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Hysterectomy and unilateral salpingectomy associate with a higher risk of subsequent ovarian cancer

A population-based cohort study in Taiwan

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Abstract

Studies on the relationship between gynecologic surgery and subsequent ovarian cancer have been carried out in limited Western ethnic groups. We aim to evaluate whether receiving hysterectomy and/or salpingectomy associated with ovarian cancer risk in Taiwan.

From the Taiwan National Health Insurance Research Database, we identified a gynecologic surgery cohort consisting of women who had newly received hysterectomy (N = 181,151), salpingectomy (N = 45,410) or both hysterectomy and salpingectomy (N = 11,875) in 2000 to 2013. A comparison cohort of 953,744 women was randomly selected from women without the surgeries, frequency-matched by age and index date of the surgery case. They were followed up to identify subsequent ovarian cancer by the end of 2013.

The overall ovarian cancer incidence was 4.4-fold greater in the gynecologic surgery cohort than in the comparison cohort (41.5 vs 9.43 per 10^6 person-years) with an adjusted hazard ratio of 3.86 (95% confidence interval = 2.56–5.84). Women with both hysterectomy and salpingectomy had the highest incidence and followed by women with hysterectomy or salpingectomy (52.5, 45.5, or 23.3 per 10^6 person-years, respectively). No ovarian cancer was noted in the subgroup with bilateral salpingectomies.

We conclude that women with gynecologic surgery of hysterectomy and/or salpingectomy are at an increased risk of developing ovarian cancer, particularly among women who have had other gynecologic comorbidity. Women with gynecologic surgery and comorbidity deserve greater attention to prevent and screen for ovarian cancer.

Abbreviations: BSO = bilateral salpingo-oophorectomy, CI = confidence interval, ERs = estrogen receptors, HPO = hypothalamic-pituitary-ovarian, HR = hazard ratio, ICD-9-CM = international classification of diseases, 9th revision, clinical modification, LH = luteinizing hormone, NHI = National Health Insurance, NHIRD = National Health Insurance Research Database, OC = ovarian cancer, PID = pelvic inflammatory disease.

Keywords: cohort, hysterectomy, ovarian cancer, population, salpingectomy

Editor: Jimmy T. Efird.

This study is supported in part by the Taiwan Ministry of Health and Welfare Clinical Trial Center (MOHW108-TDU-B-212-133004); China Medical University Hospital; Academia Sinica Stroke Biosignature Project (BM10701010021); Ministry of Science and Technology Clinical Trial Consortium for Stroke (MOST 107-2321-B-039-004-); Tseng-Lien Lin Foundation in Taichung, Taiwan; and Katsuzo and Kiyo Aoshima Memorial Funds, Japan.

The funder had no role in the design and conduct of the study; collection, management, analysis, and interpretation of the data; preparation, review, or approval of the manuscript; and decision to submit the manuscript for publication.

The authors have no conflicts of interest to disclose.

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How to cite this article: Harnod T, Tsai IJ, Chen W, Wang JH, Lin SZ, Sung FC, Ding DC. Hysterectomy and unilateral salpingectomy associate with a higher risk of subsequent ovarian cancer: a population-based cohort study in Taiwan. Medicine 2019;98:48(e18058).

Received: 18 June 2019 / Received in final form: 10 October 2019 / Accepted: 22 October 2019

http://dx.doi.org/10.1097/MD.0000000000018058

1. Introduction

Ovarian cancer (OC) is known as the second most common gynecologic malignancy and the most lethal gynecologic cancer with the incidence much greater in the Western countries than in Taiwan (9.4 vs 7.0 per 100,000).[1,2] The incidence of cancer steadily increased in recent 2 decades with the mortality varies in different regions of the world. Oral pills taking can lower down the risk of OC.[3] However, little women want to take oral pills for contraception in Taiwan than in Western countries.[4] Another risk factor for OC is obesity. Globally, the incidence increased from 6.4% to 14.9% in women over the past 4 decades.[5] However, the prevalence of obesity in Taiwan is lower than the Western countries.[6] Above all, there might cause a lower incidence of OC in Taiwan.

Because of vague symptoms and lack of effective screening programs, OC is usually diagnosed at a late stage. Despite the continuous improvement in surgical technologies and systemic treatment interventions, the prognosis of the disease generally remains discontented.[1,7–9] Previous studies lend the hypothesis that the fallopian tube plays an important role in the treatment and prevention of OC.[10,11] Salpingectomy is thus thought to decrease the development of cancer.

A meta-analysis based on 13 studies showed that tubal ligation could reduce the OC risk for 34%.[12] Another meta-analysis also suggested that tubal ligation and hysterectomy are associated with reducing the OC risk for 26% to 30%.[13] Hysterectomy alone is not associated with the risk of OC.[14] However, the mechanism associated with the beneficial relationships is not yet clear. It has been hypothesized that outlet obstruction of the fallopian tube may prevent preinvasive or invasive cells ascend into the pelvic cavity.[15] Population-based studies in Sweden, Demark, and the US found salpingectomy and excisional tubal sterilization could reduce the risk of OC in Western women.[16–18] The Sweden study found that women with salpingectomy had a 35% reduced hazard of OC.[16]

Nevertheless, no study has shown whether findings in Western women are consistent in Asian women. We; therefore, conducted a population-based retrospective cohort study to evaluate the OC risk associated with gynecologic surgeries using the insurance claims data of Taiwan. The impacts of hysterectomy and/or salpingectomy were compared against general women without gynecologic surgeries. Findings from this study might contribute to developing effective strategies for OC prevention for women in Taiwan and other Asian ethnic groups.

2. Methods

2.1. Data source

For this study, we used the claims data of inpatient expenditures, a subset data of the Taiwan National Health Insurance Research Database (NHIRD), National Health Insurance (NHI) program, released by the National Health Research Institutes.

This study was conducted using a nationwide population-based data of more than 23 million insured people in Taiwan, involving 238,436 women who had had a gynecological surgery. A retrospective cohort study is a choice for the exploration of the association using the existing data, such as the insurance claims data. The insurance policy requires cancer patients included in the Catastrophic Illness Registry after the approval of 2 physicians. Medical claims for surgeries require all the medical records can be accurately traced by the insurance administrators.

The insurance program was launched in 1995 and has a coverage of over 99% of the entire 23 million people and has contracted with 93% of the medical institutions in Taiwan since 1997. All medical records were linked using an encrypted identification number for each insured person for privacy protection. NHIRD is lack of lab data, which is a limitation of this study. Diseases were identified using codes of the international classification of diseases, 9th revision, clinical modification (ICD-9-CM). Other details were described elsewhere.[19] An ad hoc committee in the NHI Agency review claims data to prevent fraud claims. The Research Ethics Committee at China Medical University and Hospital in Taiwan approved this study (CMUH104-REC2-115).

2.2. Study cohorts identification

From the inpatient data, we identified all women (n=393,556) who had newly received any types of gynecologic surgery from 2000 to 2012 and not received any types of gynecologic surgery before, including hysterectomy (ICD-9-OP 68.3, 68.4, 68.5, 68.9), bilateral salpingo-oophorectomy (BSO) (ICD-9-OP 65.6), and salpingectomy (unilateral: ICD-9-OP 66.4, 66.61, 66.62; bilateral: ICD-9-OP 66.5, 66.63). The reason why we chose our study samples from 2000 to 2012 is that there were some gynecologic comorbidities considered before the index date (1996–1999). Unilateral salpingectomy usually performed in ectopic pregnancy and severe tubal abscess. Bilateral salpingectomy usually accompanied by oophorectomy. Partial or complete salpingectomy cannot be known by operation code. The index date for initiating follow-up time estimation was 1 year after the date of gynecologic surgery. Women with history cancers, oophorectomy at baseline or with salpingectomy location undetermined were excluded from this study.

Overall, 238,436 women were included in the gynecologic surgery cohort, which consisted of 3 sub-cohorts: women who had hysterectomy only (N=181,151), had salpingectomy only (N=45,410), and had both hysterectomy and salpingectomy (N=11875) (Fig. 1 flowchart). From women without any gynecologic surgery records in the database, we randomly selected a comparison cohort with a 4-fold of a sample size to achieve optimal statistical power.[20], frequency matched by age (exact year) and index year. The index date for the comparison group was randomly assigned to align with the index dates of women in the gynecologic surgery cohort. The exclusion criteria used for establishing the gynecologic surgery cohort were applied to establish the comparison cohort.

2.3. Outcomes and comorbidities

Women in study cohorts were followed up from index date until subsequent OC (ICD-9-CM 183) was diagnosed or until death, withdrawal from the insurance program or December 31, 2013, whichever came first. Gynecologic comorbidities before the index date that might be associated with the development of OC include endometriosis (ICD-9-CM 617), pelvic inflammatory disease (PID) (ICD-9-CM 614), and ectopic pregnancy (ICD-9-CM 633).

2.4. Statistical analysis

Distributions of age and comorbidities between gynecologic surgery cohorts and the comparison cohort were examined using Chi-square tests for categorical variables and Wilcoxon rank-

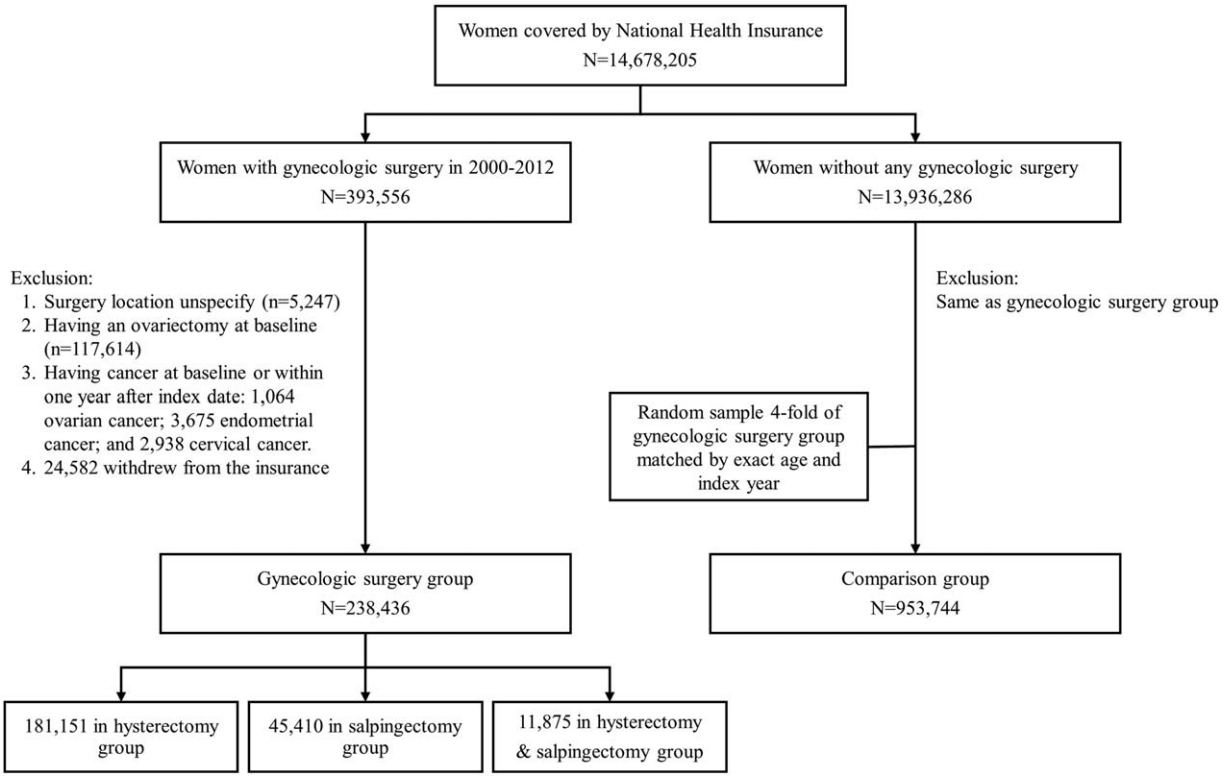

Figure 1. Study flow chart.

sum tests for continuous variables. Kaplan–Meier method was used to calculate the cumulative incidence of OC for the gynecologic surgery cohort and the comparison cohort and Log-rank test was used to examine the difference between 2 cumulative curves. Incidence density of OC was further calculated for each cohort, and the gynecologic surgery cohort to the comparison cohort hazard ratio (HR) of OC and 95% confidence interval (CI) were calculated using Cox proportional hazards regression analysis. HR assessment was also performed for each sub-cohort. The proportional assumption was measured by adding an interaction term between the study groups (gynecologic surgery/comparison cohorts) and the logarithm of follow-up time in the Cox regression model. The hazard functions were proportional over time. We further evaluated the OC risk associated with endometriosis, PID, and ectopic pregnancy. All statistical analyses were performed using SAS version 9.4 software (SAS Institute, Cary, NC). The significance threshold was set at 0.05 for a 2-tailed *P*-value.

3. Results

3.1. Baseline characteristics

The study population consisted of 238,436 women in the gynecologic surgery cohort and 953,744 comparison women without the surgery (Table 1). The overall mean ages of women in both cohorts were about 45 years, but the sub-cohort with salpingectomy was younger. The major indications of hysterectomy were uterine fibroids and adenomyosis. All comorbidities were more prevalent in the sub-cohorts of gynecologic surgery than in the comparison cohort.

3.2. The incidence of OC

Most ovarian cancers are epithelial cell origin (95%).[21] A low incidence of OC was reported in Taiwan (7.07 per 100,000 women in 2007).[2,22] The Kaplan–Meier Method estimated the cumulative incidence of OC was 0.07% greater in the gynecologic surgery cohort than in the comparison cohort (Log-rank $P < .001$) (Fig. 2). The incidence density of OC was 4.4 fold greater in the gynecologic surgery cohort than in the comparison cohort (adjusted HR = 3.86 with 95% CI = 2.56–5.84) (Table 2). Most of OC cases (n = 53 or 82.8%) were in women with hysterectomy. Whereas, in the subcohort of salpingectomy, all 7 cases of OC occurred in women with unilateral salpingectomy. There were 4 OC cases in the subcohort of both hysterectomy and salpingectomy, but 3 cases occurred in women with unilateral salpingectomy equivalent to an incidence rate of 101 per 1,000,000 person-years (adjusted HR 10.5, 95% CI = 1.78–62.2). The overall incidence of OC was 50.9 per 1,000,000 person-years in our cohort.

Table 3 shows that OC risk increased in women with comorbidities. In the sub-cohort of hysterectomy, 8.51% (n = 15422) of patients had comorbidities of endometriosis and PID, which were associated with an OC incidence of 94.4 per 1,000,000 person-years, with the adjusted HR increased to 13.8 (95% CI = 6.53–29.1). Increased OC risk was also found for women in the subcohort of salpingectomy associated with comorbidities of PID and ectopic pregnancy (adjusted HR = 19.4, 95% CI = 4.40–85.1), and for women in the subcohort with both hysterectomy and salpingectomy associated with PID (adjusted HR = 20.6, 95% CI = 6.45–65.8).

Table 1

Distributions of age and comorbidities among study cohorts.

	Comparison group N = 95,3744	Gynecologic surgery N = 23,8436	Hysterectomy N = 181,151	Salpingectomy N = 45,410	Hysterectomy and salpingectomy N = 11,875	*P*-value*
Age, yr	n (%)	n (%)	n (%)	n (%)	n (%)	
Mean (SD)	45.5 (11.1)	45.6 (11.1)	48.7 (9.79)	33.0 (7.71)	45.8 (5.66)	.16
<20	5408 (0.57)	1352 (0.57)	274 (0.15)	1061 (2.34)	17 (0.14)	
20–29	64,620 (6.78)	16,155 (6.78)	854 (0.47)	15,253 (33.6)	48 (0.40)	
30–39	168,428 (17.7)	42,107 (17.7)	18,942 (10.5)	21,881 (48.2)	1284 (10.8)	
40–49	486,548 (51.0)	121,637 (51.0)	107,259 (59.2)	5999 (13.2)	8379 (70.6)	
50–59	138,680 (14.5)	34,670 (14.5)	31,647 (17.5)	1024 (2.26)	1999 (16.8)	
60–69	47,116 (4.94)	11,779 (4.94)	11,576 (6.39)	121 (0.27)	82 (0.69)	
≥70	42,944 (4.50)	10,736 (4.50)	10,599 (5.85)	71 (0.16)	66 (0.56)	
Follow-up years						
Median (Q1, Q3)	7.29 (4.04, 10.7)	6.46 (3.20, 9.79)	6.41 (3.15, 9.77)	6.74 (3.37, 9.94)	6.23 (3.41, 9.37)	<.0001
Comorbidity						
Endometriosis	3427 (0.36)	78,506 (32.9)	70,591 (39.0)	1913 (4.21)	6002 (50.5)	<.0001
PID	8704 (0.91)	44,694 (18.7)	27,431 (15.1)	10,952 (24.1)	6311 (53.1)	<.0001
EP	824 (0.09)	38,186 (16.0)	424 (0.23)	37,217 (82.0)	545 (4.59)	<.0001

CAD = coronary artery disease, EP = ectopic pregnancy, PID = pelvic inflammatory disease.
* *P*-values, compared between the whole gynecologic surgery cohort and comparison cohort.

4. Discussion

Our surprise findings contradict some previous studies that have suggested women are benefited from reduced cancer risk from gynecologic surgery. Rice et al found that simple hysterectomy is associated with a 38% decrease in OC risk.[13] A recent meta-analysis concludes that women with BSO have near 50% reduced the risk of cancer.[23] A multicenter study found that salpingo-oophorectomy was associated with an 85% reduction in gynecologic cancer for women who carried BRCA1/2 mutation when they were 40 years old or older.[24] BSO is thought to decrease the estrogen level and its negative health impacts. A Memorial Sloan-Kettering Cancer Center study also found the BRCA-related gynecologic cancer risk is reduced for 75% in women with salpingo-oophorectomy.[25]

Conversely, our study surprisingly reveals a reversed finding in Taiwanese women. This first population-based cohort study in the eastern Asian population demonstrated that women with hysterectomy are at an increased risk of subsequent OC with an adjusted HR of 3.88. The adjusted HR of subsequent OC could increase further to 10.5 for women with both hysterectomy and 1-side salpingectomy. Effective screening method for early detection for OC is currently unavailable, our findings may provide a new implication for public health for Taiwanese and eastern Asian women. The women received hysterectomies should be followed up regularly to early detection of OC.

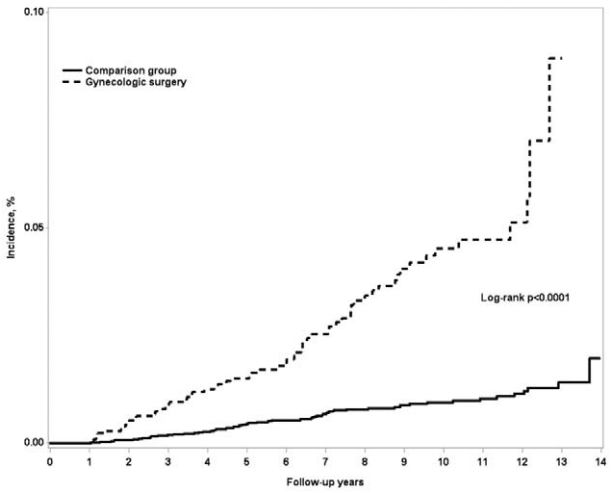

Figure 2. Kaplan–Meier method estimated the cumulative incidence of ovarian cancer compared between the gynecologic surgery cohort and comparison cohort.

The average age of women in Taiwan at the time of menopause is 49.5 years.[26] In the present data, 23.4% of women with gynecological surgery were older than 49 years old. Women who had taken hormone therapy contributed little in the OC development because of a few users in both study cohorts.[27] Our results provided a large populational data to interpret that the gynecological surgery is associated with subsequent risk of OC for women.

Our data showed that the risk of OC increased further for women who underwent a gynecologic surgery with comorbidities of endometriosis, PID and/or ectopic pregnancy. It is important to note that this relationship is particularly strong for women with a salpingectomy or with both hysterectomy and salpingectomy. Among 11 OC cases in these 2 subcohorts, 10 cases were developed in unilateral salpingectomy, and 9 cases were found in those with 1 or 2 of the comorbidities. It indicates that the OC risk is reduced for women with bilateral salpingectomy, which is consistent with findings in Western ethnic groups.[12,13,15–18]

Endometriosis including adenomyosis composed of more than 50% cases in hysterectomy and salpingectomy group in our study. Endometriosis is thought to be a cause of OC.[28–30] PID also composed of 53.1% in the hysterectomy and salpingectomy group in our study. PID is also a risk factor for OC occurrence.[28] Thus hysterectomy with salpingectomy due to endometriosis or PID may predispose to OC occurrence.

The previous study had been shown unilateral salpingectomy could decrease the incidence of OC by 29% (HR = 0.71, 95% CI = 0.56–0.91).[16] In our study, 82% of unilateral salpingectomy was due to ectopic pregnancy and 7 OC occurred. It is not clear whether ectopic pregnancy associated with OC occurrence or not. The adjusted HZ was 5.23 (95% CI = 0.90–30.5) in our study. However, there was no statistical significance.

Table 2

Incidence of ovarian cancer and the Cox method estimated gynecologic surgery cohort relative to comparison cohort hazard ratios.

					Hazard ratio (95% CI)	
	N	Event	PY	IR	Crude	Adjusted
Comparison	953,744	66	6,998,553	9.43	1.0	1.0
Gynecologic surgery	238,436	64	1,541,769	41.5	4.67 (3.30, 6.61)	3.86 (2.56, 5.84)
Hysterectomy	181,151	53	1,164,282	45.5	5.12 (3.56, 7.38)	3.88 (2.55, 5.89)
Salpingectomy	45,410	7	301,260	23.2	2.60 (1.19, 5.67)	3.52 (0.89, 13.8)
Unilateral	42,945	7	285,442	24.5	2.69 (1.23, 5.87)	5.23 (0.90, 30.5)
Bilateral	2465	0	15,818	0	–	–
Hysterectomy and salpingectomy	11,875	4	76,227	52.5	5.98 (2.18, 16.4)	3.94 (1.29, 12.0)
Unilateral	4605	3	29,578	101	11.3 (3.54, 35.9)	10.5 (1.78, 62.2)
Bilateral	7270	1	46,650	21.4	2.40 (0.33, 17.3)	2.56 (0.26, 25.5)

Models adjusted for age and comorbidities listed in Table 1.
CI = confidence interval, IR = incidence rate, per 1,000,000 person-yr, PY = person-years.

Finally, after we adjusted those comorbidities (endometriosis, PID, and ectopic pregnancy), hysterectomy and salpingectomy still associated with higher risk of OC (HR = 3.93, [95% CI = 2.53–6.09]; HR = 15.8 [95% CI = 2.18–114], respectively). However, the association between hysterectomy or salpingectomy with OC still needs further study to elucidate.

Another hypothesis is the influence of the hypothalamic-pituitary-ovarian (HPO) axis. Estrogen is the representative steroidal hormone regulating ovary activity in women, by luteinizing hormone (LH) with pulsatile release from the pituitary. The factor that increases ovarian activity may increase the risk of OC. We hypothesize that hysterectomy and

Table 3

Incidence and hazard ratio of ovarian cancer interact with endometriosis (EMT), pelvic inflammatory disease (PID) and ectopic pregnancy (EP).

							Hazard ratio (95% CI)	
Group	EMT	PID	EP	N	Event	IR	Crude	Adjusted
Comparison	N	N	N	941,927	65	9.39	1.0	1.0
	Y	N	N	2378	0	0	–	–
	N	Y	N	7593	0	0	–	–
	Y	Y	N	1022	1	161	18.5 (2.57, 133)	23.5 (3.06, 180)
	N	N	Y	713	0	0	–	–
	Y	N	Y	22	0	0	–	–
	N	Y	Y	84	0	0	–	–
	Y	Y	Y	5	0	0	–	–
Hysterectomy	N	N	N	98,415	31	47.5	5.35 (3.48, 8.22)	3.93 (2.53, 6.09)
	Y	N	N	54,994	11	30.9	3.49 (1.84, 6.63)	4.00 (2.10, 7.63)
	N	Y	N	11,896	3	43.7	5.06 (1.59, 16.1)	5.18 (1.63, 16.5)
	Y	Y	N	15,422	8	94.4	11.1 (5.30, 23.1)	13.8 (6.53, 29.1)
	N	N	Y	210	0	0	–	–
	Y	N	Y	101	0	0	–	–
	N	Y	Y	39	0	0	–	–
	Y	Y	Y	74	0	0	–	–
Salpingectomy	N	N	N	2170	1	81.5	9.50 (1.32, 68.5)	15.8 (2.18, 114)
	Y	N	N	283	0	0	–	–
	N	Y	N	5070	1	31.7	3.62 (0.50, 26.1)	4.76 (0.65, 34.7)
	Y	Y	N	670	0	0	–	–
	N	N	Y	31,425	3	13.9	1.55 (0.49, 4.95)	4.31 (1.31, 14.2)
	Y	N	Y	580	0	0	–	–
	N	Y	Y	4832	2	67.8	7.75 (1.90, 31.7)	19.4 (4.40, 85.1)
	Y	Y	Y	380	0	0	–	–
Hysterectomy and salpingectomy	N	N	N	2807	1	53.7	6.13 (0.85, 44.2)	6.77 (0.94, 48.9)
	Y	N	N	2379	0	0	–	–
	N	Y	N	2806	3	161.9	18.4 (5.77, 58.6)	20.6 (6.45, 65.8)
	Y	Y	N	3338	0	0	–	–
	N	N	Y	189	0	0	–	–
	Y	N	Y	189	0	0	–	–
	N	Y	Y	71	0	0	–	–
	Y	Y	Y	96	0	0	–	–

Models adjusted for age and comorbidities listed in Table 1.
CI = confidence interval, IR = incidence rate, per 1,000,000 person-yr.

salpingectomy might also disrupt the negative feedback regulation over the HPO axis besides oophorectomy; which then results in excessive gonadotropin secretion and hormonal over-activity in the ovary. The predominant action of estrogen is mediated by the biological effects of nuclear estrogen receptors (ERs), ERα and ERβ. There have been various studies on distributions of ERs for decades; but, the detail cellular mechanisms involved in the uterus and fallopian tube remain unclear.[31–33] Hysterectomy and/or salpingectomy may disrupt the estrogen signaling on the ER of the uterus and fallopian tube. Recent studies have demonstrated that patients with a hysterectomy are at an increased risk of subsequent depression, which probably occurs through the HPO system to change patients' brain activity and behavior.[34–36] Therefore, disruptions in the LH and estrogen regulation with subtle hormonal over-activity after a hysterectomy or 1-side salpingectomy might relate to an increased risk of subsequent OC. However, more studies to get solid evidence would be necessary to confirm this hypothesis and evaluate whether it is globally applicable in the future. Further studies are needed to clarify whether our findings are consistent with other ethnic groups.

The other hypothesis is the similar pathophysiology shared by ovarian malignancy and the indication of gynecological surgery (the most common surgical indications in our study: uterine myoma, adenomyosis, uterine prolapse, endometrial, and cervical benign tumors). The previous study has been shown adenomyosis was associated with the risk of endometrial cancer (HR = 2.19 95% CI = 1.51–3.16).[37] Another study also showed adenomyosis was associated with the risk of OC (HR = 5.50, 95% CI = 1.95–15.50).[38] Pelvic floor disorders were also associated with gynecologic malignancy.[39] Endometrial and endocervical polyps were reported associated with ovarian endometriosis, which was associated with OC.[40] Genome-wide association study also showed leiomyoma shared some oncogene (eg, *TP53* gene) and hormone-related gene variants (eg, *ESR1* gene) with OC.[41] Above all, the patients received hysterectomies due to benign indications that might predispose future ovarian malignancy development. Further study needs to be clarified about our findings.

4.1. Strength and limitations

This study was conducted using a nationwide population-based data of more than 23 million insured people in Taiwan, involving 238,436 women who had had a gynecological surgery. Because of the latent period before developing OC is long, randomized clinical trials are not feasible to explore the association between pre-existing gynecological surgery and OC. A retrospective cohort study is a choice for the exploration of the association using the existing data, such as the insurance claims data. The insurance policy requires cancer patients included in the Catastrophic Illness Registry after the approval of 2 physicians. Medical claims for surgeries require all the medical records can be accurately traced by the insurance administrators. Patients with any gynecologic surgeries could be adequately followed up and identified the possible existing malignancy. Therefore, our real-world claims data provided evidence with high accuracy to assess the association between gynecological surgery and subsequent OC. Our findings suggest that prophylactic 1-side salpingectomy or hysterectomy for benign indications should be considered before more data are available in future studies.

However, there are limitations to this study. First, a maximum of 14-year follow-up time in the present study may not long enough to observe all OC cases to be developed, compared to the previous Western population studies. It took 35 years in the Sweden study and 29 years for the Denmark study to observe the outcomes.[16,17] Second, Information on pregnant frequency was not fully available in our cohorts due to a shorter period of the database. Pregnancy is a protective factor for OC, the shorter follow-up time could be confounding for assessing the risk. Third, we selected the reference cohort matched by age and with comorbidities adjusted for in the data analysis. But, it is possible that there were some potential confounders not considered in this study. Fourth, information on tubal ligation could not be retrieved in our database due to the insurance did not cover the expense of tubal ligation and enroll the subjects into the database. However, we did not note any OC event during the whole follow-up period in the bilateral salpingectomy group in our study. Fifth, we were unable to evaluate the OC risk associated with oral contraceptive use in the present study because of a few users in Taiwan.[42] Oral contraceptive use is a well-known factor that can reduce OC development.[43,44] The surgical history before the database setup could not be obtained. There may be some detection bias that existed. Women who have surgery are more likely to see a doctor and be diagnosed with OC. The follow-up period is not very long in this study. However, our results indicated that the large study population size was sufficient to statistically demonstrate the subsequent risk of OC in patients who had undergone gynecological surgery.

5. Conclusions

This population-based study showed that Taiwanese women with a hysterectomy and/or 1-side salpingectomy could have a higher risk of subsequent OC as compared to those without the surgery. Women with bilateral salpingectomy are less likely to develop cancer, which is consistent with findings in Western women. It is important for clinicians and patients with gynecologic surgery to develop risk reduction strategies. Opportunistic salpingectomy or tubal sterilization might be a measure to reduce the risk of OC. Further studies are needed to clarify whether our findings are consistent with other ethnic groups.

Author contributions

Data curation: I-Ju Tsai, Weishan Chen, Fung-Chang Sung.
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Writing – review and editing: Dah-Ching Ding.

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