

Original Research

Increased hypertension following hysterectomy among reproductive women in India

Shiva S. Halli^{a,*}, Dharmendra P. Singh^b, Rajeshwari A. Biradar^c^a Department of Community Health Sciences, University of Manitoba, Winnipeg, MB, Canada^b School of Research Methodology, Tata Institute of Social Sciences, Mumbai, India^c School of Development Studies, Tata Institute of Social Sciences, Mumbai, India

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ABSTRACT

Background: In recent years, hysterectomy has received increased attention in health policy debates in India. On the other hand, based non-communicable disease specific data for India, in 2011, WHO portray a grim picture and recommended to the government a 20% reduction in hypertension by 2020; however, the trends show that it is increasing. Yet, to date, there has not been a single nationally representative study of hypertension prevalence among women who undergo a hysterectomy.

Methods: The study has used the Indian fourth round of National Family Health Survey data, which is a cross-sectional nationally representative sample of 699,686 women in the age group 15–49 years and conducted during 2015–16. Bivariate and multivariate logistic regressions were used to examine the effect of hysterectomy on increased odds of hypertension among women of reproductive age groups.

Results: The age adjusted prevalence of hypertension was higher among women those who undergone hysterectomy (11.9%) compared to non-hysterectomy women (10.6%). The pattern holds true among relevant background characteristics such as age, place of residence, education, caste, religion, wealth, family size, years since hysterectomy, body mass index (BMI), anaemia and consumption of tobacco. The adjusted odds of hypertension among women who underwent hysterectomy compared to those who did not was 1.72 (95% CI: 1.14–2.58).

Conclusions: The results indicated increased hypertension level among hysterectomy women. However, these results are based on a cross-sectional study, and hence, further through investigation based on a prospective study is necessary before undertaking any policy changes. Meanwhile, the government of India may like to suggest surveillance to the general practitioners as well as obstetricians and gynaecologists following a hysterectomy in order to better understand the effect of hysterectomy on hypertension.

1. Introduction

Hysterectomy is the surgical removal of the woman's uterus. More than 600,000 hysterectomies are conducted in the United States each year [1]. Hysterectomy is the second most common major operation in women of childbearing age [2]. For many gynaecological problems especially women suffering from heavy bleeding, hysterectomy is a recommended treatment for women. There is evidence to have a concomitant bilateral salpingo-oophorectomy (BSO) at the time of hysterectomy to prevent the subsequent development of ovarian cancer, treat medical conditions, or prevent the need for future adnexal surgery [1,3,4]. However, this may lead to an immediate decline in the production of sex

hormones such as estrogen and progesterone, which are responsible for vessel wall endothelial dysfunction leading to hardening of arteries and subsequent hypertension [5]. Other researchers also found that women who had a hysterectomy without ovarian removal were more likely to have high cholesterol, high blood pressure, irregular heartbeat, and heart disease and to become obese later in life than those who had their reproductive organs [6,7]. Moreover, women who had hysterectomy before the age of 35 experienced a 4.6-fold increased risk of congestive heart failure and a 2.5-fold increased risk of coronary artery disease. A cohort study found that women with hysterectomy experienced increased risks of hyperlipidemia (a high concentration of fats in the blood), hypertension, obesity, cardiac arrhythmias, and coronary artery

* Corresponding author. Department of Community Health Sciences, Rady Faculty of Health Sciences, University of Manitoba, Winnipeg, Manitoba, R3E 0T6, Canada.

E-mail address: shiva.halli@umanitoba.ca (S.S. Halli).

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disease [8]. A special study conducted among nurses found a 17% increased likelihood of coronary heart disease and a 14% increased likelihood of stroke for women with a hysterectomy and bilateral oophorectomy compared with those with ovarian conservation [9]. The most recent cohort study conducted in Taiwan found that hypertension was higher in the hysterectomy cohort than in the comparison cohort [4]. In spite of these findings, the association between hysterectomy and subsequent cardiovascular disorders are controversial [10–15].

In the past few years, hysterectomy has received increased attention in health policy debates in India. The trigger for increased focus is provided by a series of media reports that have highlighted an unusual surge in the number of women undergoing hysterectomy in many parts of the country, with a significant number of cases involving young and early menopausal women from low-income families [16–18]. British Broadcasting Corporation's (BBC) documentary on hysterectomy highlights that doctors especially in rural India instead of resorting to conservative techniques, went straight for surgeries which meant more money for them by exploiting the national health insurance scheme [16]. Reports from a few Indian states, including Rajasthan, Chhattisgarh, Bihar, and Andhra Pradesh, suggest that an unusually high number of women are having their uteruses removed, including many below the age of 40 [19]. For instance, the Oxfam report on India from one of the health camps stated that of 2606 women who were examined, 316 women, about 12% had their uteruses removed unnecessarily [20]. Furthermore, Oxfam's Health Policy Advisor reported the immediate health consequences such as incontinence, irritable bowel syndrome, back pain, depression, loss of sexual pleasure, thrombosis and vaginal prolapse [20].

In spite of this, very little is known about the risk of developing subsequent cardiovascular diseases following a hysterectomy in Asia with the exception of one study in Taiwan.

For effective targeting of health system resources and services in a developing country like India, it is essential to understand how the level of hypertension varies among women with and without hysterectomy. Yet, to date, there has not been a single study to understand increased level of hypertension among women who undergo hysterectomy (hereafter referred to as hysterectomy women) and women who did not undergo hysterectomy (hereafter referred to as non-hysterectomy women) in India. Fortunately, for the first time in India, the National Family Health Survey-4 (NFHS-4) collected data both on hysterectomy and hypertension among reproductive women. Hence, the purpose of this study is an attempt towards addressing this research gap to provide much-needed evidence to inform policymakers.

2. Methods

The study used the women's file of National Family Health Survey round four (NFHS-4) 2015–16. This was a household survey covering 640 districts from 29 States and 6 Union Territories of India. The International Institute for Population Sciences conducts NFHS under the sponsorships of the Ministry of Health and Family Welfare (MoHFW), Government of India (GOI). NFHS-4 provides information on population, health and nutrition for India and all state/union territory and districts. During NFHS-4, across the country, 28,586 Primary Sampling Units (PSUs) were selected, out of which 28,522 clusters fieldwork was completed. With a response rate of 98%, a total of 601,509 households were successfully interviewed using Computer-assisted personal interviewing (CAPI) electronic device to answer the free installed structured questionnaire. A total of 723,875 eligible women age 15–49 were identified for an interview among interviewed households. With a 97% response rate, 699,686 women participated in the survey. However, we excluded pregnant women and included a sample of 667,258 non-pregnant women.

The outcome variable used in the present analysis was hypertension among non-hysterectomy and hysterectomy women. NFHS-4 collected hypertension information using an Omron Blood Pressure Monitor to determine the prevalence of hypertension in reproductive age women.

Blood pressure measurements for each respondent were taken three times with an interval of 5 minutes between readings. According to NFHS-4 report, reproductive women are classified as having hypertension with an average systolic blood pressure (SBP) of >140 mm Hg or average diastolic blood pressure (DBP) of >90 mm Hg or currently taking antihypertensive medication to lower her blood pressure. We used the same definition of NFHS- report for defining the prevalence of hypertension among non-pregnant reproductive women in India.

The NFHS-4 asked women various questions related to hysterectomy. The first question was: "When did your last menstrual period start?" Among the several answers to this question, one of the options was "Has had hysterectomy". The direct question on hysterectomy canvassed was "Some women undergo an operation to remove the uterus. Have you undergone such an operation?" If the answer was yes, women were categorized in the hysterectomy group, else, categorized in the non-hysterectomy women.

Based on past studies, a number of socioeconomic and demographic variables have been included to profile the sample [21,22]. More specifically, these variables are age (15–29, 30–39, and 40–49), place of residence (Rural and Urban), education level (No education, Primary, Secondary and Higher), type of caste (Scheduled Caste/Scheduled Tribe (SC/ST), other backward caste (OBC), religion (Hindu, Muslim and Others), wealth index (Poorest, Poor Middle Richer and Richest), marital status (Never married, Currently Married, and Others), occupation (Not working and Working), consumption of alcohol (No and Yes), consumption of tobacco include both smoking (include cigarettes, pipe, cigars and any other tobacco products including local *beedies* in the village) and tobacco chewing (*gutkha/paan masala* containing tobacco, *paan* with tobacco, chewing tobacco and snuff) (No and Yes). In addition to this, body mass index (BMI) was categorized as too thin for their height (BMI below 18.5 kg/m²), normal (between 18.5 and 24.9 kg/m²), overweight (between 25 and 29 kg/m²) and obese (above 30 and above kg/m²) (NFHS-4), and anaemia levels (Severe, Moderate, Mild and Not anaemic) were included (NFHS-4). We also included the regions of India such as North, Central, East, Northeast, West and South.

Data were analysed using bivariate and multivariate statistical methods. The bivariate analysis has been used to assess the association between the prevalence of hypertension among hysterectomy and non-hysterectomy women by background characteristics. Because of the substantial difference in the compositions of age groups among women with and without hysterectomy, it is necessary to age-standardize the prevalence rates of hypertension for comparison. For this purpose, we selected 2011 Indian Census age distribution as standard and employed it in deriving all the age adjusted rates. The formula calls computing the weighted average of the age specific hypertension rates, using as weights the age distribution of the 2011 Census distribution. In other words, in standardizing the hypertension rate for age, each age-specific hypertension rate is multiplied by the population of the 2011 Census in that age group. The cumulative product is divided by the total population. The procedure is applied for both the groups of women with and without hysterectomy to compute age standardized hypertension rates for comparison.

Multivariate logistic regression analysis has been used for assessing the effect of hysterectomy after controlling for background characteristics on the odds of hypertension among non-pregnant women.

2.1. Limitations and strengths

There are some limitations of the study, for instance, the study is using cross-sectional data and the lack of follow-up for cardiovascular disease events to see whether the greater hypertension prevalence translated into increased cardiovascular event risk is not possible. The fact that this was not a longitudinal study, we were unable to observe at the actual development of hypertension among women with or without hysterectomy. However, for the first time in India, the National Family Health Survey-4 (NFHS-4) collected data on hysterectomy, hypertension

and life style factors among reproductive women. This would allow us to examine the standardized assessment of blood pressure among hysterectomy women while controlling for important life style factors such as body mass index, drinking and smoking habits.

3. Results

Table 1 is included to provide age adjusted hysterectomy prevalence among reproductive age women, the type of facility where the women underwent hysterectomy and the self-reported reasons for hysterectomy. The table indicates that 16% of the women underwent hysterectomy before the age of 45. Moreover, more than two-thirds of the women underwent hysterectomy in private health facilities; and 55% of the total were reported to be for excessive menstrual bleeding/pain. According to NFHS-4, the age adjusted prevalence of hypertension among reproductive women is 10.6% in India (Fig. 1). However, it is increased to 11.9% among women who underwent hysterectomy (Fig. 1). Table 2 reveals a comparative overview of the prevalence hypertension by background characteristics among hysterectomy and non-hysterectomy women in India. The data revealed that women with hysterectomy even during premenopausal years are at an increased odds of hypertension. According to the table, the prevalence of hypertension was higher among hysterectomy women compared to non-hysterectomy women for each category of background characteristics. For instance, among secondary school educated, not working, richest, dissolution of marriage, obese and severely anaemic hysterectomy women, the prevalence of hypertension was 23.9%, 22.2%, 29.2%, 24.4%, 41.9% and 27.4% compared to non-hysterectomy women with the levels 9.1%, 9.9%, 11.7%, 17.3%, 27.6% and 7.4% respectively. As expected, age, wealth index, and BMI are all positively associated with the prevalence of hypertension and OBC caste, Hindus, never-married, non-alcohol consuming, non-smoking women had lower hypertension compared to their counterparts for both groups of women (hysterectomy and non-hysterectomy) (Table 2). Similarly, significant differences in place of residence as well as regional differences in the prevalence by hysterectomy status were noticed (Table 2). The table also indicates that more than 26% of the hysterectomy women experienced hypertension compared to less than 5% of the non-hysterectomy women before they had any children. Moreover, 39% of the women underwent hysterectomy two years prior to the survey.

Because of possible confounding factors, the results of multivariate logistic regressions are presented in Table 3 to understand the effect of hysterectomy status on hypertension level after controlling for the

Table 1
Percentage of women undergone hysterectomy by age, place of hysterectomy and reported reasons for hysterectomy, India.

Characteristics	Percentage	Sample (N)*
Age group		
15-19	0.0	17
20-24	0.2	190
25-29	1.0	1078
30-34	2.6	2425
35-39	4.8	4314
40-44	7.8	6053
45-49	10.7	7967
Place of Hysterectomy		
Public	32.3	7123
Private	67.4	14848
Other	0.3	74
Reasons for hysterectomy		
Excessive menstrual bleeding/pain	55.3	12199
Fibroids/Cysts	19.5	4294
Uterine disorder (Rupture)	13.9	3056
Cancer	5.6	1225
Uterine prolapse	7.8	1721
Severe post-partum haemorrhage	3.5	762
Other	7.4	1639

Note: Weighted cases

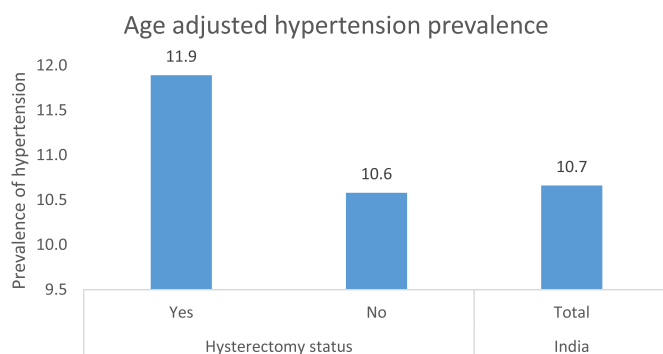


Fig. 1. Prevalence of hypertension by hysterectomy status among non-pregnant reproductive women in India, 2015-16.

significant background variables. The results of the multivariate analysis were no different from the bivariate with the exception of a few variables being insignificant. The most notable being the years since hysterectomy. It is observed that the increased odds of hysterectomy is present regardless of time since hysterectomy. The conspicuous finding was that even after controlling for all the background factors including important factors such as age, wealth status, family size, years since hysterectomy, life style factors (alcohol consumption, smoking, BMI and anaemia) those women who underwent hysterectomy experienced a significant increase in hypertension. The adjusted odds of hypertension among women who underwent hysterectomy compared to those who did not was 1.72 (95% CI: 1.14–2.58).

4. Discussion

Hypertension is an important risk factor for attributable burden of disease in India since it is directly responsible for 57% of all stroke deaths and 24% of all coronary heart disease deaths [23]. Based on non-communicable disease specific data for India in 2011, the WHO portray a grim picture and recommended a 20% reduction in hypertension by 2020; however, trends show that it is increasing [24]. Similarly, hysterectomy has received increased attention in health policy debates in recent years in India. This was partly because series of media reports including BBC documentary (repetitive from intro) had highlighted an unusual surge in the number of women undergoing hysterectomy in many parts of the country, with a significant number of cases involving young and early menopausal women from low-income families [16]. Considering seriousness of the problem, the Government of India should consider effective targeting of health system resources and services. Hence, it is necessary to understand important contributing factors for hypertension including how the prevalence of hypertension varies among hysterectomy and non-hysterectomy women. Based on a large scale, nationally representative sample, our study results showed that the overall age adjusted prevalence of hypertension among non-pregnant reproductive women in India was 10.6% and the prevalence of hypertension was 11.9% among hysterectomy women. Surprisingly, the prevalence was consistently higher for each of the characteristics considered in the study among the hysterectomy women compared to the non-hysterectomy women. The multivariate adjusted odds ratios have also shown that the adjusted odds after controlling for significant background factors, women who underwent hysterectomy experienced 72% increased likelihood (odds ratio of 1.72; 95% CI: 1.14–2.58) of hypertension compared to those who did not. The pathophysiology of the hypertension odds among hysterectomy women remains elusive. Some of the reasons in the literature regarding increased odds of hypertension among hysterectomy women are: ovarian hormones, especially estrogens and progesterone, play a pivotal role for vessel wall endothelial dysfunction leading to hardening of arteries and subsequent hypertension [5]. Moreover, women who had a hysterectomy without ovarian removal were more likely to have high cholesterol, high blood pressure,

Table 2

Hypertension by background characteristics among non-hysterectomy and hysterectomy non-pregnant reproductive women in India, 2015–16.

Variables		Hypertension among non-hysterectomies	p-value*	Total**	Hypertension among hysterectomies	p-value*	Total**
Age in 5-year groups	15–19	3.1	0.000	121,177	3.5	0.000	15
	20–24	4.7		109,073	3.5		147
	25–29	6.9		104,387	8.0		876
	30–34	10.3		91,375	12.2		2019
	35–39	14.7		85,641	17.2		3577
	40–44	19.8		71,414	23.3		4959
Place of residence	45–49	25.1	0.000	66,042	28.1	0.000	6556
	Urban	11.3		191,892	26.4		5025
Religion	Rural	10.3	0.000	457,217	19.7	0.000	13,124
	Others	12.0		167,856	28.7		3377
Caste	Hindu	10.3	0.000	481,253	20.5	0.000	14,772
	SC/ST	10.2		234,421	21.2		5092
Educational level	OBC	10.3	0.000	252,327	20.4	0.000	8427
	Others	11.8		162,361	24.5		4630
	No education	14.0		179,305	19.4		9102
	Primary	12.8		80,979	23.6		3031
Wealth index	Secondary	9.1	0.000	313,506	24.2	0.000	5347
	Higher	7.6		75,319	23.9		669
	Poorest	9.6		122,920	14.4		2646
	Poorer	9.8		138,259	17.9		3591
	Middle	10.2		136,441	19.0		4130
Marital Status	Richer	11.6	0.000	128,838	25.2	0.000	4089
	Richest	11.7		122,651	29.2		3693
	Never married	3.9		171,629	8.2		75
	Married	12.6		450,633	21.5		16,769
Body Mass Index	Others	17.3	0.000	26,847	24.4	0.000	1305
	Too thin for their height	5.8		137,968	9.4		2262
	Normal	9.1		375,629	17.3		9207
	Overweight	19.4		87,671	29.1		4404
Alcohol consumption	Obese	27.6	0.000	27,056	41.9	0.586	1731
	No	10.6		632,791	21.7		17,757
Anaemia level	Yes	18.4	0.000	16,318	18.6	0.000	392
	Severe	7.4		6390	27.4		99
	Moderate	9.5		73,393	20.4		1286
	Mild	9.6		249,531	18.7		6067
Occupation	Not anaemic	12.5	0.000	305,962	24.4	0.000	10,335
	Not working	9.9		78,743	22.2		2013
Smoking	Working	10.8	0.000	33,535	14.4	0.604	1164
	No	10.6		640,709	21.7		17,878
Chewing tobacco	Yes	13.7	0.000	8400	21.8	0.144	271
	No	10.4		600,520	21.7		16,860
Regions	Yes	15.3	0.000	48,589	20.7	0.000	1289
	North	11.0		131,440	26.9		3055
	Central	9.3		171,246	20.7		4564
	East	10.2		115,870	18.5		3853
	Northeast	16.9		92,933	30.1		1212
Children ever born	West	11.0	0.000	52,444	22.6	0.000	1713
	South	11.0		85,176	22.2		3752
	0	4.9		210,045	26.1		366
	1	9.9		82,376	26.4		1226
	2	12.4		147,425	21.4		5343
Years since hysterectomy performed	3 and above	15.4	N/A	209,263	21.1	0.000	11,214
	<1	N/A		N/A	17.6		1192
	1–2	N/A		N/A	21.0		3220
	3–4	N/A		N/A	20.6		3249
	5 and above	N/A		N/A	22.6		10,364

Note: *The Chi-square statistic is significant at 0.05 level; **Unweighted cases.

irregular heartbeat, and heart disease [6,7]. Another theory was that hysterectomy might compromise ovarian blood flow from the ovarian ligament, leading to premature ovarian failure, which in turn leads to a decline in hormonal levels, thereby accelerating the development of early menopause. The confounding effects of early menopause and hormone changes likely lead to increased likelihood of hypertension [7].

5. Conclusions

The prevalence of hypertension among hysterectomy women is a critical issue for women's health in India. Women in India who undergo a hysterectomy at a younger age have a longer risk of exposure to

hypertension leading to other cardiovascular diseases. The current study provided unequivocal support for the increased odds of hypertension following hysterectomy among women in reproductive ages in India. As found in other studies, early menopausal women develop significantly more hardening of arteries after hysterectomy in comparison to post-menopausal women which may lead to long-term effects of hysterectomy on cardiovascular diseases in particular and women's health in general. In the present study, we found a modest increase in the odds ratio of hypertension due to hysterectomy based on cross-sectional data, and hence, further investigation through a prospective study is necessary before undertaking any policy changes. Meanwhile, it is worth the effort for the government to suggest surveillance to the general practitioners as

Table 3

Adjusted Odds Ratio for association of covariates with hypertension among non-pregnant reproductive women in India, 2015–16.

Variables	Sig.	Exp(B)	95% C.I.for EXP(B)		
			Lower	Upper	
Age	0.000	1.07	1.07	1.07	
Education	0.000	0.94	0.93	0.95	
Place of residence	Urban (Reference)				
	Rural	0.000	1.05	1.03	1.07
Religion	Others (Reference)				
	Hindu	0.000	0.89	0.87	0.91
Caste	SC/ST (Reference)				
	OBC	0.002	0.97	0.95	0.99
	Others	0.000	1.06	1.04	1.08
Wealth index	Poorest (Reference)				
	Poorer	0.154	0.98	0.95	1.01
	Middle	0.004	0.96	0.93	0.99
	Richer	0.358	0.99	0.96	1.02
	Richest	0.000	0.92	0.88	0.95
Marital Status	Others (Reference)				
	Married	0.014	1.04	1.01	1.06
Body Mass Index	Too thin for their height (Reference)				
	Normal	0.000	1.27	1.24	1.30
	Overweight	0.000	2.43	2.36	2.50
	Obese	0.000	3.82	3.68	3.96
Alcohol consumption	No (Reference)				
	Yes	0.000	1.39	1.33	1.45
Anaemia level	Severe/Moderate (Reference)				
	Mild	0.000	1.05	1.02	1.08
	Not anaemic	0.000	1.32	1.29	1.36
Smoking	No (Reference)				
	Yes	0.245	0.96	0.90	1.03
Chewing tobacco	No (Reference)				
	Yes	0.000	0.91	0.88	0.93
Hysterectomy	No (Reference)				
	Yes	0.010	1.72	1.14	2.58
Regions	North (Reference)				
	Central	0.000	0.88	0.86	0.90
	East	0.000	0.93	0.90	0.96
	Northeast	0.000	1.36	1.32	1.40
	West	0.000	0.94	0.91	0.97
Children ever born	0 (Reference)				
	1	0.009	0.95	0.92	0.99
	2	0.000	0.91	0.88	0.94
	3 and above	0.000	0.87	0.84	0.90
	<1 (Reference)				
Years since hysterectomy performed	1–2	0.654	1.04	0.87	1.24
	3–4	0.781	1.03	0.86	1.22
	5 and above	0.951	0.99	0.85	1.17

well as obstetricians and gynaecologists following a hysterectomy in order to better understand the effect of hysterectomy on hypertension of women.

Ethics approval and consent to participate

We have used publicly available secondary data sources.

Consent for publication

Data sources are in public domain and available for researchers for publication.

Availability of data and material

Data and material are publicly available for researchers.

Authors' contributions

SSH conceptualized the study wrote the text of the paper and edited the text DPS Formal analysis. RAB helped in conceptualizing led the analysis and helped in writing the text. All authors read and approved the final version of the manuscript.

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Declaration of competing interest

There are no competing interests.

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References

- [1] Mikhail E, Salemi J, Mogos M, Hart S, Salihu H, Imudia A. National trends of adnexal surgery at the time of hysterectomy for benign indication, United States 1998–2011. *J. Minim. Invasive Gynecol.* 2015 Mar 1;22(3):S18.
- [2] Ding D-C, Chu T-Y, Chang Y-H. Trend changes in the proportion of minimal invasive hysterectomies over a five-year period: a singlecenter experience. *Tzu Chi Med. J.* 2012;24:136–8.
- [3] Wu M-P, Huang K-H, Long C-Y, Tsai E-M, Tang C-H. Trends in various types of surgery for hysterectomy and distribution by patient age, surgeon age, and hospital accreditation: 10-year population-based study in Taiwan. *J. Minim. Invasive Gynecol.* 2010;17:612–9.
- [4] Ding D-C, I-J Tsai, c,d CY Hsu, e, J-H Wang, f S-Z Lin, ,g, F-C Sung. Risk of hypertension after hysterectomy: a population-based study. *International Journal of Obstetrics and Gynaecology*, DOI: 10.1111/1471-0528.15389.
- [5] Dubey RK, Oparil S, Imthurn B, Jackson EK. Sex hormones and hypertension. *Cardiovasc. Res.* 2002;53:688–708.
- [6] Luoto R, Kaprio J, Reunanen A, Rutanen EM. Cardiovascular morbidity in relation to ovarian function after hysterectomy. *Obstet. Gynecol.* 1995;85:515–22.
- [7] Menon RK, Okonofua FE, Agnew JE, Thomas M, Bell J, O'Brien PM, et al. Endocrine and metabolic effects of simple hysterectomy. *Int. J. Gynaecol. Obstet.* 1987;25: 459–63.
- [8] Ingelsson E, Lundholm C, Johansson ALV, Altman D. Hysterectomy and risk of cardiovascular disease: a population-based cohort study. *Eur. Heart J.* 2011;32: 745–50.
- [9] Parker WH, Broder MS, Chang E, Feskanich D, Farquhar C, Liu Z, et al. Ovarian conservation at the time of hysterectomy and long term health outcomes in the nurses' health study. *Obstet. Gynecol.* 2009;113:1027–37.
- [10] Gibson CJ, Thurston RC, El Khoudary SR, Sutton-Tyrrell K, Matthews KA. Body mass index following natural menopause and hysterectomy with and without bilateral oophorectomy. *Int. J. Obes.* 2013;37:809–13.
- [11] Matthews KA, Gibson CJ, El Khoudary SR, Thurston RC. Changes in cardiovascular risk factors by hysterectomy status with and without oophorectomy: study of women's health across the nation. *J. Am. Coll. Cardiol.* 2013;62:191–200.
- [12] Howard BV, Kuller L, Langer R, Manson JE, Allen C, Assaf A, et al. Risk of cardiovascular disease by hysterectomy status, with and without oophorectomy. *Circulation* 2005;111:1462–70.
- [13] Kharazmi E, Fallah M, Luoto R. Cardiovascular diseases attributable to hysterectomy: a population-based study. *Acta Obstet. Gynecol. Scand.* 2007;86: 1476–83.
- [14] Radin RG, Rosenberg L, Palmer JR, Cozier YC, Kumanyika SK, Wise LA. Hypertension and risk of uterine leiomyomata in US black women. *Hum. Reprod.* 2012;27:1504–9.
- [15] Laughlin-Tommaso SK, Khan Z, Weaver AL, Schleck CD, Rocca WA, Stewart EA. Cardiovascular risk factors and diseases in women undergoing hysterectomy with ovarian conservation. *Menopause* 2016;23:121–8.
- [16] McGivering J. The Indian Women Pushed into Hysterectomies. *The British Broadcasting Corporation (BBC)*. 2013 Feb 1.
- [17] Radheshyam J. Why many women in Maharashtra's Beed district have no wombs. Retrieved from: <https://www.thehindubusinessline.com/economy/agri-business/why-half-the-women-in-maharashtra-beed-district-have-no-wombs/article-26773974.ece>; 2019.
- [18] Namita K. Experts raise concern about rising hysterectomies in India. Retrieved from, <https://www.theweek.in/leisure/lifestyle/2018/09/18/Experts-raise-concern-about-rising-hysterectomies-in-India.html>; 2019.
- [19] IIPS I. National Family Health Survey Report (NFHS-4), 2015–16: India. Mumbai: International Institute for Population Sciences; 2017.

- [20] Bhaumik S. Oxfam calls for new regulations to reduce unnecessary hysterectomies in private hospitals. Retrieved from, <https://www.bmj.com/content/346/bmj.f852.long>.
- [21] Shekhar C, Paswan B, Singh A. Prevalence, sociodemographic determinants and self-reported reasons for hysterectomy in India. *Reprod. Health* 2019 Dec 1;16(1): 118.
- [22] Radha K, Devi GP, Chandrasekharan PA, Swathi P, Radha G. Epidemiology of hysterectomy-a cross sectional study among Pilgrims of Tirumala. *IOSR J. Dent. Med. Sci.* 2015;1(14):1-5.
- [23] Gupta R. Trends in hypertension epidemiology in India. *J. Hum. Hypertens.* 2004 Feb;18(2):73-8.
- [24] World Health Organization. *Noncommunicable Diseases Country Profiles 2018*