Epidemiological Features of Spontaneous Abortion in the North Africa and the Middle East From 1990 to 2019: Results From the Global Burden of Disease Study 2019

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Abstract
Objective: Spontaneous abortion is one of the most common problems which a woman may encounter during her pregnancy which is one of the most important causes of maternal death. Therefore, the aim of this study was to report the epidemiological features of spontaneous abortion in North Africa and the Middle East (NAME) countries.
Materials and methods: The study population included 21 countries in the NAME region with a population of more than 600 million. The Global Burden of Disease (GBD) 2019 database was used. Incidence rates, the prevalence rates, death rates, the disability adjusted life years (DALYs) rates by age-standardized rate (ASR) per 100,000 people were measured. Also, the attributed burden to iron deficiency was reported.
Results: In 2019, the highest prevalence 39.44 (95% CI, 24.58_ 59.26) and incidence 4794.16 (95% CI, 3491.77_ 6353.03) rates of spontaneous abortion were in Afghanistan. In 2019, the highest spontaneous abortion related-death 5.88 (95% CI, 3.23_ 8.97) and DALYs 339.12 (95% CI, 184.29_ 516.95) rates by ASR were in Yemen. In MENA, average prevalence (44.7 to 19.82) and incidence (5434.95 to 2409.61) rates have decreased by nearly 56%, and also average death (1990 4.51 to 2019 0.48) and DALYs (263.15 to 29.37) rates have decreased by nearly 89% between 1990 and 2019. The highest spontaneous abortion-related DALYs rate was attributed to iron deficiency. In 2019, Yemen (29%) had the highest attributed burden to iron deficiency.
Conclusion: This study on 21 countries in the NAME region with a population of more than 600 million showed that average prevalence and incidence rates of spontaneous abortion have decreased by nearly 56%, and also average and the disability adjusted life years (DALYs) rates have decreased by nearly 89% between 1990 and 2019.

Keywords: Spontaneous Abortion; Burden of Disease; Middle East; North Africa

Introduction
Abortion is described as removing conception products from the uterus before the 20th week of pregnancy and or delivery of a fetus with a weight of less than 500 g (1, 2). Abortion is either spontaneous or induced. Spontaneous abortion, also known as miscarriage, is one of the most common problems which a woman

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may encounter during her pregnancy which mostly predominates from hormonal problems, maternal disorders, and chromosomal abnormalities (3). Lifestyle, diet, smoking, and alcohol are also other important risk factors for miscarriage (4). A miscarriage is the natural death of a fetus in the womb.

With nearly 130 million births per year across the world, a 15% risk of miscarriage proposes nearly 23 million miscarriages per year or 44 per min. given that the miscarriages and preclinical pregnancy losses are usually managed at home, the absolute number of miscarriages is significantly higher than reported (5). Moreover, miscarriage is associated with long-term health problems (such as thromboembolism, cardiovascular disease, and etc.) and psychological consequences (such as bereavement, anxiety, depression, suicide, and etc.) (6). Also, miscarriage is one of the most important causes of maternal death (7).

In the MENA region, most health determinants are similar, however, there is a significant discrepancy in health and disease index among these countries (8). On the other hand, health policymakers nationally should be informed about their country's health compared with other countries with the same socioeconomic statuses. They can also use other countries' experiences in improving their health care. GBD studies provide an opportunity to compare countries and describe the pattern of diseases (9).

Health policymakers require actual and reliable up-to-date reports of spontaneous abortion and miscarriage across different countries and populations. Such estimates set priorities and help to tailor cost-effective health interventions and resource allocation. Epidemiological study plays an important role in the recognition of occurrence, patterns, related risk factors, and etiology of diseases. Therefore, the aim of this study was to determine the epidemiological features and the burden of spontaneous abortion in the MENA countries to develop beneficial policies for decreasing the incidence, mortality, and consequences of spontaneous abortion in these regions.

Materials and methods

Geographical location and population: NAME region, with a population of more than 600 million (608,713,600), consists of 21 countries including Afghanistan, Algeria, Bahrain, Egypt, Iran, Iraq, Jordan, Kuwait, Lebanon, Libya, Morocco, Palestine Oman, Qatar, Saudi Arabia, Sudan, Syria, Tunisia, Turkey, United Arab Emirates (UAE), and Yemen

(10), which were compared in terms of age, sex, and risk factors for neurological disorders.

Data collection and quality control: We used the latest data refresh from the Global Burden of Disease (GBD) (the 2019 update) in the current study. The data of GBD estimate the incidence, prevalence, mortality, and disability-adjusted life-years (DALYs) of 369 diseases and injuries, and 84 risk factors in terms of location, age, and sex in 204 countries and regions from 1990 to 2019 (https://vizhub.healthdata.org/).

A detailed description of the metrics, data sources, and statistical modeling of GBD 2019 have been documented elsewhere (11). Annual data on age-standardized rate (ASR) of prevalence, incidence, DALYs, and death of maternal abortion and miscarriage were derived from the Global Health Data Exchange (GHDx) query tool. The original data was estimated by the GBD for maternal disorders such as miscarriage were obtained mainly from vital registration systems, sample registration systems, household surveys, censuses, demographic surveillance sites, and maternal and child surveillance systems. In the GBD dataset, designing for all countries is based on the quality and accessibility of data. To reliable and accurate comparisons between various countries and times, the same method was applied for each location and year in MENA Region.

Due to public availability of GBD, ethics approval and informed consent were not required.

Definition of spontaneous abortion: Spontaneous abortion (ICD-10 code= O03) was identified from the 10th revision of the International Classification of Diseases and injuries discharge diagnosis codes. Spontaneous abortion, is referred to as a miscarriage, is the loss of pregnancy naturally before twenty weeks of gestation (3). GBD study evaluated the different risk factors attributable to spontaneous abortion-related DALYs consisting of iron deficiency. Further information is available at http://vizhub.healthdata.org/gbd-compare/.

Statistical analysis: The main outcome measures of our study were the prevalence, incidence, deaths, and DALYs associated with spontaneous abortion. The rates in GBD are standardized based on the total world population. DALYs are the sum of the years of life lost (YLLs) and the years lived with disability (YLDs) (12, 13). YLLs are counted as the product of the estimated number of deaths and a standard life expectancy at the age of death. YLDs are computed by multiplying the prevalence of individual consequences of the disease, by their corresponding disability

weights, which quantify the severity of consequences as a number between 0 (full health) and 1 (death). Details of data sources and estimation methods have been published here (11, 14). Also, all estimates were reported in terms of counts, age-standardized rates (ASR) per 100 000 population (15, 16).

To do this study, all data were extracted from GBD (https://vizhub.healthdata.org/). In general, the external validity of GBD was evaluated by performing cross-validation on a limited number of sequelae due to the computational time and complexity of this analysis. Then, we analyzed the data based on the study's objectives e.g. age groups, risk factors, and etc. Also all estimates were reported with 95% uncertainty intervals (UI). By the way, all analyses and figures were applied by Microsoft Office Excel 2016.

Results

In 1990, the highest incidence rates of spontaneous abortion were in Turkey 7901.26 (95% CI, 5654.1- 10465.37), Bahrain 7723.23 (95% CI, 5706.25- 10036.26), and Tunisia 7593.7 (95% CI, 5534.24- 9958.13), and also the countries of UAE 2733.13 (95% CI, 2032.48_ 3512.61) and Kuwait 2881.92 (95% CI, 2150.8_ 3768.19) had the lowest incidence rate, respectively. But in 2019, Afghanistan 4794.16 (95% CI, 3491.77_ 6353.03) and Sudan 4314.6 (95% CI, 3276.89_ 5593.48) had the highest incidence rates of spontaneous abortion, and the lowest rates were in UAE 1005.21 (95% CI, 762.16_ 1347.45) and Libya 1028.62 (95% CI, 767.7_ 1339.51). The incidence rate of spontaneous abortion in the NAME region 2409.61 (95% CI, 1827.15_ 3108) was found to be higher than the global average 2172.36 (95% CI, 1666.41_ 2758.01).

In 1990, the highest prevalence rates of spontaneous abortion by ASR were in Turkey 64.96 (95% CI, 39.85_ 98.59), Bahrain 63.5 (95% CI, 40.04_ 95.59), and Tunisia 62.45 (95% CI, 38.8- 93.95) and also, the country of UAE 22.49 (95% CI, 14.16_ 33.62) and Kuwait 23.7 (95% CI, 14.78_ 35.41) had the lowest prevalence rate of spontaneous abortion. But in 2019, Afghanistan 39.44 (95% CI, 24.58_ 59.26) and Sudan 35.5 (95% CI, 22.17_ 52.48) had the highest prevalence rates of spontaneous abortion, and the lowest rates were in UAE 8.27 (95% CI, 5.08_ 12.34), Libya 8.46 (95% CI, 5.29_ 12.64), and Saudi Arabia 8.76 (95% CI, 5.45_ 13.23). The prevalence rate of spontaneous abortion in the NAME region 19.82 (95% CI,

12.56- 29.53) was found to be higher than the global average 17.87 (95% CI, 11.38_ 26.01).

In 1990, the highest spontaneous abortion related-death 33.05 (95% CI, 18.44_ 50.44) and DALYs 1882.63 (95% CI, 1022.13_ 2890.61) rates by ASR were in Yemen, and as well as Yemen continued to have the highest death 5.88 (95% CI, 3.23_ 8.97) and DALYs 339.12 (95% CI, 184.29_ 516.95) rates in 2019. Kuwait had the lowest death 0.08 (95% CI, 0.06_ 0.1) and DALYs 6.93 (95% CI, 5.13-9.19) rates in 1990, and also Kuwait continued to have the lowest death 0.01 (95% CI, 0.01_ 0.01) and DALYs 1.59 (95% CI, 0.88_ 2.51) rates in 2019. The death rate of spontaneous abortion in the NAME region 0.48 (95% CI, 0.33_ 0.65) was found to be lower than the global average 0.98 (95% CI, 0.82_ 1.17) Table 1.

In the countries of the NAME region except for Yemen and Afghanistan, in 2019, the DALYs rate of spontaneous abortion was reported to be lower than the average global Figure 1.

Between 1990 and 2019, average DALYs rates by ASR have decreased in all countries of the NAME region. In the MENA region, the DALYs rate of spontaneous abortion decreased by 89% from 263.15 (95% CI, 215.39_ 318.04) to 29.37 (95% CI, 20.83- 39.83) between 1990 and 2019. The DALYs rate of spontaneous abortion in the NAME region 29.37 (95% CI, 20.83_ 39.83) was found to be lower than the global average 56.7 (95% CI, 47.49- 67.19) in 2019. Between 1990 and 2019, the highest decrement of the spontaneous abortion -related DALYs with a 98% decrement was related to Oman (190.80 to 3.98) Figure 2.

Between 1990 and 2019, average death rates by ASR have decreased in all countries of the NAME region. In NAME, average death rates by ASR have decreased by nearly 89% from 1990 4.51(95% CI, 3.66_ 5.46) to 2019 0.48 (95% CI, 0.33_ 0.65). Between 1990 and 2019, the highest decrement of spontaneous abortion -related death with a 99% decrement was related to Turkey (3.37 to 0.04) followed by UAE with 99 decrements (2.054 to 0.027) Figure 3.

Between 1990 and 2019, average prevalence and incidence rates by ASR have decreased in all countries of the NAME region. In NAME, average prevalence (44.7 to 19.82) and incidence (5434.95 to 2409.61) rates by ASR have decreased by nearly 56%. Between 1990 and 2019, the highest decrement of spontaneous abortion -related prevalence (4908.38 to 1028.62) and incidence (40.38 to 8.46) with a 79% decrement was related to Libya Figure 3.

Table 1: Comparison of spontaneous abortion burden in the NAME countries

Country	Year	Incidence	prevalence	Death	DALYs
Afghanistan	1990	6359.53(4581.72_ 8497.36)	52.31(32.18_ 78.19)	9.93(6.83_ 14.04)	564.28(393.63_ 790.01)
	2019	4794.16(3491.77_ 6353.03)	39.44(24.58_ 59.26)	1.72(1.15_ 2.57)	102.21(69.1_ 150.86)
Algeria	1990	3817.54(2894.33_ 4920.03)	31.4(19.67_ 46.61)	1.43(0.97_ 2.09)	89.49(61.66_ 129.18)
	2019	1973.26(1481.22_ 2664.48)	16.23(10.13_ 24.22)	0.04(0.03_ 0.05)	3.94(2.59_ 5.61)
Bahrain	1990	7723.23(5706.25_ 10036.26)	63.5(40.04_ 95.59)	0.87(0.63_ 1.17)	58.47(42.74_ 76.15)
	2019	2392.12(1809.81_ 3167.52)	19.68(12.31_ 29.29)	0.09(0.06_ 0.13)	6.84(4.76_ 9.85)
Egypt	1990	3978.62(2898.66_ 5323.4)	32.73(20.34_ 49.42)	1.78(1.36_ 2.26)	106.42(81.22_ 134.22)
	2019	2117.32(1543.61_ 2767.31)	17.42(10.69_ 26.5)	0.03(0.02_ 0.05)	3.69(2.37_ 5.28)
Global	1990	3700.33(2783.48_ 4753.52)	30.43(19.18_ 44.89)	4.36(3.79_ 5)	253.53(220.74_ 290.36)
	2019	2172.36(1666.41_ 2758.01)	17.87(11.38_ 26.01)	0.98(0.82_ 1.17)	56.7(47.49_ 67.19)
Iran	1990	5263.41(3868.6_ 6851.06)	43.29(26.53_ 64.67)	0.68(0.51_ 0.86)	44.48(34.32_ 55.52)
	2019	2037.84(1523.5_ 2681.42)	16.77(10.51_ 24.8)	0.04(0.03_ 0.05)	4.03(2.97_ 5.32)
Iraq	1990	5502.91(4029.11_ 7192.17)	45.26(28.2_ 67.13)	0.88(0.58_ 1.31)	55.49(37.47_ 79.09)
	2019	2274.09(1685.52_ 3005.67)	18.7(11.71_ 28.02)	0.05(0.03_ 0.08)	4.92(3.25_ 7.08)
Jordan	1990	5365.58(3973.33_ 7003.33)	44.14(28.02_ 66.47)	1.22(0.86_ 1.67)	70.39(51.06_ 93.82)
	2019	3151.28(2424.3_ 3993.72)	25.94(16.65_ 38.33)	0.05(0.03_ 0.07)	5.39(3.57_ 7.64)
Kuwait	1990	2881.92(2150.8_ 3768.19)	23.7(14.78_ 35.41)	0.08(0.06_ 0.1)	6.93(5.13_ 9.19)
	2019	1199.29(891.18_ 1614.51)	9.87(6.19_ 15.02)	0.01(0.01_ 0.01)	1.59(0.88_ 2.51)
Lebanon	1990	4341.55(3235.09_ 5679.73)	35.72(22.47_ 53.42)	0.39(0.25_ 0.57)	26.08(17.75_ 36.42)
	2019	2014.81(1500.53_ 2633.33)	16.58(10.42_ 25.2)	0.03(0.02_ 0.05)	3.74(2.4_ 5.45)
Libya	1990	4908.38(3585.3_ 6457.81)	40.38(24.81_ 60.79)	0.42(0.27_ 0.62)	27.48(19.02_ 38.62)
	2019	1028.62(767.7_ 1339.51)	8.46(5.29_ 12.64)	0.05(0.03_ 0.07)	3.28(2.1_ 4.79)
Morocco	1990	3192.54(2387.6_ 4178.41)	26.26(16.62_ 39.26)	16(11.97_ 20.74)	916.61(694.87_ 1188.86)
	2019	1454.41(1101.25_ 1855.6)	11.97(7.63_ 17.66)	0.39(0.25_ 0.62)	22.83(15.03_ 36.15)
Mena	1990	5434.95(4044.24_ 7043.84)	44.7(27.61_ 66.81)	4.51(3.66_ 5.46)	263.15(215.39_ 318.04)
	2019	2409.61(1827.15_ 3108)	19.82(12.56_ 29.53)	0.48(0.33_ 0.65)	29.37(20.83_ 39.83)
Oman	1990	4810.84(3602.02_ 6216.71)	39.57(24.79_ 59.56)	3.37(2.21_ 4.96)	190.8(127.82_ 278.19)
	2019	2029.05(1497.71_ 2677.77)	16.7(10.42_ 25.23)	0.04(0.03_ 0.06)	3.98(2.61_ 5.61)
Palestine	1990	5846.99(4296.82_ 7759.25)	48.1(29.96_ 73)	0.3(0.19_ 0.46)	22.07(15.21_ 31.14)
	2019	2648.41(1912.89_ 3529.26)	21.79(13.17_ 32.93)	0.06(0.04_ 0.08)	5.68(3.88_ 7.9)
Qatar	1990	3123.45(2289.74_ 4067.61)	25.7(16.24_ 38.76)	1.94(1.33_ 2.73)	112.26(78.57_ 158.08)
	2019	1168.32(866.77_ 1561.52)	9.61(6.02_ 14.16)	0.09(0.06_ 0.14)	6.13(4.06_ 8.76)
Saudi Arabia	1990	4421.31(3255.97_ 5797.43)	36.38(22.69_ 55.43)	1.43(0.9_ 2.11)	84.76(54.26_ 125.15)
	2019	1064.49(809.65_ 1399.79)	8.76(5.45_ 13.23)	0.04(0.03_ 0.07)	3.21(2.12_ 4.63)
Sudan	1990	6648.88(4876.51_ 8867.11)	54.7(33.81_ 81.21)	10.58(7.36_ 15.1)	619.51(425.47_ 872.15)
	2019	4314.6(3276.89_ 5593.48)	35.5(22.17_ 52.48)	0.63(0.35_ 1.03)	39.88(23.59_ 61.65)
Syrian Arab Republic	1990	4635.52(3424.51_ 6166.83)	38.14(23.53_ 57.42)	1.22(0.8_ 1.73)	71.87(48.45_ 99.18)
	2019	1388.93(1040.17_ 1811.01)	11.43(7.19_ 17.25)	0.03(0.01_ 0.04)	2.51(1.57_ 3.72)
Tunisia	1990	7593.7(5534.24_ 9958.13)	62.45(38.8_ 93.95)	2.27(1.63_ 3.07)	141.14(101.95_ 190.39)
	2019	2956.14(2207.55_ 3958.22)	24.33(15.06_ 36.75)	0.05(0.03_ 0.07)	5.27(3.36_ 7.74)
Turkey	1990	7901.26(5654.1_ 10465.37)	64.96(39.85_ 98.59)	2.05(1.5_ 2.75)	126.78(93.02_ 170.71)
	2019	2584.6(1892.34_ 3416.72)	21.27(13.32_ 32.88)	0.03(0.02_ 0.04)	3.78(2.38_ 5.66)
United Arab Emirates	1990	2733.13(2032.48_ 3512.61)	22.49(14.16_ 33.62)	0.47(0.29_ 0.69)	28.85(18.48_ 40.91)
	2019	1005.21(762.16_ 1347.45)	8.27(5.08_ 12.34)	0.04(0.02_ 0.07)	3.13(1.96_ 4.67)
Yemen	1990	7177.54(5285.17_ 9472.7)	59.05(36.78_ 87.5)	33.05(18.44_ 50.44)	1882.63(1022.13_ 2890.61)
	2019	3419.21(2553.55_ 4493.04)	28.12(17.38_ 41.98)	5.88(3.23_ 8.97)	339.12(184.29_ 516.95)

In Afghanistan and Yemen, the spontaneous abortion-related DALYs have been peaked between the ages of 35 and 39 Figure 4.

The highest spontaneous abortion-related DALYs rate was attributed to iron deficiency. Iron deficiency in the NAME region was higher than the global average.
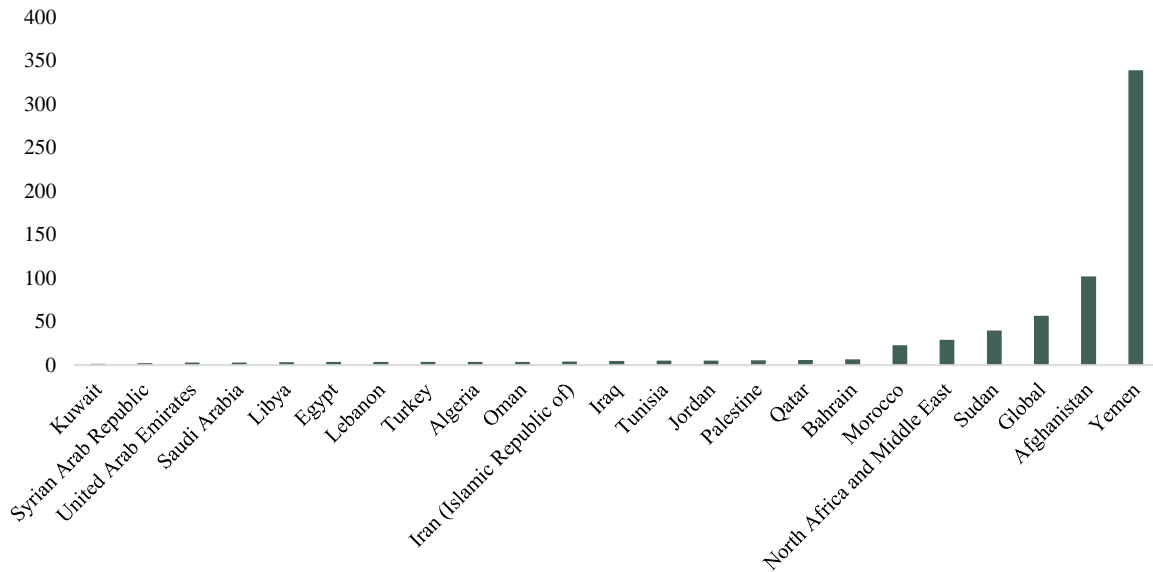
Figure 1: The DALY rates of spontaneous abortion according to ASR in the NAME region in 2019

In 2019, Yemen (29%) had the highest attributed burden to iron deficiency in the NAME region Figure 5.

Discussion

The results of the current study found that in the NAME region, the incidence and prevalence rates of spontaneous abortion decreased by 56%, and also the mortality and DALYs rates decreased by 89% between 1990 and 2019. Moreover, the incidence and prevalence rates of spontaneous abortion in the

NAME region was found to be higher than the global average, however, the death and DALYs rates of spontaneous abortion in the NAME region was lower than the global average. The high incidence and prevalence rates of spontaneous abortion in the NAME reveal the frequent occurrence of unplanned pregnancy, therefore, unwanted pregnancy and abortion can be decreased by informing, access to health services, and also tailoring, expanding, and improving family planning services.
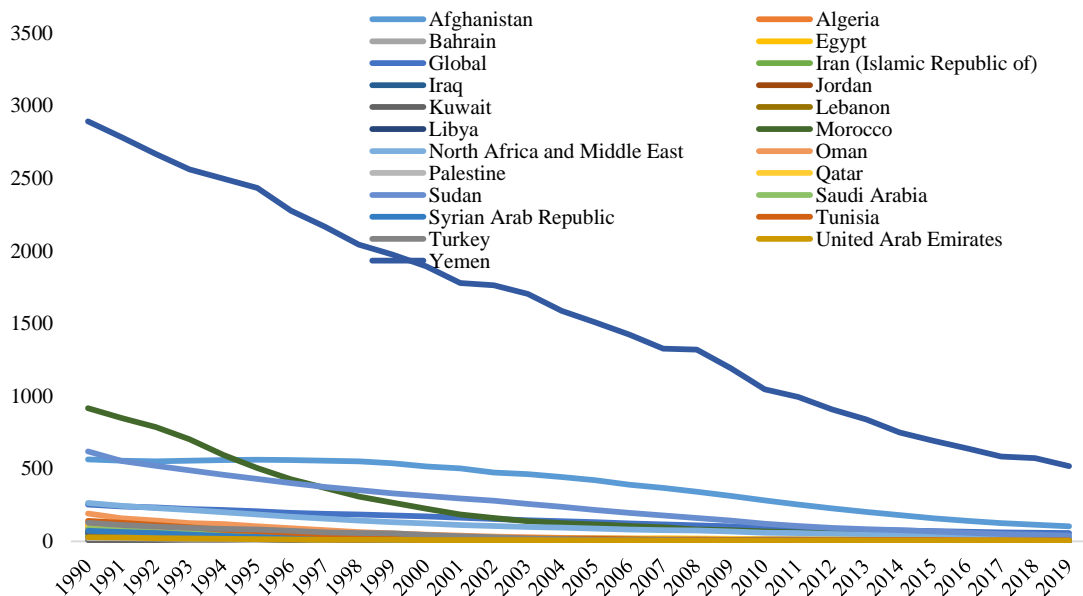

Figure 2: The DALY rates of spontaneous abortion according to ASR in the NAME region from 1990 to 2019
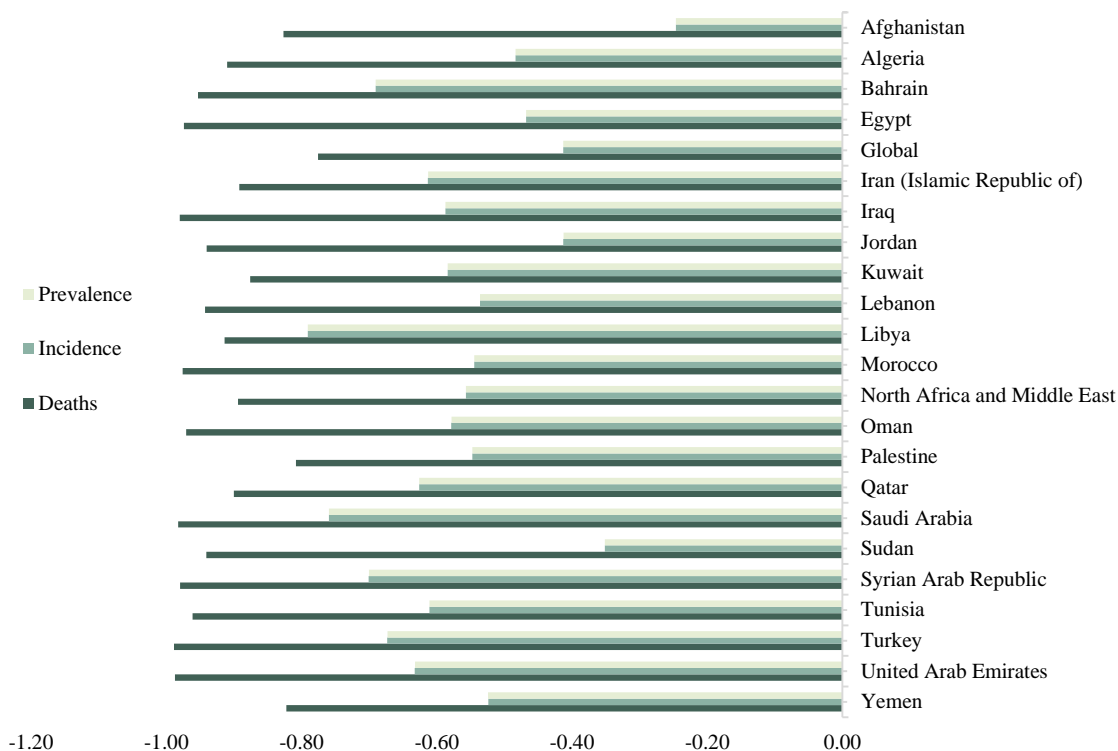
Figure 3: Percentage changes in the prevalence, incidence, and DALYs rate according to ASR from 1990 to 2019

On the other hand, North Africa/Middle East includes low/middle-income countries since low income and material deprivation was associated with poor housing, nutrition, and health care access which in turn negatively affected the general health physically and mentally (17, 18). The countries of Afghanistan and Sudan had the highest prevalence and incidence rates of spontaneous abortion, and the lowest prevalence and incidence rates by ASR were in United Arab Emirates (UAE) in 2019.
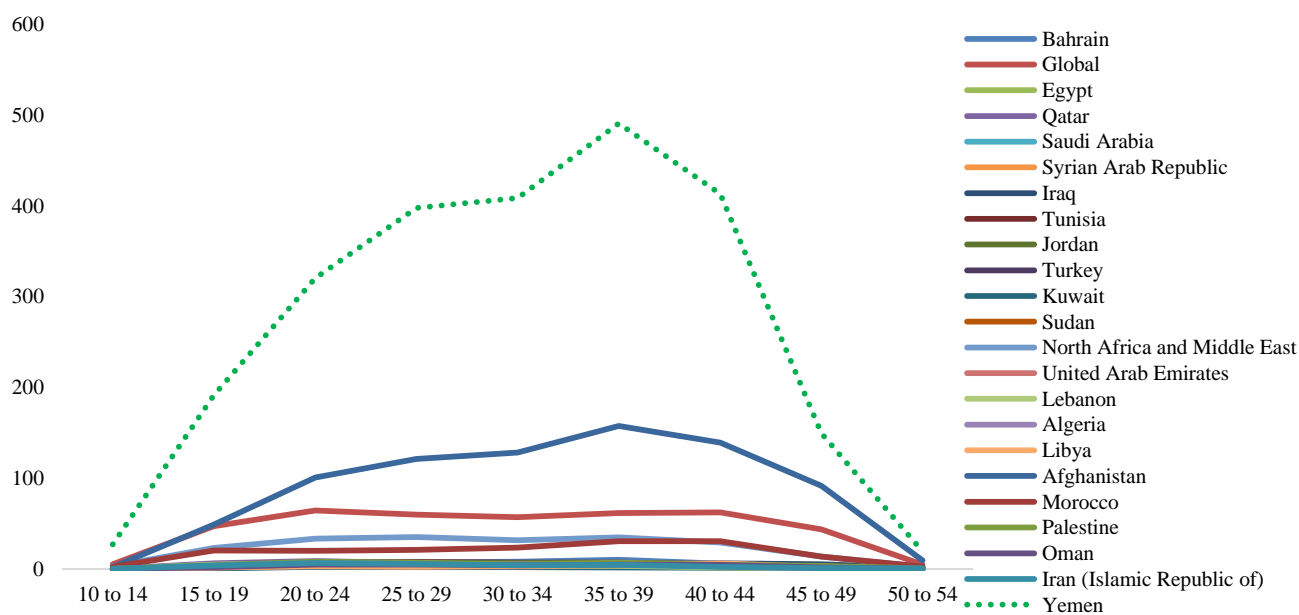

Figure 4: The age trend of the DALYs rate of spontaneous abortion in 2019
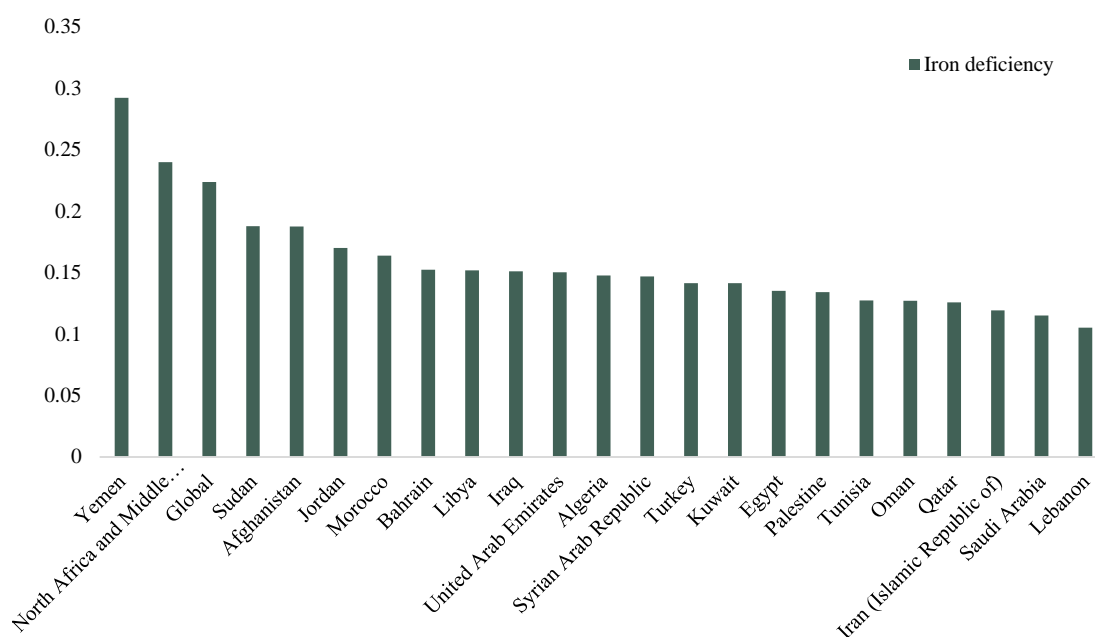
Figure 5: The DALYs rate of spontaneous abortion attributed to Iron deficiency in 2019

This might be due to civil war, persistent political tensions, dispersion and displacement in Afghanistan and Sudan, which have damaged the population's health and the healthcare infrastructures. Furthermore, UAE is renowned for its high-quality health care services and is known as the destination for medical tourism in the NAME region. As well as, in recent years, this country has realized very health reforms (19). Between 1990 and 2019, the highest decrement of spontaneous abortion -related prevalence and incidence with a 79% decrement was related to Libya.

The result showed that Yemen had the highest death and DALYs rates by ASR among the NAME countries, and also Kuwait had the lowest death and DALYs in 1990 and 2019. Between 1990 and 2019, the highest decrement of spontaneous abortion -related death with a 99% decrement was related to Turkey, and also the highest decrement of the spontaneous abortion -related DALYs with a 98% decrement was related to Oman. This decrement is due to that these countries has improved its health care system in recent decades. For instance, Turkey, between 2003 and 2013, has applied very successful health reforms such as the family medicine model, organizing universal health coverage plan, developing primary health care, and applying integrated care (20).

The highest spontaneous abortion-related DALYs rate was attributed to iron deficiency. In 2019,

Yemen (29%) had the highest attributed burden to iron deficiency in the NAME region. The high prevalence of iron deficiency in Yemen could be attributed to malnutrition due to civil and foreign war, less industrialization, and a poor economy.

Strengths and limitations of the study: The strengths of the present study were comparing the data of countries that approximately have the same information registration system and socio-demographic Index. Other strengths of the present study were the comprehensive estimations of spontaneous abortion burden as reported by prevalence, incidence, death, and DALYs between different countries from 1990 to 2019, hence, it can detect the strengths and weaknesses of the health care systems in different countries. All limitations of the GBD study are detailed elsewhere (21) and our study fully was subjected to those limitations. By the way, major limitation of this study is a lack of information on the other risk factors. Furthermore, the quality of the data collection system is different across countries, and the comparison of countries may be ambiguous. In July 2011, Sudan divided into two countries of Sudan and South Sudan but was considered as a single country, showing another limitation of this study. Likewise, the uncertainty intervals do not account for several sources of bias including measurement bias, selection bias due to missing data, and model specification bias. Finally, given GBD estimates are updated annually, the

present limitations should be addressed.

Conclusion

In the NAME region, the incidence and prevalence rates of spontaneous abortion decreased by 56%, and also the mortality and DALYs rates decreased by 89% between 1990 and 2019. Afghanistan and Sudan had the highest prevalence and incidence rates of spontaneous abortion, and Yemen had the highest death and DALYs rates by ASR among the NAME countries between 1990 and 2019. The highest spontaneous abortion-related DALYs rate was attributed to iron deficiency, and Yemen (29%) had the highest attributed burden to iron deficiency. As recurrent miscarriage is a marker for various obstetric risks in future pregnancies, women should receive post-abortion care. As psychological consequences are common after abortion, effective screening and timely treatment for mental health complications of miscarriage need to be available. At the national and state levels, health policymakers can use the information reported in this study to facilitate comparison of rates among countries, to accelerate research, to develop their health planning, to resource allocation, to improve patient care and policy development, and to decrease the burden of spontaneous abortion.

Conflict of Interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Acknowledgments

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