.76	206.01	216.95	5.31	0.29
West Azarbayejan	5030.25	5399.23	7.34	12.06	401.98	431.42	7.32	0.93	173.65	188.00	8.27	0.47
Yazd	5184.66	5476.41	5.63	9.01	411.17	437.60	6.43	0.80	178.86	190.76	6.65	0.36
Zanjan	5072.37	5440.66	7.26	12.17	404.77	434.81	7.42	0.95	174.97	189.79	8.47	0.40

Abbreviation: YLD, years lived with disability.

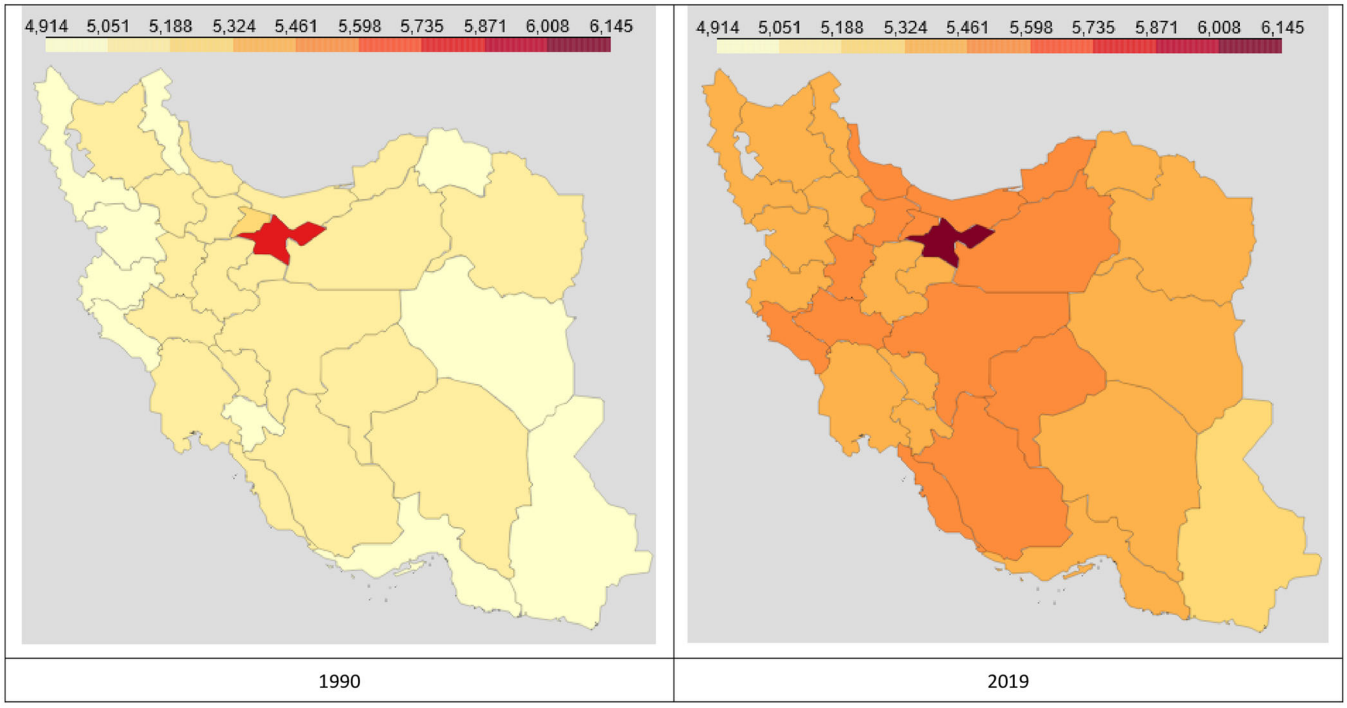

FIGURE 4 | National map of the age-standardized prevalence rate of osteoarthritis in both sexes in Iran, 1990 and 2019.

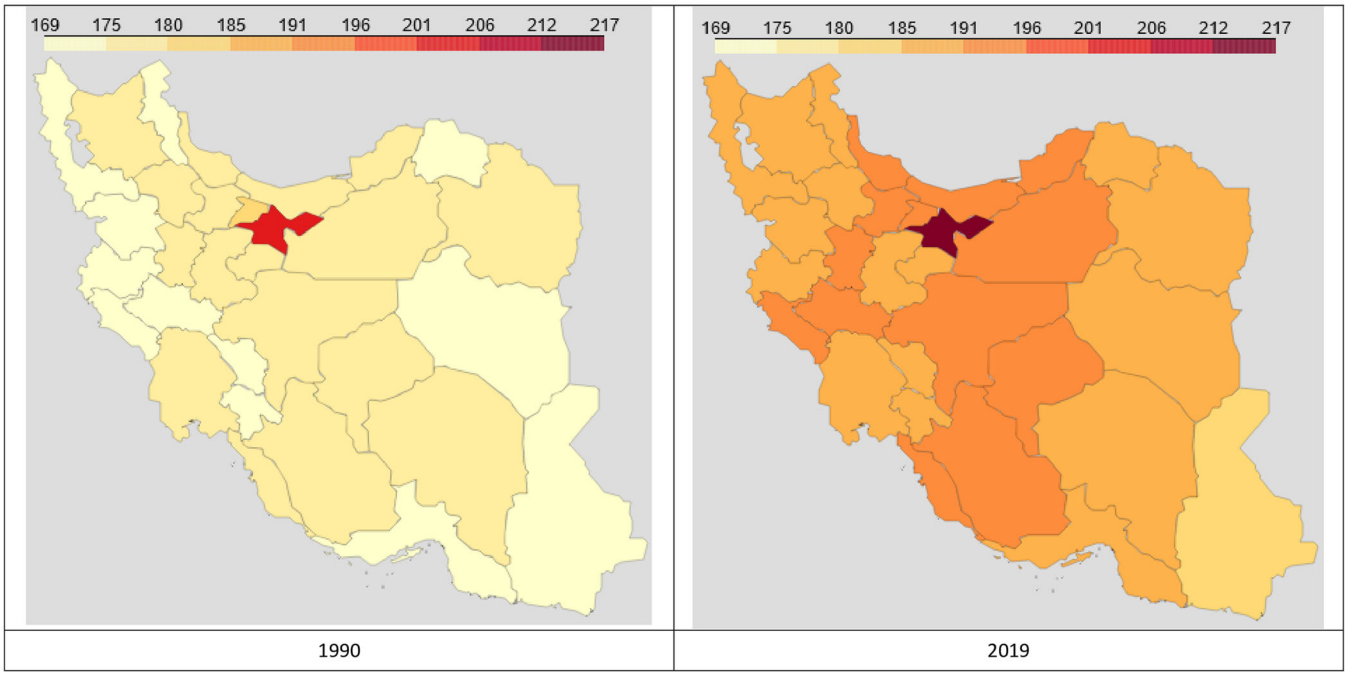

FIGURE 5 | National map of the age-standardized YLD rate of osteoarthritis in both sexes in Iran, 1990 and 2019.

based rehabilitation services and incorporating OA risk assessment into primary healthcare can aid in better managing the course of the illness. The health and financial impact of OA in Iran may be lessened with the help of focused, evidence-based strategies.

Longitudinal studies and national-level data collecting should be the main priorities of future Iranian research to confirm and build upon the patterns found using GBD-modeled estimations. The lack of comprehensive, population-based data hampers our capacity to evaluate local risk factors and disease trajectories. Data accuracy would be improved by creating open-access registries and incorporating musculoskeletal modules into health surveys. Further research into environmental and behavioral factors, such as obesity, occupational stress, and inactivity, may also help develop more focused therapies. These actions are necessary to establish empirical evidence that will inform policy and successfully lessen the burden of OA.

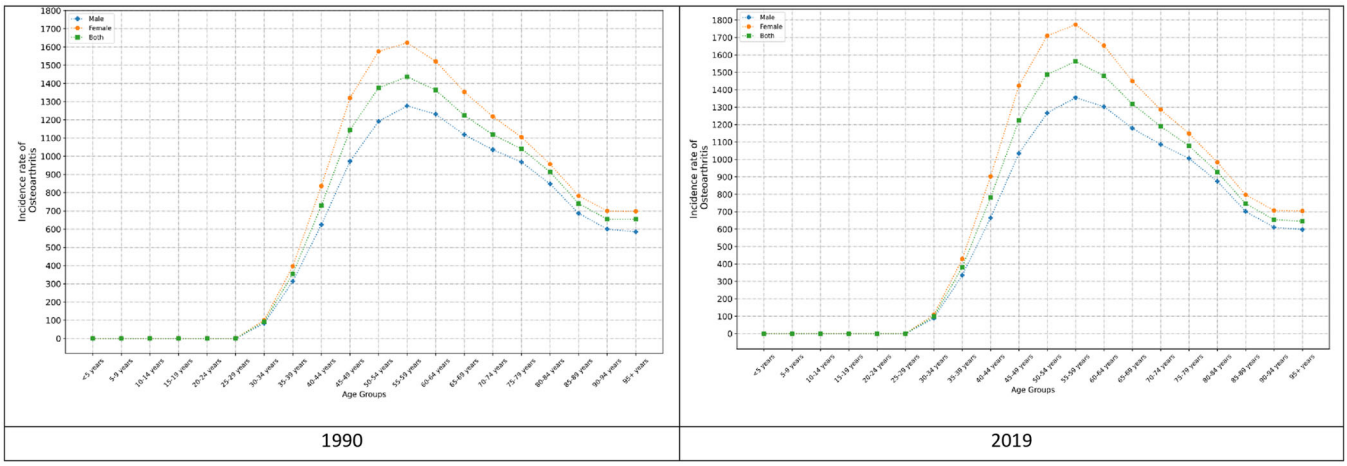

FIGURE 6 | Incidence rate of osteoarthritis based on sex in age groups in Iran, 1990 and 2019.

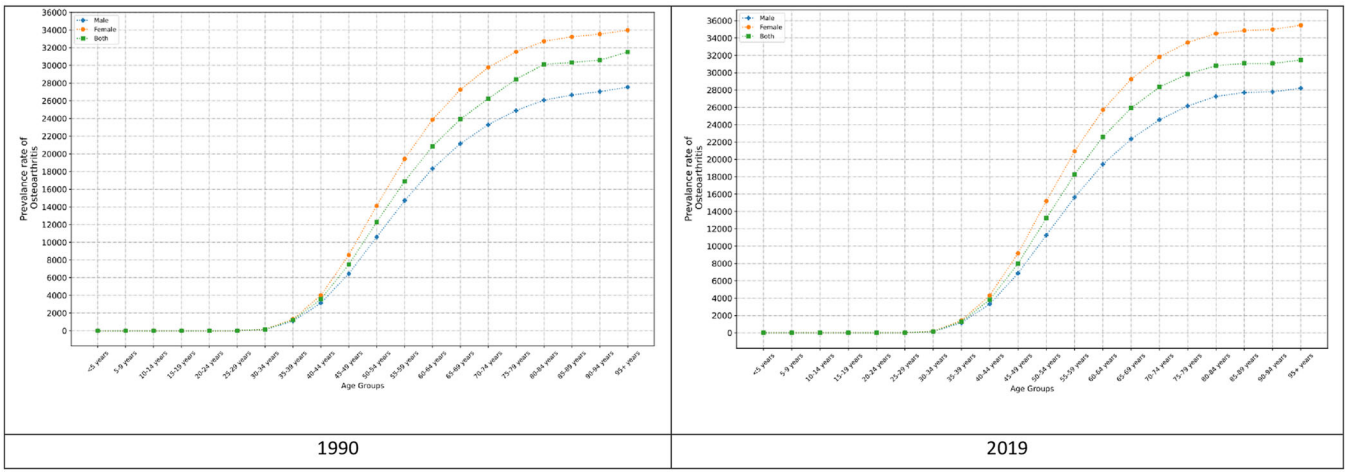

FIGURE 7 | Prevalence rate of osteoarthritis based on sex in age groups in Iran, 1990 and 2019.

5 | Strengths and Limitations

The data utilized in this study primarily originated from modeled data obtained from DisMod-MR 2.1, which was generated by the Institute for Health Metrics and Evaluation (IHME). This study presents a comprehensive analysis of epidemiological measures and the burden of OA, focusing on both overall OA and site-specific OA in Iran and at a subnational level. The utilization of the GBD model addresses the shortage of available or limited data pertaining to disease burden, thereby facilitating cross-regional and temporal comparisons. This feature is valuable for health policymakers in allocating prevention and treatment facilities with greater precision.

This study has some limitations. The primary constraint on our investigation was the availability of source data. Inadequate reporting and data entry can raise concerns about the accuracy of the information gathered. A lack of access to high-quality data could affect the study results, reducing the strength of the evidence. The implications could be more severe in some areas, such as a weaker healthcare system and ongoing conflicts, since fewer healthcare institutions may begin epidemiological studies. Also, the GBD Study 2019's definition of OA did not encompass symptoms and disabilities related to the spine. These aspects were instead classified as "low back pain" or "neck pain" which published elsewhere [40], resulting in an underestimation of the overall impact of OA. Additionally, some of the limitations of this study are related to the methodology of GBD studies, which is mentioned elsewhere [8].

6 | Conclusion

This study presents the prevalence, incidence, YLD, and age-standardized rates for OA and site-specific OAs in the Iranian population based on 1990 and 2019. Although age-standardized prevalence, incidence, and YLD rates of OA in Iran were lower than the global level in both 1990 and 2019, these rates have increased in Iran over three decades. Moreover, the percentage changes of OA YLD and incidence in Iran were exceeded the global average and represented the faster OA progression in Iran compared with the global average. Health authorities should implement focused preventative measures, such as early risk screening, obesity control, and national exercise promotion, to successfully address Iran's rising OA burden. Interventions specifically designed for vulnerable groups are crucial for reducing disability and slowing the progression of disease.

Author Contributions

Mohammad Amin Khadembashiri: conceptualization, data curation, software, validation, formal analysis, methodology, visualization, writing – original draft. **Mohamad Mehdi Khadembashiri:** writing – review and editing, writing – original draft, data curation, software, investigation. **Mohammad Saeid Khonji:** data curation, software, formal analysis, visualization. **Mohammad Ahmadi:** writing – original draft. **Niloofar Mirdamadi:** writing – original draft, formal analysis. **Tannaz Ahadi:** supervision, writing – review and editing, methodology. **Gholamreza Raissi:** supervision, validation, writing – review and editing. **Masumeh Bagherzadeh Cham:** writing – review and editing, methodology. **Hosna Soleymanzadeh:** methodology, formal analysis. **Hamid Ansari:** writing – original draft, visualization. **Bijan Forogh:** supervision, validation, conceptualization.

Acknowledgments

The authors have nothing to report.

Ethics Statement

In this paper, no individual data were used, and the information is based on aggregated online secondary data that already existed. This investigation reported aggregated epidemiologic data; no individual data were reported. However, this study has been approved by the Ethics Committee of Iran University of Medical Sciences.

Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

This study used publicly available data sets. The data are available here: Global Burden of Disease (GBD) Compare Viz Hub, https://vizhub.healthdata.org/gbd-compare.

Transparency Statement

The lead authors, Mohammad Amin Khadembashiri and Bijan Forogh, confirm that this manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned (and, if relevant, registered) have been explained.

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Supporting Information

Additional supporting information can be found online in the Supporting Information section.