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ORIGINAL ARTICLE

Spatial Clustering of Pregnancy Wastage and its Determinants in Manipur: Evidence from National Family Health Surveys

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Abstract

Background Pregnancy-related deaths and complications have remained unacceptably high, particularly in low- and middle-income countries. Manipur is the most prevalent state for pregnancy wastage in India with an increasing trend over the last two decades.

Aim The study aims to explore the level, pattern, spatial clustering, and determinants of pregnancy wastage in Manipur.

Data and Methods We utilized the NFHS-4 (2015–2016) and NFHS-5(2019–2021) data of Manipur. The Getis-OrdGi* spatial statistical tool was used to identify the hotspots clusters. Bayesian logistic regression analysis was applied to identify the determinants of pregnancy wastage.

Results The major hotspot clusters for pregnancy wastage were found in the valley districts, namely Imphal East, Imphal West, Thoubal, and Bishnupur. Further, a significant decline in hotspot clusters can be seen in the last five years. BMI was found to be a significant determinant for both abortion and miscarriage. Education, working status, number of antenatal care visits, wealth index and use of smokeless tobacco were associated with higher risks of having abortion among women.

Conclusion The results highlight the need to develop district- centric antenatal care services to reduce the risk of pregnancy-related complications. Intervention should be tailored according to the life style choices and unique cultural practices of women in Manipur, India. It may also be beneficial to study the factors associated with declining hotspot clusters in some districts of Manipur.

Keywords Pregnancy outcomes · Hotspot analysis · Abortion · Miscarriage · Still birth

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Background

Maternal health is one of World Health Organization's key priorities and linked to efforts on universal health coverage. Although important progress has been made in the last two decades, about 2,87,000 women died during and following pregnancy and childbirth in 2020, globally [1]. In India, unsafe abortions are the third leading cause of maternal mortality; the pooled estimate of the mean prevalence is as high as 37.56%. High rates of unsafe abortions were reported even in high-performing states such as Delhi and Tamil Nadu [2]. Similarly, miscarriage is a common phenomenon, affecting one in ten women in their lifetime. An estimation of 23 million miscarriages occurs globally, translating to 44 pregnancy losses per minute, which are attributable to multiple factors such as nutrition, occupation, lifestyle and environmental factors, individual health status, socio-economic, cultural and demographic factors, as well as various clinical parameters [3]. The rate of stillbirths globally is alarming, with 13.9 stillbirths per 1000 births in 2019 [4, 5]. Furthermore, an estimation of 7.45 lakh infants died during labour in 2019 in sub-Saharan Africa and South Asia, accounting for 89% of all intrapartum stillbirths worldwide, which could have been prevented with access to high-quality care during childbirth [6]. The overall rate of stillbirth from the health management information system (HMIS) data set is found to be 12.9 per 1000 total births during 2017–2020 in India [7]. However, the high magnitude of stillbirths has not received much attention and is not included as a specific target in the Sustainable Development Goals [5].

In Manipur, the percentage of pregnancy wastage owing to abortion, miscarriage, and stillbirth has been gradually increasing, marking highest prevalent state in the country in each round of NFHS [8]. A geospatial based hotspot and regression analysis study on abortion and stillbirth in Manipur from 2011 to 2018 reported a high prevalence of both cases that were mainly concentrated in blocks located in the valley regions of Manipur [9]. Further, a study based in Manipur shows that women with advanced maternal age (35 years and above) experienced one or more forms of pregnancy complications. Additionally, such women have higher odds of developing pregnancy-induced hypertension, preterm birth and postpartum complications [10].

Rationale

Abortion, miscarriage, and stillbirth are serious maternal and child health problems that add to the burden of MMR and IMR.

The study by Oinam et al. identified the hotspot zones of abortion and stillbirth prevalence and their associated factors in Manipur and results indicated that both the cases are mainly concentrated in the blocks located in the valley regions of Manipur [9]. However, this study used block as a unit of analysis and not an individual, and the data obtained from various health care facilities led to the clustering of reported cases at block level, due to which the blocks with better facilities tend to have a higher number of cases. Thus, findings of this study cannot be generalized at the individual level.

Maternal and child health remains one of the top public health concerns in India, and there is scarce of information about the prevailing risk factors that are especially attributed to prenatal care and non-pregnancy wastage, particularly in Manipur. Hence, there is an urgent need for study using individual women as unit level and aerial surveys at the village/household/individual level at different locations of Manipur in order to get a better understanding of the pattern, hotspot clusters, and factors associated with pregnancy wastage. Such research will help policy makers to bring related legislations and policies to counter the problem effectively by targeting such specific factors rather than adopting a general and generic policy. The aim and the objectives of the present study are (i) to assess the rates of pregnancy wastage owing to abortion, and miscarriage and stillbirth among women of reproductive age group 15–49; (ii) to identify the hotspot clusters in the state owing to pregnancy wastage; and (iii) to identify risk factors associated with pregnancy wastage.

Data and Methods

We utilized the NFHS-4 (2015–2016) and NFHS-5(2019–2021) data of Manipur; individual woman data from the fourth and fifth round were extracted from the country survey data covering nine districts. Last pregnancies during the five year preceding the survey among the women age 15–49 were the unit of analysis. The pregnancy wastage i.e. abortion, miscarriage and stillbirth is the outcome variable of the study. We included mother's age at birth, place of residence, living situation of the mother, educational level, working status, social group, religion, wealth quintile, number of antenatal care (ANC) visits, husband's presence during ANC visit, consumption of smokeless tobacco and body mass index (BMI) as independent variables. Analysis for stillbirth was not carried out as the number of cases were very small (8 sample).

Methods

The Hot Spot Analysis tool that is Getis-Ord Gi* spatial statistic for analysing the location-related tendency (clustering) in the attributes of spatial data (points or areas)was used

to identify high and low hotspots clusters. The Gi* statistic returned for each feature in the data set with a *Z* score and p-values tell where features with either high or low values cluster spatially and also create confidence level bin field (Gi_Bin) for each feature[11]. The Gi bin field identifies statistically significant hot and cold spots regardless of whether or not the false discovery rate (FDR) correction is applied. Features in the ± 3 bins reflect statistical significance with a 99 per cent confidence level; features in the ± 2 bins reflect a 95 per cent confidence level; features in the ± 1 bins reflect a 90 per cent confidence level. In this study, we were taking features in the ± 1 , ± 2 and ± 3 bins to reflect statistical significance. A high *z*-score and a low *p*-value indicate a significant hotspot. A low negative *z*-score and a small *p*-value indicate a significant cold spot. The higher (or lower) the *z*-score, the more intense the clustering. A *z*-score near 0 means no spatial clustering [12]. Further, we used Bayesian logistic regression for multivariable analysis.

Results

Figure 1 shows the hotspot analysis of abortion in 9 districts of Manipur during NFHS-4 and NFHS-5. Spatial heterogeneity has been observed as the total number of hotspots and cold spots for abortion has decreased from NFHS-4 to NFHS-5. The districts of Imphal East, Imphal West, Thoubal, and Bishnupur have persistent major hotspot clusters during NFHS-4 and NFHS-5; however, the number

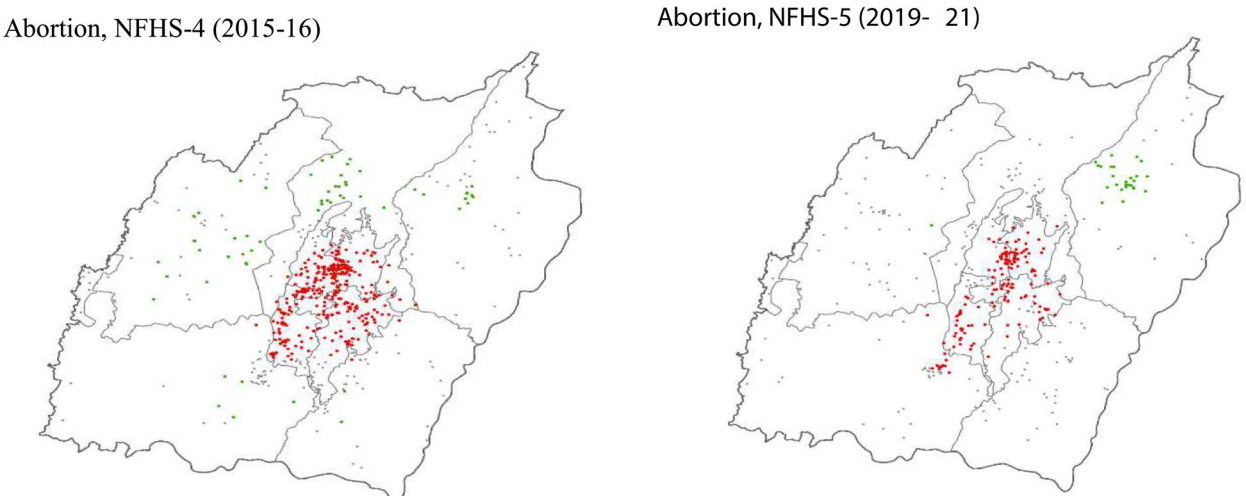

Fig. 1 Spatial clustering of abortion in Manipur NFHS-4 (2015–2016) and NFHS-5 (2019–2021)

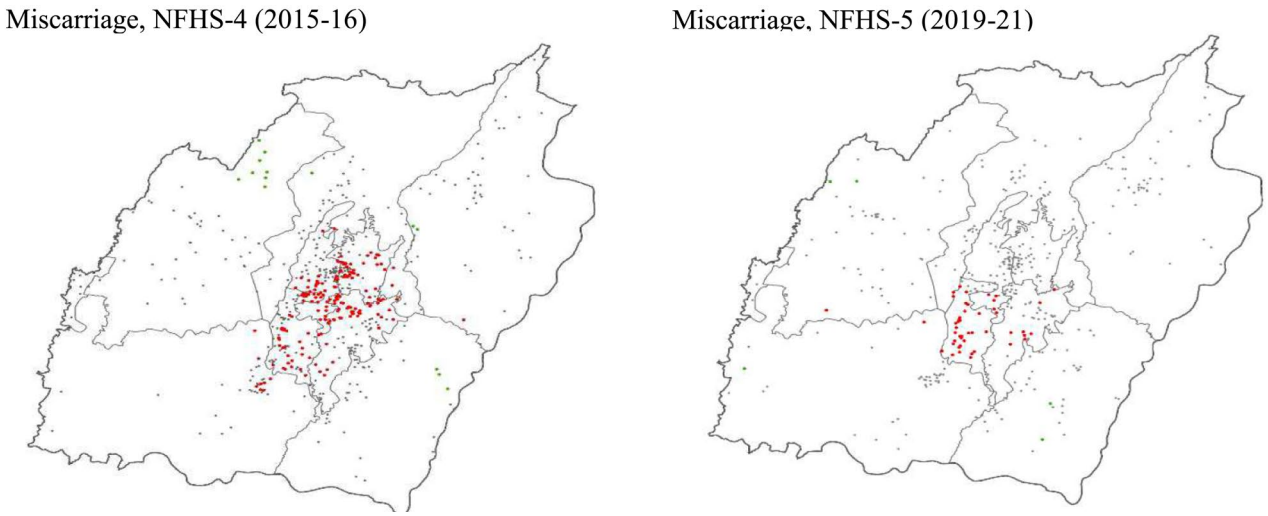

Fig. 2 Spatial clustering of miscarriage in Manipur NFHS-4 (2015–2016) and NFHS-5 (2019–2021)

of hotspot clusters has reduced in the 4 valley districts in 2019–2021.

Figure 2 shows the hotspot analysis of miscarriages in 9 districts of Manipur during NFHS-4 and NFHS-5. The total number of hotspot clusters has significantly decreased in the last five years. Previously, major hotspot clusters were spotted in the districts of Imphal East, Imphal West, Thoubal, and Bishnupur. In NFHS-4, some hotspots are also observed in the hill districts of Churachandpur and Senapati. However, major hotspots were seen only in the districts of Thoubal and Bishnupur in NFHS-5.

Figure 3 depicts the hotspot analysis of pregnancy wastage in 9 districts of Manipur during NFHS-4 and NFHS-5. The number of hotspots and cold spots have decreased in the last five years. During 2015–2016 and 2019–2021, major persistent hotspot clustering of pregnancy wastage was observed in the valley of districts of Manipur, namely, Imphal East, Imphal West, Bishnupur, and Thoubal. However, significant changes can be seen as the total number of major hotspot clusters in these 4 districts has decreased in 2019–2021.

As evident from Table 1, there is a gradual decline in the prevalence of live births from NFHS-2 to NFHS-5. Further, the percentage of miscarriage has been continuously increasing from NFHS-2 to NFHS-5. Considering stillbirth and abortion, no significant changes can be observed in the last two rounds of NFHS.

It is evident from Table 2 that the cases of live births in Manipur are remarkably low (except for the age group of 15–19) compared to the rest of the north-eastern states. In relation to other states, abortion and miscarriage are also exceptionally high among Manipuri women of all age groups, except 15–19 years.

Bayesian Logistic Regression Analysis

A Bayesian logistic regression analysis (Table 3) revealed that the number of abortions among OBC, and SC/Other women was three times higher than that of ST women. According to religion, Muslim women had a 14% lower abortion rate than Hindu women, while Christian women and other women had a 11% and 42% higher abortion rate than Hindu women, respectively. Further, the risk of abortion increased by 82% and 88% for women in the middle and upper quintiles, respectively, compared to women from the poorest families. Women who visited antenatal care

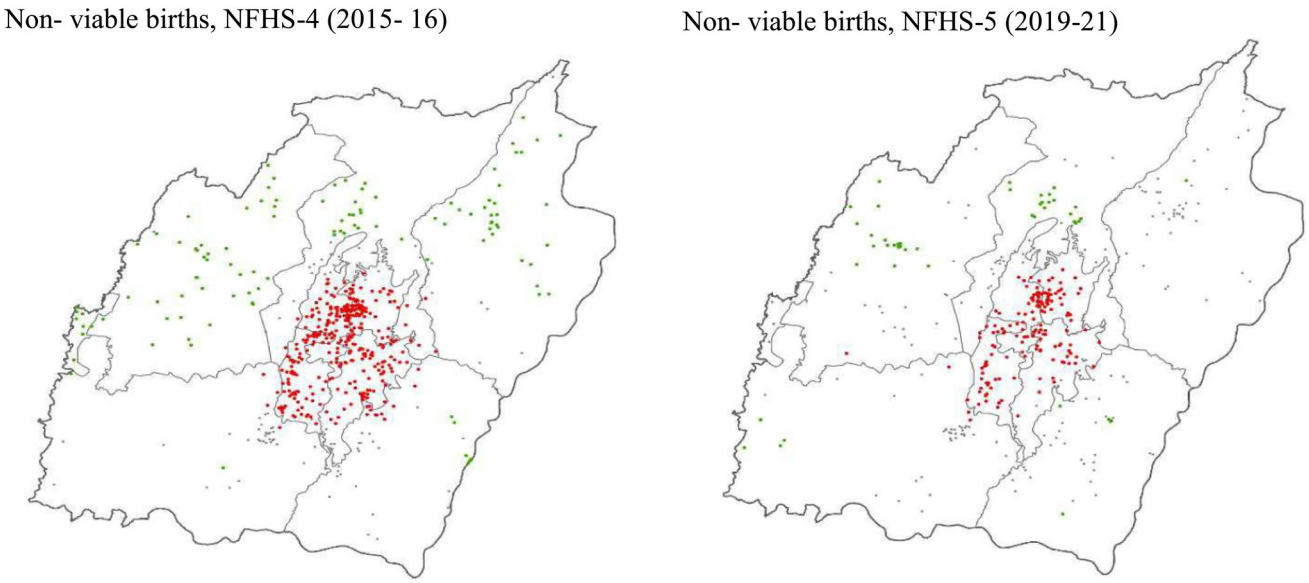

Fig. 3 Spatial clustering of pregnancy in Manipur NFHS-4 (2015–2016) and NFHS-5 (2019–2021)

Table 1 Pregnancy outcomes in Manipur based on the last 25 years of NFHS data

Manipur	Live birth	Non-live birth	Total	Miscarriage	Stillbirth	Abortion
NFHS-2	85.8	14.2	100	6.6	1.2	6.3
NFHS-3	82.6	17.4	100	NA	NA	NA
NFHS-4	78.9	21.2	100	10	0.4	10.8
NFHS-5	76.8	23.2	100	12.3	0.4	10.4

Table 2 NFHS-5 data on pregnancy outcomes in the north-eastern states of India (age: 15–49 years)

State			Arunachal Pradesh	Assam	Manipur	Meghalaya	Mizoram	Nagaland	Sikkim	Tripura
Age group	15–19 years	Live birth	88.9	89.4	92	92.4	93.9	88.5	No data available	91.4
		Abortion	4.3	2.9	1.3	0.3	0	4.5		6.2
		Miscarriage	6.7	7.3	6.7	7.3	6.1	7.1		1.9
		Still birth	0	0.4	0	0	0	0		0.6
	20–29 years	Live birth	93.9	90.9	80.2	96	95.1	93.8		88.6
		Abortion	2.7	4.3	7.7	0.1	0.1	1.7	2.1	6.8
		Miscarriage	3.1	4.2	11.7	2.9	4.7	4.5	3	3.7
		Still birth	0.2	0.7	0.4	1	0.1	0.1	0	0.8
	30–39 years	Live birth	93.3	87.8	75.9	95	92.6	91.5	90.5	83.8
		Abortion	2.7	6.5	14.8	0.2	0.4	2.5	1.4	9.2
		Miscarriage	3.5	5.3	9	4.1	6.9	5.5	6	6.2
		Still birth	0.5	0.4	0.3	0.6	0.2	0.5	2.1	0.8
	40–49 years	Live birth	94.7	76.3	54.2	90.8	84.9	86.2	No data available	78.1
		Abortion	1.1	10.8	22.6	0.3	0	0.8		13.7
		Miscarriage	3.2	10.8	20.9	7.9	15.1	11.7		8.2
		Still birth	0.9	2.1	2.3	1	0	1.3		0
Total no. of pregnancies			4958	9922	2665	4510	1796	2072	528	1939

Table 3 Socioeconomic characteristics, prevalence of abortion and miscarriage and Bayesian logistic regression analysis

	Abortion			Miscarriage		
Independent variables	% (n)	χ^2 value	adjusted Odd Ratio (95% CI)	% (n)	χ^2 value	adjusted Odd Ratio (95% CI)
Mother's age at birth		10.72			6.57	
15–24 (youth)	7.2(990)		Reference	14.9(990)		Reference
25–34 (middle)	10.0(1758)		1.48(1.06–2.05)	11.5(1758)		0.91(0.76–1.08)
34–49 (older)	6.1(477)		0.83(0.51–1.30)	12.4(477)		0.79(0.64–0.99)
Place of residence		6.26			11.35*	
Urban	10.3(690)		Reference	15.6(690)		Reference
Rural	7.7(2535)		1.08(0.86–1.34)	11.3(2535)		0.91(0.76–1.08)
Living situation of the mother		2.63			2.68	
Living with husband	8.8(2858)		Reference	13.0(2858)		Reference
Living without husband	6.2(367)		0.87(0.61–1.19)	9.9(367)		0.69(0.54–0.88)
Education level		5.13			3.76	
Illiterate	6.7(304)		Reference	10.0(304)		Reference
Primary	7.3(488)		0.88(0.57–1.25)	11.7(488)		1.22(0.96–1.48)
Secondary	9.3(2016)		1.07(0.72–1.51)	13.5(2016)		1.21(0.95–1.65)
Higher	7.0(417)		0.63(0.40–0.93)	11.5(417)		1.25(0.95–1.71)
Currently working		0.7			0.02	
No	8.6(3073)		Reference	12.7(3073)		Reference
Yes	6.7(152)		0.64(0.45–0.90)	13.1(152)		1.09(0.77–1.51)
Social groups		53.01*			23.73*	
ST	3.5(1912)		Reference	8.8(1912)		Reference
OBC	9.7(289)		2.97(2.17–4.15)	12.9(289)		1.21(0.79–1.79)
SC/Others	11.4(1024)		3.30(2.19–4.58)	15.2(1024)		1.13(0.78–1.53)
Religion		63.59*			21.81*	
Hindu	11.1(730)		Reference	14.7(730)		Reference
Muslim	7.9(259)		0.86(0.49–1.43)	11.9(259)		0.95(0.65–1.30)
Christian	3.6(1928)		1.11(0.79–1.50)	9.3(1928)		0.66(0.46–0.90)
Others	13.9(308)		1.42(0.93–2.02)	16.2(308)		1.00(0.75–1.31)
Wealth quintile		20.85*			10.76	
Poor	6.0(1747)		Reference	10.5(1747)		Reference
Middle	11.2(583)		1.82(1.33–2.41)	14.1(583)		1.23(0.89–1.57)
High	10.0(895)		1.88(1.33–2.54)	14.5(895)		1.03(0.82–1.26)
Number of ANC visit		26.61*			5.72*	
Less than 4	5.1(1500)		Reference	10.8(1500)		Reference
More than 4	10.4(1725)		2.15(1.53–2.90)	13.7(1725)		0.91(0.78–1.07)
Husband's presence at ANC visit		2.32			4.81	
Not present	7.6(1471)		Reference	13.7(1754)		Reference
Present	9.1(1754)		1.75(1.29–2.27)	11.1(1471)		1.18(0.88–1.52)
Consumed smokeless tobacco		15.79*			0.01	
No	6.9(1967)		Reference	12.6(1967)		Reference
Yes	10.9(1258)		1.49(1.14–1.90)	12.8(1258)		0.92(0.76–1.11)
BMI		20.22*			12.76*	
Thin	9.7(202)		Reference	9.0(202)		Reference
Normal	6.8(2107)		1.01(0.51–1.90)	11.6(2107)		1.14(0.89–1.38)
Overweight & obese	11.5(916)		1.52(1.24–1.81)	15.6(916)		1.48(1.13–1.86)

(ANC) more than four times had twice as many abortions as those who visited fewer than four times. The risk of facing or having an abortion was 49% higher for women who used smokeless tobacco than those who did not consume it. Another important factor that influences abortion is women's body mass index (BMI); overweight/obese women had a 52% higher chance of having an abortion than women who were thin or underweight BMI.

Further, the results also showed that covariates such as the type of place of residence (rural/ urban), social groups (ST/OBC/SC or others), religion (Hindu, Muslim, Christian, others), number of antenatal (ANC) visits (less than 4, more than 4), and body mass index (BMI) were significantly related with miscarriages among pregnant women in Manipur.

Women living in rural areas were less likely to experience miscarriage than urban women in Manipur. Miscarriage rates among OBC and SC/Other women were 21% and 13% higher, respectively, than those of ST women. According to religion, Christian women had a 33% lower miscarriage rate than Hindu women, whereas Muslim women and women who belonged to other religion had likely the same miscarriage rate as Hindu women.

It can also be observed that that miscarriage rates were 9% less for women who visited antenatal care more than four times compared to those who visited fewer than four times. Also, the risk of miscarrying increased by 34% and 48% for women with a BMI of normal or overweight/obese compared to those with a BMI of thin or underweight.

Discussion

The present research explored the spatial clustering and determinants of pregnancy wastage in 9 districts of Manipur. Spatial analysis was also carried out to understand the relative change in clustering patterns of pregnancy wastage from 2015–2016 to 2019–2021.

It was observed that persistent major hotspot clusters of abortion, miscarriage, and total pregnancy wastage fall in the valley districts of Manipur, namely Imphal East, Imphal West, Thoubal, and Bishnupur. Comparatively, the hill districts of Manipur were observed to have no major hotspot clusters of pregnancy wastage. A recent geospatial analysis study also reported that the prevalence of abortion and still birth were majorly concentrated in the valley regions of Manipur [9].This geographical variation in the prevalence of pregnancy wastage may be indicative of the role played by lifestyle and other socio-economic factors in the outcomes of pregnancy among women in hill and valley districts. Hence, the need for developing district- centric, targeted and tailored intervention becomes a necessary measure in combating the issue.

Further, our results also showed that the hotspot clusters of pregnancy wastage have drastically decreased from NFHS-4 to NFHS-5. However, despite the decline, a recent report (NFHS-5) indicated that Manipur has the highest prevalence of pregnancy wastage in India (15%), against the national average value of 8.8% [8]. Hence, pregnancy wastage continue to be a major public health issue in Manipur.

Regarding determinants of pregnancy wastage, overweight and obese women were 52% and 48% more likely to experience abortion and miscarriage, respectively, when compared to women with thin and normal BMI. Similar findings have been reported where obesity has been linked to various perinatal complications [13]. These findings emphasize the need for behaviour change intervention to help women adopt healthy lifestyle choices. This could help prevent adverse pregnancy outcomes among women. Also, Christian women have 44% fewer chance of having miscarriages and religious affiliation may have a protective role in this regard.

Considering abortion, women with higher education and working women were, respectively, 37% and 36% less likely to experience abortion compared to other counterparts. This shows that education and working environment might have played a pivotal role in preventing or reducing the risk of abortion among women. It was also observed that mother's age at birth (25–34 years) and mother with higher wealth quintile have 1.5 times and 2 times higher risk of having abortion, respectively; more studies are required to understand the possible factors unique to these groups. Additionally, women with more than 4 ANC visits, husband's presence during ANC visit and use of smokeless tobacco were 2 times, 1.8 times and 1.5 times more likely of having abortion.

The high prevalence of pregnancy wastage in Manipur highlights the need for conducting extensive and in-depth research to understand lifestyle and other psycho-social risk factors. For instance, many studies have shown that sleep quality, stress, depression, anxiety, marital dissatisfaction, and a lack of social support have been linked to adverse pregnancy outcomes [14, 15].

Strength and Limitation

A graphic representation of places with a higher density of hotspots may be able to guide health professionals to target geographically and visual cues may serve better than information tables. Being nationally representative surveys, the NFHS-4 and NFHS-5 surveys are exhaustive and comprehensive. The sample consists of a diverse population from all corners of the state which includes women from all backgrounds, religion, region, caste, culture, creed, socio-economic status, etc. The current research analysed data extracted from these surveys;

therefore, the limitations of the original data are applicable to the current study too. The frequency of stillbirth is very small and was not considered for analysis in the current study. Other contributing factors which might have led to high prevalence, i.e. psycho-social factors, genetic factors, environmental and geographical factors, etc., are not included in the study.

Conclusion

The higher density cluster of hotspots in the valley districts is alarming and maximum efforts are required from related authorities to counter the problem. Investigation of under-reported cases must also be considered. Psycho-education regarding stigma or taboo associated with abortion, miscarriage or stillbirth must be addressed in places where there is higher prevalence as well as possible under-reporting. Positive viable births are a sign of development index of a country; the central as well as the local government must consider laying efforts and resources, and implement customized policies to intervene the alarming rise in the rates of pregnancy wastage in Manipur. More targeted and area specific intervention to control the factors responsible may help bring about drastic improvement. It is also imperative that maternity clinics in hospitals and health centres have holistic intervention and counselling services for pregnant women. Additionally, better access to health facilities, improvement of currently existing health infrastructure, better psycho-education, and information regarding pregnancy wastage, and medical professionals' voluntary sensitization to couples may vastly improve the condition of pregnancy wastage and eventually save lives.

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Declarations

Conflict of interest The authors declare no competing interests.

Ethical Statement The present study is based on a secondary data set from the NFHS-4 and NFHS-5 survey with no identifiable information on the survey participants. This data set is available in the public domain for various research purposes [https://dhsprogram.Com/data/dataset.India_Standard-DHS_2015.Cfm?flag=1]. Hence, no ethical approval was needed.

Informed Consent Informed consent was obtained from all individual participants.

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