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Original Article

Decreasing trend of hysterectomy in Taiwan: A population-based study, 1997–2010

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ABSTRACT

Objective: Gynecologists in Taiwan are lacking a comprehensive picture of the changes in clinical practice and indications of hysterectomy over a long period of time. The aims of this study were to examine the national trends in the utilization of hysterectomy and to explore changes in its utilization rate over a 14-year period from 1997 to 2010.

Materials and methods: We conducted a population-based trend analysis using the claims data from the Taiwan's National Health Insurance program.

Results: We identified a total of 341,993 women aged 20 years or older who underwent hysterectomy between 1997 and 2010. The total number of hysterectomies increased from 22,961 in 1997 to 27,757 cases in 1999, followed by a decline to 22,351 in 2010. Overall, 5406 fewer hysterectomies (−19.5%) were performed in 2010 when compared with those performed in 1999. The number of hysterectomies performed decreased from 1997 to 2010 for precancerous lesions (−55.6%), chronic pelvic pain (−35.2%), uterine leiomyoma (−13.1%), and uterine prolapse (−7.2%). However, the utilization of hysterectomy increased for endometriosis (+76.3%) and gynecologic cancer (+22.7%) during the same time frame.

Conclusion: The clinical utilization and primary indications of hysterectomy changed substantially in Taiwan from 1997 to 2010. The continued monitoring of changes in hysterectomy rates will be critical for understanding the appropriate indications for hysterectomy and oophorectomy, the emergence of alternative managements for uterine disorders, and future trends in women's reproductive health.

Introduction

Hysterectomy is now a very-well established procedure with a relatively low mortality of 12 per 10,000 [1]. Most hysterectomies are elective and have been recommended for many clinical indications, including uterine leiomyoma, abnormal uterine bleeding, endometriosis, and reproductive cancers (endometrial, cervical, ovarian, or tubal cancers) [2]. Over the past decades, however, the practice patterns of hysterectomy have changed significantly in many countries, including the United States [3] and Taiwan [4]. Surgical procedures, such as uterine-artery embolization and endometrial ablative therapy, have been introduced in place of hysterectomy for the management of uterine leiomyoma [5] and abnormal uterine bleeding [6], respectively. Many medications are now available for endometriosis-related pain, including combined oral contraceptive pills, gonadotropin-releasing-hormone agonists,

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tranexamic acid, nonsteroidal anti-inflammatory drugs, progestins, and androgen derivatives, such as danazol, and levonorgestrel intrauterine system [7]. There is also an increasing utilization of fertility-conserving procedures for young women with genital tract malignancies [8,9]. In addition, the minimal invasive approach of laparoscopic surgery has become a popular alternative globally, which offers significantly more benefits than the conventional abdominal and vaginal hysterectomies in the management of gynecological indications [10]. Although previous reports have included some information on the hysterectomy trend [4,11,12], gynecologists in Taiwan are lacking a comprehensive picture of the changes in clinical practice and indications of hysterectomy over a long period of time. The aims of this study were to examine the trends in the utilization of hysterectomy, and to explore changes in utilization rate, surgical routes, primary indications, and oophorectomy rate over a 14-year period from 1997 to 2010 in Taiwan.

Materials and methods

Our main data source was the National Health Insurance Research Database (NHIRD). The NHIRD is a public-released population-based data set, which contains registration files and original administrative-claim records filed for reimbursement by all beneficiaries covered under Taiwan's National Health Insurance (NHI) program [13]. The NHI program is a universal, single-payer insurance program for all civilian residents in Taiwan since 1995. We used the 1997–2010 NHI enrollment files, NHI inpatient files, the medical-personnel registries, and the hospital registries. The NHI enrollment files contain basic sociodemographic information (age, sex, birth date, payroll-related insurance premium, and area zip code of enrollment location). The NHI inpatient files contain disease diagnoses and surgical/diagnostic/therapeutic procedures for each inpatient admission claims. The medical-personnel registries contain the physicians' demographic data and specialties. The hospital registries contain the characteristics of practice setting, such as accreditation level and ownership. A double-scrambled unique identifier is encrypted for each patient, physician, and practice setting before releasing for research purposes. This research was approved by the Institutional Review Board of the National Yang-Ming University in Taiwan (No. 10000111).

We conducted a population-based trend analysis. A total of 343,115 women undergoing hysterectomy were initially identified from the inpatient admission claims between January 1, 1997 and December 31, 2010, using the following International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) procedure codes: subtotal abdominal hysterectomy (68.3), total abdominal hysterectomy (68.4), vaginal hysterectomy (68.5), radical abdominal hysterectomy (68.6), radical vaginal hysterectomy (68.7), and unspecified hysterectomy (68.9). The laparoscopic-assisted vaginal hysterectomy (68.51) and any hysterectomy in the presence of secondary procedure code 54.21 within the same inpatient admission claims were considered as laparoscopic-assisted hysterectomy. Since hysterectomy was rarely performed in women younger than 20 years, these women accounted for <1% of the entire cohort ($n = 371$), and were excluded from this study. For the purpose of this study, the unspecified hysterectomies (68.9) were excluded from this study, which contained <1% of the entire cohort ($n = 751$). In aggregate, the study cohort consisted of 341,993 women who underwent hysterectomy between 1997 and 2010. Although no values were missing for the women's ages, comorbidities, indications for surgery, or surgical procedures, at least 5% of the selected cohort lacked information necessary for the calculation of socioeconomic status (SES) and residential urbanicity in the NHI enrollment files.

Both women and physician characteristics were broadly classified into abdominal (subtotal or total), vaginal, radical, or laparoscopic-assisted hysterectomy. The women's characteristics, including age, SES and residential urbanicity, comorbidity, indications for surgery, concomitant salpingo-oophorectomy, and hysterectomy types, were defined as the values at the index year. The women were classified into six age groups according to their age at hysterectomy, from 20–39 years to 80 years or older, and four 10-year age groups in between (40–49, 50–59, 60–69, and 70–79 years). SES was classified into four categories according to the payroll-related insurance premium for women with well-defined monthly wage, head tax for those without a well-defined monthly wage, or other adults (mostly parents in the case of dependents): (1) without a well-defined monthly wage (union and association members, such as farmers, fishermen, professional workers, veterans, and local-government enrollees); (2) low-income [less than new Taiwan dollar (NTD) 20,000 or United States dollar (USD) 667] or certified low-income (mostly unemployed) individuals enrolled in the NHI through local-government offices; (3) middle income (NTD 20,000–39,999, or USD 667–1333); and (4) high income (more than NTD 40,000 or USD 1333) (30 NTD = 1 USD, in May 2014). Women's residential urbanicity was defined according to Liu et al [14]: urban classification for metropolitan cities, sub-urban classification for all other cities and counties, and rural classification for all townships and rural areas. The Romano adaptation of the Charlson comorbidity index was used for risk assessment based on at least one inpatient claim filed within 1 year to 1 month prior to the index admission [15,16]. Diseases with the following primary-diagnosis codes of hysterectomy admission claims were also included in the analysis: gynecologic cancer (179–184), uterine leiomyoma (218), endometriosis (617), uterine prolapse (618), precancerous lesions (233), pelvic infection (614–616), chronic pelvic pain (625), benign neoplasm of ovary (220), and benign neoplasm of corpus uteri (219.1). The remaining indications were placed under the “others” category. Women with concomitant oophorectomy were classified according to the ICD-9-CM codes within the same inpatient admission claims of hysterectomy into unilateral salpingo-oophorectomy (65.4) or bilateral salpingo-oophorectomy (BSO) (also includes second unilateral salpingo-oophorectomy) (65.6). Each hysterectomy type was further stratified into a total or subtotal procedure.

The physician characteristics included the physician's age, sex, total hysterectomy case volume, and attributes of physician-practice setting (hospital location by region, accreditation level, and institution ownership). The physician's age was classified into one of four age categories: <35, 35–44, 45–54, and 55 years or more. The total hysterectomy case volume was defined as the total number of hysterectomy performed by a physician between January 1, 1997 and December 31, 2010. Low-volume physicians were defined as those who performed <50 hysterectomies in the study period of 14 years, the middle-volume physicians were those who performed between 50 and 249 hysterectomies, and the high-volume physicians as those who performed 250 hysterectomies or more. The hospital location where the services were delivered was classified into four geographic locations: northern, central, southern, or eastern regions of Taiwan. All medical providers were classified into four levels as accredited by the Taiwan Joint Commission on Hospital Accreditation: medical center, regional hospital, district hospital, or clinics [17]. Institution ownership was classified as private or public (government-owned) medical institutions.

The mean (standard deviations) and frequency (%) were presented for continuous variables and categorical variables, respectively. The dissimilarities in women and physician

characteristics among different procedures were assessed by one-way analysis of variance for continuous variables, and Pearson's Chi-square (χ^2) for categorical variables. The national trends in the utilization of hysterectomy, indications, surgical types, concomitant BSO procedures, and characteristics of the physician-practice setting (accreditation levels and locations) were illustrated descriptively. An α level of 0.05 was considered statistically significant with reported p values corresponding to a two-sided analysis. All analyses were conducted using SAS software version 9.2 (SAS Institute Inc., Cary, NC, USA).

Results

Table 1 shows the women and physician characteristics of 341,993 women 20 years of age or older in Taiwan who underwent hysterectomy during an inpatient hospitalization between 1997 and 2010. The overall utilization was highest among women aged 40–49 years (53.8%) with an average age of 48.7 years, and lowest among those aged 60 or above (13.8%) (Table 2). There were significant differences in the utilization of hysterectomy types in women of various age groups ($p < 0.001$). Vaginal hysterectomies were performed for older women (mean age, 61.5 years ± 12.2 years), and increased gradually with increasing age, whereas younger women undergone abdominal (mean age, 47.5 years ± 9.2 years), laparoscopic (mean age, 46.6 years ± 7.6 years), or radical hysterectomies (mean age, 51.8 years ± 11.4 years). Uterine leiomyoma and endometriosis were the leading indications for both abdominal and laparoscopic hysterectomies, whereas uterine prolapse and gynecologic cancer were the leading indication for vaginal and radical hysterectomies, respectively. Subtotal hysterectomies accounted for 13,440 (7.4%) of abdominal hysterectomies. Concomitant BSO was performed in 9245 (63.2%) of radical, 54,551 (30.2%) of abdominal, 12,203 (10.6%) of laparoscopic, and 859 (2.7%) of vaginal hysterectomies.

The total number of hysterectomies increased from 22,961 in 1997 to 27,757 cases in 1999, followed by a decline to 22,351 in 2010 (Figure 1). Overall, 5406 fewer hysterectomies (relative reduction by 19.5%) were performed in 2010 when compared with those performed in 1999. Of these, 180,733 (52.8%) were performed abdominally, followed by 115,388 (33.7%) laparoscopic assisted, 31,250 (9.1%) vaginal, and 14,622 (4.3%) radical procedures. There was a significant shift in the utilization of various types of hysterectomy over the study period (Figure 2). The utilization of abdominal hysterectomy declined by 34.8% from 75.4% in 1997 to 49.2% in 2010, vaginal hysterectomy declined by 27.9% from 12.5% to 9.0%, whereas radical hysterectomy demonstrated the largest decline of 49.8% from 5.7% to 2.9%. However, the utilization of laparoscopic hysterectomy increased by fivefold from 6.4% in 1997 to 38.9% in 2010.

In general, the leading indications for hysterectomy remained relatively constant, but with an overall decreasing utilization trend across time (Figure 3). Hysterectomy for precancerous lesions increased from 1982 in 1997 to 2722 cases in 1999, followed by a largest decline to 884 in 2010 (1997–2010, relative reduction by 55.6%; 1999–2010, relative reduction by 59.7%). Hysterectomy for chronic pelvic pain increased from 109 in 1997 to 349 cases in 2001, and dropped to only 71 cases in 2010 (1997–2010, relative reduction by 35.2%; 2001–2010, relative reduction by 75.8%). In contrast to the overall declining trend, the utilization of hysterectomy remained relatively stable with a slight decline from 2222 to 2072 (relative reduction by 7.2%) for uterine prolapse, and from 10,827 to 9452 (relative reduction by 13.1%) for uterine leiomyoma from 1997 to 2010. However, the utilization of hysterectomy increased consistently from 2828 to 5007 (relative increase by 76.3%) for endometriosis, and from 2463 to 3036 (relative increase by 22.7%) for gynecologic cancer during the same time frame.

There was a significant shift in the BSO rate at hysterectomy over the study period (Figure 4). The overall BSO rate declined steadily by 33.6% from 29.4% in 1997 to 19.6% in 2010. The BSO rate at vaginal hysterectomy declined by 64.4% from 5.2% in 1997 to 1.8% in 2010; abdominal hysterectomy declined by 11.9% from 32.6% to 28.7%, whereas the BSO rate at laparoscopic hysterectomy dropped by 38.8% from 14.2% to 8.7% during the same time frame. However, the BSO rate at radical hysterectomy increased by 13.2% from 57.4% in 1997 to 65.0% in 2010.

The hysterectomy types varied considerably by physician case volume ($p < 0.001$) and physician-practice settings [accreditation levels ($p < 0.001$) and ownership ($p < 0.001$)] (Table 1). Less than 1% of any hysterectomies were performed in clinics. More than 80% were performed by male physicians, physicians with a high case volume, and those who practiced in medical centers and regional hospitals of private ownerships. The percentage of hysterectomies performed annually at medical centers remained relatively stable from 47.4% (10,887 cases) in 1997 to 49.7% (11,116 cases) in 2010 (Figure 5). However, the number of hysterectomies performed at regional hospitals increased from 6783 in 1997 to 8951 in 2010 (relative increase by 35.6%), whereas at district hospitals decreased from 5172 to 2132 (relative reduction by 57.7%) over the study period.

There were little differences in the utilization of hysterectomy by geographic region of the physician-practice setting. The numbers of hysterectomies performed annually remained relatively stable throughout northern (10,940–10,451), southern (7465–7127), and central Taiwan (4144–4267) during the study period (Figure 6). In Eastern Taiwan, however, the performed hysterectomies increased by 26.2% from 412 operations in 1997 to 506 in 2010.

Discussion

Our findings suggest that the overall hysterectomies have declined substantially (i.e., by 19.5%) with 5406 fewer hysterectomies in 2010 than those performed in 1999 in Taiwan. The declining trend is consistent with the findings reported by both Wright et al [3] in the United States and Spilsbury et al [18] in Australia. The former reported a 36.4% decline from 2002 to 2010, whereas the latter reported a 23% decline from 1981 to 2003. One explanation for the observed decreasing trend could be the introduction of nonsurgical treatment options, such as uterine-artery embolization and endometrial ablative therapy of uterine leiomyoma [5]. Although uterine leiomyoma remains the most common primary indication associated with benign hysterectomy, the proportion of hysterectomies with uterine leiomyoma as the primary diagnosis has decreased by 13.1% from 1997 to 2010. Nonetheless, it is unclear whether the more conservative nonsurgical alternative merely delays hysterectomy to a latter day, or entirely avoids hysterectomy in the long run [19]. The other explanation for the observed decreasing trend could be the substantial decrease in the number of procedures for precancerous lesions. Ever since 1995, the nationwide Papanicolaou-smear screening programs for precancerous lesions have been highly effective for young women [20]. Approximately three-fifths of women (61%) aged 30 years or older had at least one smear test by 2001 in Taiwan. The early identification of precancerous lesions allows earlier treatment by local excision procedure and avoids future hysterectomy. Since the incidences of precancerous cervical lesion have remained stationary during the study period, this reduction in procedures reflects the adaptation of the national guideline for precancerous cervical

Table 1
Women and physician characteristics for women aged 20 years or older by hysterectomy types, 1997–2010 ($N = 341,993$).

	Abdominal, $n = 180,733$ (52.8%)	Vaginal, $n = 31,250$ (9.1%)	Laparoscopic, $n = 115,388$ (33.7%)	Radical, $n = 14,622$ (4.3%)	
Women characteristics					
Age (y)					
20–39	24,460 (13.5)	991 (3.2)	13,845 (12.0)	2011 (13.8)	*
40–49	101,882 (56.4)	5554 (17.8)	71,952 (62.4)	4751 (32.5)	
50–59	36,677 (20.3)	6085 (19.5)	22,433 (19.4)	4128 (28.2)	
60–69	10,517 (5.8)	9268 (29.7)	4797 (4.2)	2665 (18.2)	
70–79	5908 (3.3)	7793 (24.9)	2108 (1.8)	941 (6.4)	
≥80	1289 (0.7)	1559 (5.0)	253 (0.2)	126 (0.9)	
Mean ± SD	47.5 ± 9.2	61.5 ± 12.2	46.6 ± 7.6	51.8 ± 11.4	*
SES (NTD)					
Without well-defined monthly wage	91,204 (50.5)	19,154 (61.3)	59,406 (51.5)	8271 (56.6)	*
≥40,000	26,051 (14.4)	3991 (12.8)	15,762 (13.7)	1603 (11.0)	
20,000–39,999	29,119 (16.1)	3711 (11.9)	18,920 (16.4)	2108 (14.4)	
<20,000	23,959 (13.3)	2640 (8.4)	15,756 (13.7)	1799 (12.3)	
Unknown	10,400 (5.8)	1754 (5.6)	5544 (4.8)	841 (5.8)	
Residential urbanicity					
Urban	58,894 (32.6)	7866 (25.2)	30,091 (26.1)	3881 (26.5)	*
Suburban	99,229 (54.9)	17,845 (57.1)	70,324 (60.9)	8575 (58.6)	
Rural	12,347 (6.8)	3824 (12.2)	9478 (8.2)	1367 (9.3)	
Unknown	10,263 (5.7)	1715 (5.5)	5495 (4.8)	799 (5.5)	
Comorbidity					
0	174,340 (96.5)	30,032 (96.1)	113,155 (98.1)	13,328 (91.2)	*
1	2570 (1.4)	745 (2.4)	1320 (1.1)	196 (1.3)	
≥2	3823 (2.1)	473 (1.5)	913 (0.8)	1098 (7.5)	
Indications for surgery					
Uterine leiomyoma	95,824 (53.0)	3171 (10.1)	60,722 (52.6)	37 (0.3)	*
Endometriosis	29,842 (16.5)	1013 (3.2)	29,712 (25.7)	5 (0.0)	
Gynecologic cancer	19,886 (11.0)	250 (0.8)	3168 (2.7)	14,144 (96.7)	
Uterine prolapse	2597 (1.4)	24,214 (77.5)	2777 (2.4)	10 (0.1)	
Precancerous lesions	11,126 (6.2)	751 (2.4)	11,872 (10.3)	191 (1.3)	
Chronic pelvic pain	1256 (0.7)	984 (3.1)	1095 (0.9)	1 (0.0)	
Pelvic infection	2303 (1.3)	76 (0.2)	503 (0.4)	3 (0.0)	
Benign neoplasm of ovary	2102 (1.2)	26 (0.1)	282 (0.2)	5 (0.0)	
Benign neoplasm of corpus uteri	1118 (0.6)	31 (0.1)	660 (0.6)	4 (0.0)	
Others	14,679 (8.1)	734 (2.3)	4597 (4.0)	222 (1.5)	
Salpingo-oophorectomy					
None	105,833 (58.6)	29,871 (95.6)	96,919 (84.0)	4555 (31.2)	*
Unilateral	20,349 (11.3)	520 (1.7)	6266 (5.4)	822 (5.6)	
Bilateral	54,551 (30.2)	859 (2.7)	12,203 (10.6)	9245 (63.2)	
Hysterectomy type					
Total	167,293 (92.6)	31,249 (100.0)	115,386 (100.0)	14,622 (100.0)	*
Subtotal	13,440 (7.4)	1 (0.0)	2 (0.0)	0	
Physician characteristics					
Age (y)					
<35	7641 (4.2)	1357 (4.3)	5982 (5.2)	495 (3.4)	*
35–44	66,653 (36.9)	12,575 (40.2)	48,981 (42.4)	4940 (33.8)	
45–54	75,149 (41.6)	12,712 (40.7)	45,054 (39.0)	6639 (45.4)	
≥55	30,850 (17.1)	4541 (14.5)	15,217 (13.2)	2522 (17.2)	
Unknown	440 (0.2)	65 (0.2)	154 (0.1)	26 (0.2)	
Mean ± SD	46.4 ± 20.0	45.7 ± 22.7	44.7 ± 29.4	46.1 ± 35.3	*
Sex					
Female	20,629 (11.4)	2641 (8.5)	10,322 (8.9)	2414 (16.5)	*
Male	159,889 (88.5)	28,578 (91.4)	105,021 (91.0)	12,205 (83.5)	
Unknown	215 (0.1)	31 (0.1)	45 (0.0)	3 (0.0)	
Total hysterectomy case volume					
Low (<50)	13,436 (7.4)	1415 (4.5)	2630 (2.3)	301 (2.1)	*
Middle (50–249)	42,392 (23.5)	5690 (18.2)	18,062 (15.7)	959 (6.6)	
High (≥250)	124,905 (69.1)	24,145 (77.3)	94,696 (82.1)	13,362 (91.4)	
Hospital location					
Northern	91,817 (50.8)	14,452 (46.2)	42,521 (36.9)	6641 (45.4)	*
Central	29,898 (16.5)	5555 (17.8)	25,136 (21.8)	2820 (19.3)	
Southern	55,363 (30.6)	10,613 (34.0)	44,721 (38.8)	5021 (34.3)	
Eastern	3655 (2.0)	630 (2.0)	3010 (2.6)	140 (1.0)	
Accreditation level					
Clinic	1347 (0.7)	71 (0.2)	100 (0.1)	0	*
District hospital	30,057 (16.6)	5770 (18.5)	14,552 (12.6)	294 (2.0)	
Regional hospital	60,915 (33.7)	10,135 (32.4)	45,819 (39.7)	3033 (20.7)	
Medical center	88,414 (48.9)	15,274 (48.9)	54,917 (47.6)	11,295 (77.2)	
Institution ownership					
Public	47,459 (26.3)	8,924 (28.6)	26,051 (22.6)	6184 (42.3)	*
Private	133,274 (73.7)	22,326 (71.4)	89,337 (77.4)	8438 (57.7)	

Data are mean (standard deviation) or % unless otherwise indicated.
*$p < 0.001$.
NTD = new Taiwan dollars (1 United States dollar = 30 NTD in May 2014); SD = standard deviation; SES = socioeconomic status.

Table 2
Age distribution of performed hysterectomies for women aged 20 years or older, 1997–2010 ($N = 341,993$).

Age at hysterectomy (y)	20–39	40–49	50–59	60–69	70–79	80+
Cases of hysterectomy	41,307	184,139	69,323	27,247	16,750	3227
(%)	(12.1)	(53.8)	(20.3)	(8.0)	(4.9)	(0.9)

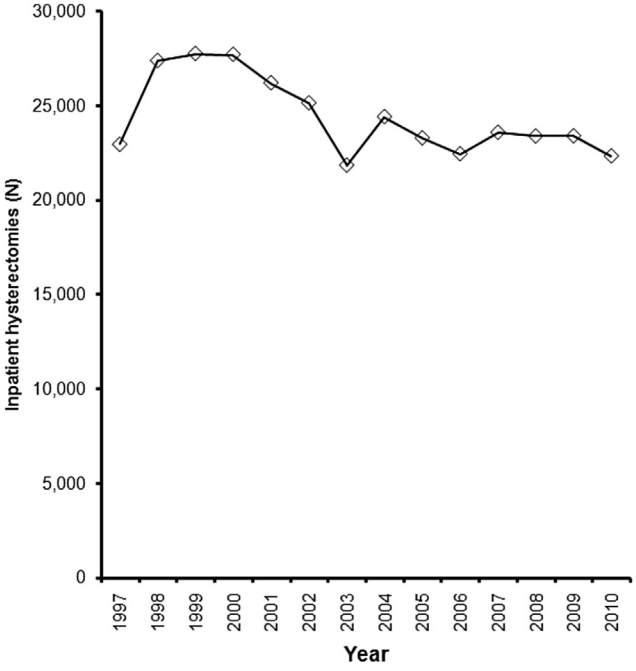

Figure 1. Nationwide trend of hysterectomies for women aged 20 years or older by year, 1997–2010 ($N = 341,993$).

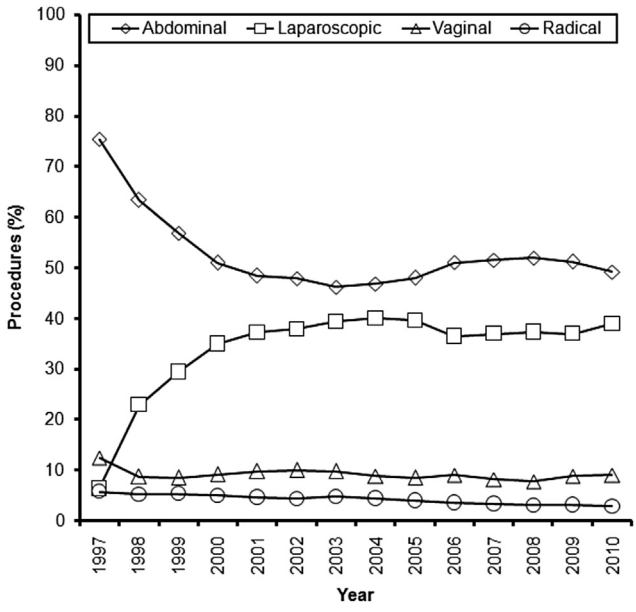

Figure 2. Nationwide trend of hysterectomies for women aged 20 years or older by surgical types and year, 1997–2010 ($N = 341,993$).

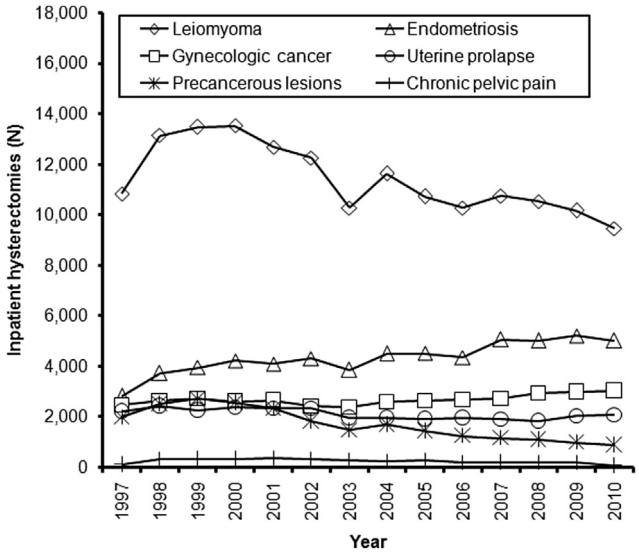

Figure 3. Nationwide trend of hysterectomies for women aged 20 years or older by top six indications for surgery and year, 1997–2010 ($N = 341,993$).

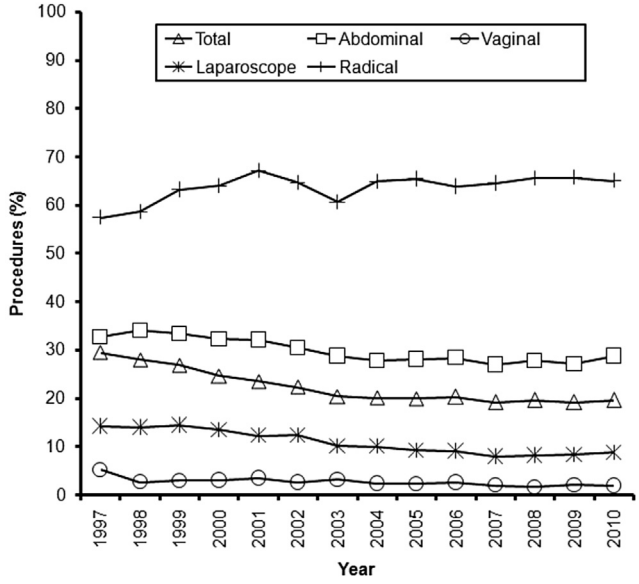

Figure 4. Nationwide trend of bilateral salpingo-oophorectomy at hysterectomies for women aged 20 years or older by surgical types and year, 1997–2010 ($N = 341,993$).

lesion by practicing gynecologists. The decline in the rate of hysterectomy might also be associated with the considerations for long-term health risks and benefits of hysterectomy. Although most women have reported an overall symptom improvement associated with benign conditions, particularly relief from vaginal bleeding, more than half believe that some symptoms are worsened or caused by hysterectomy. A study showed that nearly 7% had complications, and new symptoms 1 year after hysterectomy included hot flashes (13%), weight gain (12%), depression (8%), and lack of interest in sex (7%) [21]. Women who consider elective hysterectomies as a therapeutic measure should therefore carefully weigh not only the immediate benefits of the procedure, but should also consider the new symptoms that might emerge after the operation. Similarly, the trend among young women to defer elective hysterectomy for future

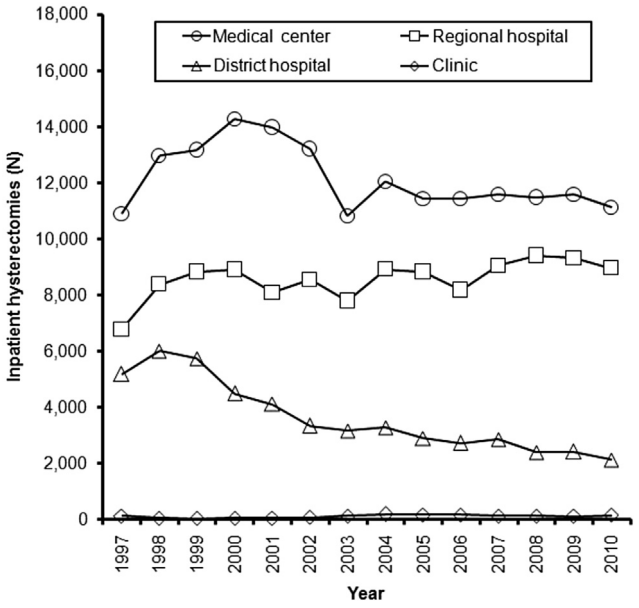

Figure 5. Nationwide trend of hysterectomies for women aged 20 years or older by the accreditation levels of physician-practice setting and year, 1997–2010 (N = 341,993).

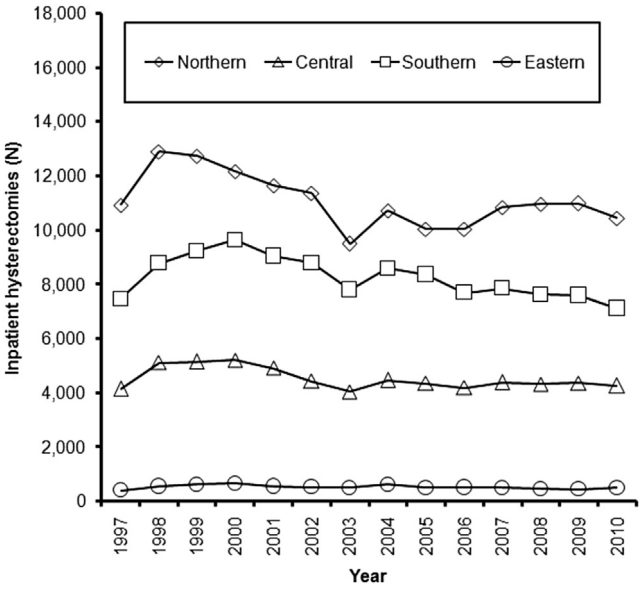

Figure 6. Nationwide trend of hysterectomies for women aged 20 years or older by physician-practice locations and year, 1997–2010 (N = 341,993).

childbearing [22] may also have influenced the downward trend in the utilization of hysterectomy. Additionally, the availability of second-surgical-opinion programs for elective hysterectomy has been shown to prevent unnecessary hysterectomy [23]. A shift in the physician's counseling on hysterectomy as well as the changing patient preferences in favor of nonsurgical alternatives might also play an important role in the observed downward trend in the utilization of hysterectomy [24].

The use of laparoscopic-assisted surgery has become a widespread alternative to conventional abdominal and vaginal hysterectomies in the management of gynecological indications [10]. However, the change in the use of laparoscopic-assisted hysterectomy types varies considerably by country over the past years. In contrast to the United States, we found a much higher frequency (35–40%) of laparoscopic-assisted hysterectomies between 2000 and 2010 in Taiwan, whereas laparoscopic hysterectomies declined from 15.5% to 8.6% in the United States from 2006 to 2010 [3]. It is possible that the longer intraoperative time and higher inpatient expenses associated with laparoscopic surgery than abdominal hysterectomies [19] have precluded its use in the United States, a country without national health insurance. The observed discrepancy in the use of laparoscopic-assisted hysterectomies could also be attributed to the increase in the use of robotic hysterectomy from 0.9% in 2008 to 8.2% in 2010 in the United States [3]. Since robotic hysterectomy is currently not covered under the NHI program, the use of robotic hysterectomy is not considered to be of any significant scale in Taiwan.

We observed a decreasing trend of concomitant BSO performance at benign hysterectomy from 1997 to 2010. Ovarian cancer is the leading cause of cancer mortality in women worldwide. Most women are diagnosed at advanced stage with an overall 5-year survival rate of less than 30% [25]. Being the only effective intervention to reduce the incidence of ovarian cancer, physicians would recommend concomitant BSO procedure for peri- or postmenopausal women. However, premenopausal women with BSO would exhibit surgical menopause, similar to menopausal symptoms that occur in natural menopause. Surgical menopause reduces the circulating estrogen and androgen levels. Estrogen deficiency raises concern about additional risks for short- and long-term health consequences, namely, osteoporosis and hip fracture, coronary heart disease, and menopausal symptoms [26]. Moreover, since the early 2000s, various observation studies have also suggested several possible long-term adverse effects of the BSO procedure, including an increase in all-cause mortality, stroke, and coronary heart disease, particularly in premenopausal women [26,27]. Since no randomized study has yet investigated the issue on the long-term health outcomes of elective BSO versus ovarian conservation at hysterectomy, the trade-offs between the risks and benefits of BSO are a difficult choice not only for women at benign hysterectomy, but also for physicians in giving recommendations to their patients.

The current study should be interpreted within the inherent limitation of administrative-claim records. First, the NHIRD lacks sociodemographic variables, such as SES and education, as well as clinical variables, such as disease severity and parity. Romano adaptation of the Charlson comorbidity index for use with ICD-9-CM codes was used as a risk assessment for disease severity. Second, the physicians' training, attitudes, and clinical-practice patterns may affect the change in surgical routes [28]. Third, the principle of the utilization of hysterectomy may vary between medical institutions. This may partially explain the hysterectomy rates among different physician-practice settings, much higher in medical centers and regional hospitals than in district hospitals.

Several trends are observed in this study. The trends reported can have significant public-health implications. Although the overall utilization of hysterectomy has declined over the past decades, the improvement of screening efficacy for precancerous lesions and the advancement of less invasive therapeutic options will bring about even lower hysterectomy-utilization rates in the future. The continued monitoring of changes in the utilization, surgical routes, primary indications, and concomitant BSO rate of hysterectomy will be critical for understanding the appropriate indications for hysterectomy and oophorectomy, the emergence of alternative managements for uterine disorders, and future trends in women's reproductive health.

Conflicts of interest

The authors declared no conflicts of interest.

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