



Original Article

# Surgical trends for benign ovarian tumors among hospitals of different accreditation levels: An 11-year nationwide population-based descriptive study in Taiwan

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## Abstract

**Objective:** Using a population-based nationwide database, we describe the changing surgical trends for laparoscopy or laparotomy for benign ovarian tumors among hospitals of different accreditation levels in Taiwan (medical centers, regional hospitals, and local hospitals).

**Materials and methods:** Women who had National Health Insurance and received either laparoscopy or laparotomy as the primary surgery for benign ovarian tumors in Taiwan during 1999–2009 were identified for analysis.

**Results:** In total, 135,793 women who received either laparotomic (39,779) or laparoscopic surgery (96,014) for benign ovarian pathology were identified. The increase in annual laparoscopy number from 7176 in 1999 to 11,046 in 2009 was significant according to a log-linear regression test ( $p < 0.0001$ ). The decrease in laparotomies from 3845 to 3567 was not significant ( $p = 0.190$ ). Service volume shifts from local hospitals to regional hospitals were noted, with a concomitant decrease in the numbers of local hospitals. Laparoscopy was used more often than laparotomy among all three hospital accreditation levels. An increasing trend for choosing laparoscopy was observed for medical centers and local hospitals ( $p < 0.0001$ ), but not regional hospitals ( $p = 0.0745$ ). Laparoscopy was used more often in younger patients, by younger surgeons, and by male surgeons among hospitals at all three accreditation levels.

**Conclusion:** Laparoscopy was preferentially used over laparotomy at all three hospital levels. An increasing trend for choosing laparoscopy was observed for medical centers and local hospitals, but not regional hospitals. Service volume shifts from local hospitals to regional hospitals were noted. Use of laparoscopy differed according to patient age, surgeon age, and surgeon gender among different hospital levels.

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**Keywords:** benign ovarian tumor; laparotomy; laparoscopy; National Health Insurance Research Database (NHIRD); oophorectomy

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## Introduction

Ovarian tumors are common gynecologic findings among women of all age groups [1], with an estimated prevalence of 7% in women aged over 50 years and premenopausal women [2]. These women may be either asymptomatic or have symptoms such as abdominal pain and menstrual irregularity. Detection of an adnexal mass is most frequently an incidental finding on imaging or during an examination [3]. Common benign ovarian tumor types include functional ovarian cysts, and epithelial, germ, and stroma cells. [2]. Many ovarian disorders can be managed conservatively with observation and pain control if required. Other circumstances, either because of symptoms or concerns about a possible malignancy, may prompt surgical evaluation. Surgery for benign ovarian pathology is either by a laparotomic or laparoscopic approach.

Minimally invasive surgery has gained in popularity during the past two decades worldwide [4,5]. It includes innovative technologies, (e.g., laparoscopy, hysteroscopy, video-camera systems, electro-surgery energy resources) and concepts (e.g., smaller and fewer incisions, less manipulation, tissue and organ preservation) [5]. Because of the rapid evolution of instrumentation and wide acceptance by surgeons, laparoscopy has flourished in recent years [4]. Shorter recovery times and aesthetic advantages have also fueled patient advocacy. Industry, in partnership with pioneering surgeons, has been primarily responsible for these advances. Although the complication rate for laparoscopic surgery is still a concern, the intraoperative complication rate is around 1.4%, which is favorable compared to laparotomy [6,7]. Laparoscopy is now fully integrated in pelvic surgery approaches and is essential for gynecologic surgeons [4].

The laparoscopic approach is currently considered the preferred treatment for benign adnexal cysts [8]. However, there are some concerns about the use of laparoscopy in treating ovarian tumors, such as inadvertent intraoperative rupture of the cyst capsule and possible spillage and dissemination of its contents [9], and fear of encountering cancer and performing inadequate staging or upstaging of the disease via tumor seeding [10]. On the basis of a nationwide population-based database and previous experience [11,12], our objectives in this study were to describe changing trends in surgery for benign ovarian tumors using either laparoscopy or a laparotomy among hospitals of different accreditation levels in Taiwan. We also evaluated other variables such as patient age and surgeon age and gender among hospitals of different accreditation levels over an 11-year span.

## Materials and methods

### *The National Health Insurance (NHI) program in Taiwan*

Detailed information on the NHI was described in our previous report [11]. The comprehensive and universal NHI program in Taiwan commenced in March 1995. It is primarily financed by payroll taxes, with additional subsidies from

general government revenues. The NHI covered approximately 96.1% of the total population in Taiwan in 1999, which increased to 99.3% in 2009. During 1999–2009, approximately 91.0–92.5% of hospitals in Taiwan were under contract to the Bureau of NHI (BNHI) [9,13].

### *Data sources*

The data used in this study were obtained from the NHI Research Database (NHIRD). The NHIRD was established by the National Health Research Institute, in cooperation with the BNHI, to promote research into current and emerging medical issues in Taiwan. Three types of files from the NHIRD were used in this study [11]: i. inpatient expenditure by admission contains information on all NHI-reimbursed hospital discharge diagnosis codes and surgery codes (based on the International Classification of Diseases, 9th Revision, Clinical Modification; ICD-9-CM); ii. a registry of contracted medical facilities; and iii. a registry of data on medical personnel. Confidentiality assurance was guaranteed in accordance with the BNHI data regulations and institutional review board approval was waived.

### *Study population*

We investigated data for female patients diagnosed with benign ovarian pathology who underwent surgical procedures in Taiwan between 1 January 1999 and 31 December 2009. The ovarian pathology codes for 220 benign neoplasms of the ovary were as follows: 614.0, acute salpingitis and oophoritis; 614.1, chronic salpingitis and oophoritis; 614.2, salpingitis and oophoritis not specified as acute, subacute, or chronic; 617.1, endometriosis of the ovary (chocolate cyst of the ovary, endometrial cystoma of the ovary); 620.0, follicular cyst of the ovary; 620.1, corpus luteum cyst or hematoma; and 620.2, other and unspecified ovarian cyst. We were interested in cases for which surgery for ovarian pathology was the principle procedure. Therefore, patients who received a concomitant hysterectomy were excluded, including subtotal abdominal hysterectomy (supracervical hysterectomy, code 68.3), total abdominal hysterectomy (code 68.4), laparoscopic hysterectomy (code 68.51), or vaginal hysterectomy (68.59). The ICD-9 codes for the laparotomy and laparoscopy surgical procedures for benign ovarian pathology are available online.

### *Variables*

The variables used in the study fell into the following three categories: patient age; surgeon age and gender; and hospital accreditation level and ownership. Patients were divided into four 10-year age groups, <30, 30–39, 40–49, and ≥50 years. Surgeon age was divided into four 5-year age groups, <40, 40–44, 45–49, and ≥50 years. In Taiwan, hospitals are accredited by the Taiwan Joint Commission on Hospital Accreditation, which is supervised by the Department of Health, and classified into three levels based on healthcare quality, medical teaching ability, clinical capabilities, and bed

capacity. The three levels in this study were medical centers, regional hospitals, and local hospitals.

### Statistical analysis

The Cochran–Armitage trend test was used to distinguish laparotomy and laparoscopy proportions. A log-linear regression test was used to distinguish yearly trends in the use of laparotomy and laparoscopy during the study period. We determined the statistical significance of regression coefficients according to a two-sided *t* test [14]. Pearson  $\chi^2$  tests were used to examine differences in the distribution of the two types of surgery according to patient age and surgeon age and gender among hospitals of different accreditation levels. Multivariate logistic regression was used to examine the independent effects of individual variables in choosing laparoscopy to treat benign ovarian tumors. Statistical significance was determined by a *p* value of <0.05. All analyses in this study were carried out using Statistics Analysis System (SAS) software for Windows (version 9.13; Cary NC, USA).

## Results

### Total numbers of annual surgical procedures for benign ovarian tumors

In total, 135,793 women with 142,980 surgeries were identified. Only primary surgeries, involving either laparotomy (39,779) or laparoscopy (96,014), for benign ovarian pathology were analyzed. The total annual number of surgeries increased after 2004 and remained stationary thereafter. The proportion of total surgeries differed among hospitals of different accreditation levels (Table 1). The service volume decreased in local hospitals and increased in regional hospitals, with contrast coefficients for the trend analysis of  $p < 0.0001$ . Consistent with the service volume shifts from

local hospitals to regional hospitals, the number of local hospitals decreased from 503 in 1999 to 427 in 2004 and 385 in 2009, while the number of regional hospitals increased from 63 in 1999 to 80 in 2004 and remained stationary through to 2009. The annual number of laparoscopic procedures performed significantly increased from 7176 (65.1%) in 1999 to 11,046 (75.6%) as evidenced by a log-linear regression test ( $p < 0.0001$ ). The number of laparotomies decreased from 3845 (34.9%) to 3567 (24.4%), but the decrease was not significant ( $p = 0.190$ ; Table 1).

### Trends in surgical type: laparoscopy versus laparotomy

In general, laparoscopy was used more often than laparotomy among the three hospital accreditation levels in 1999–2009. An increase in the trend for choosing laparoscopy occurred in medical centers and local hospitals ( $p < 0.0001$ ), but not regional hospitals ( $p = 0.0745$ ; Fig. 1).

### Tendency to choose laparoscopy according to patient age and surgeon age and gender

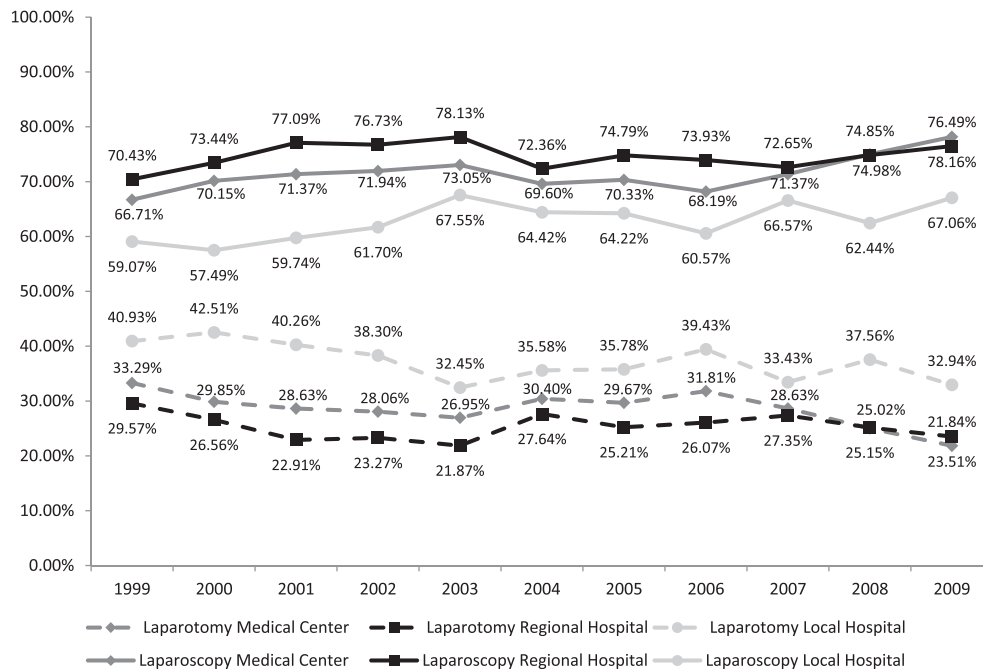
Use of laparotomy (29.29%) and laparoscopy (70.71%) differed according to patient age and surgeon age and gender among the three hospital accreditation levels. Laparoscopy was more commonly performed on patients aged <30 years, followed by 30–39, 40–49, and  $\geq 50$  years ( $p < 0.0001$ ). Similar trends occurred among hospitals at the three accreditation levels (all  $p < 0.0001$ ; Fig. 2). Laparoscopy was more commonly performed by younger surgeons of <40 years, followed by 40–44, 45–49, and  $\geq 50$  years ( $p < 0.0001$ ; Fig. 3). Similar trends occurred among hospitals at the three accreditation levels (all  $p < 0.0001$ ). Laparoscopic surgery was more commonly performed by both male and female surgeons, although the trend was more obvious for male than for female surgeons ( $p < 0.0001$ ). Similar trends occurred

Table 1  
Total annual surgical procedures for benign ovarian tumors among hospitals at three accreditation levels and proportion of laparoscopic and laparotomic procedures, 1999–2009.

	1999 <i>n</i> (%)	2000 <i>n</i> (%)	2001 <i>n</i> (%)	2002 <i>n</i> (%)	2003 <i>n</i> (%)	2004 <i>n</i> (%)	2005 <i>n</i> (%)	2006 <i>n</i> (%)	2007 <i>n</i> (%)	2008 <i>n</i> (%)	2009 <i>n</i> (%)	Total
Medical centers <i>N</i> =	4277 (38.8%)	4646 (44.9%)	4823 (46.7%)	4839 (46.5%)	4541 (43.3%)	5838 (42.4%)	5749 (42.3%)	5825 (43.5%)	6084 (44.5%)	6284 (44.4%)	6460 (44.2%)	59,366 (43.7%)
Regional hospitals <i>N</i> =	18 (27.1%)	22 (30.3%)	23 (29.8%)	23 (31.5%)	23 (33.3%)	24 (36.2%)	24 (37.0%)	24 (36.2%)	23 (36.2%)	23 (38.1%)	23 (38.4%)	186 (34.5%)
Local hospitals <i>N</i> =	63 (34.1%)	71 (24.8%)	74 (23.5%)	80 (22.0%)	80 (23.4%)	80 (21.4%)	73 (20.7%)	70 (20.4%)	72 (19.3%)	77 (17.5%)	78 (17.3%)	503 (21.8%)
All hospitals <i>N</i> =	503 (11,021)	484 (10,351)	468 (10,323)	450 (10,409)	437 (10,489)	427 (13,768)	417 (13,587)	414 (13,403)	397 (13,686)	383 (14,143)	385 (14,613)	584 (135,793)
Laparoscopy	7176 (65.1%)	7039 (68.0%)	7261 (70.3%)	7411 (71.2%)	7704 (73.4%)	9567 (69.5%)	9608 (70.7%)	9210 (68.7%)	9704 (70.9%)	10,288 (72.7%)	11,046 (75.6%)	96,014 (70.7%)
Laparotomy	3845 (34.9%)	3312 (32.0%)	3062 (29.7%)	2998 (28.8%)	2785 (26.6%)	4201 (30.5%)	3979 (29.3%)	4193 (31.3%)	3982 (29.1%)	3855 (27.3%)	3567 (24.4%)	39,779 (29.3%)

Number of surgical procedures is presented as *n* (%). *N* denotes the number of hospitals.

Trend test: laparotomy coefficient = 64.78, 95% confidence interval (CI) (–38.48, 168.05),  $t = 1.419$ ,  $p = 0.190$ ; laparoscopy coefficient = 410.70, 95% CI (306.21, 515.19),  $t = 8.891$   $p < 0.0001$ .



**Note:** Cochrane-Armitage trend test: *p* values for medical centers, regional hospitals, and local hospitals were < 0.001, 0.0745, and < 0.0001, respectively.

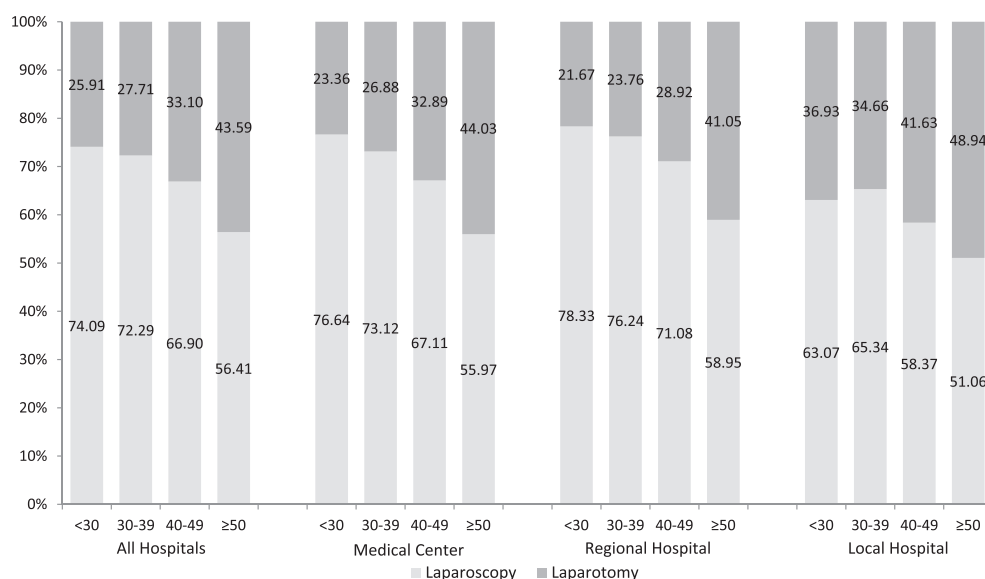
Fig. 1. Trends in surgical type (laparoscopy or laparotomy) for benign ovarian tumors in Taiwan at three hospital accreditation levels, 1999–2009.

among hospitals at the three accreditation levels (all  $p < 0.0001$ ; Fig. 4).

#### Multiple logistic regression for predicting laparoscopy

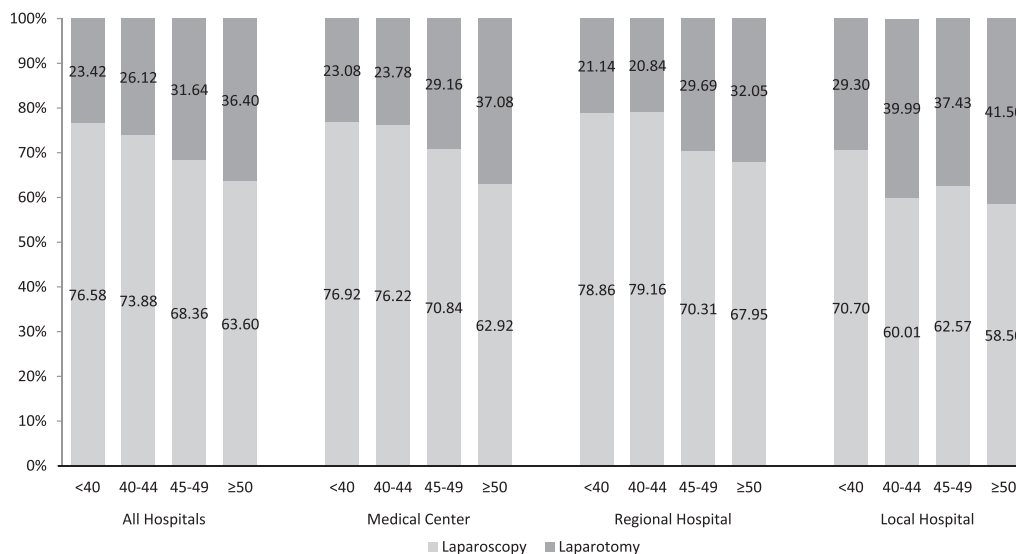
To eliminate confounding factors, multivariate logistic regression was used to evaluate individual variables for

predicting use of laparoscopy to treat benign ovarian pathology among hospitals of different accreditation levels (Table 2). Older patients ( $\geq 50$  years) had the lowest probability of receiving laparoscopy, followed by those aged 40–49 and 30–39 years, compared to women aged <30 years. Older surgeons ( $\geq 50$  years) had the lowest probability of performing laparoscopy, followed by those aged 45–49 and 40–44 years,



**Note:** Cochrane-Armitage trend test: *p* values for medical centers, regional hospitals, and local hospitals were all < 0.0001.

Fig. 2. Tendency to choose a type of surgery for benign ovarian tumors according to patient age at three hospital accreditation levels, 1999–2009.



**Note:** Cochran-Armitage trend test:  $p$  values for medical centers, regional hospitals, and local hospitals were all  $< 0.0001$ .

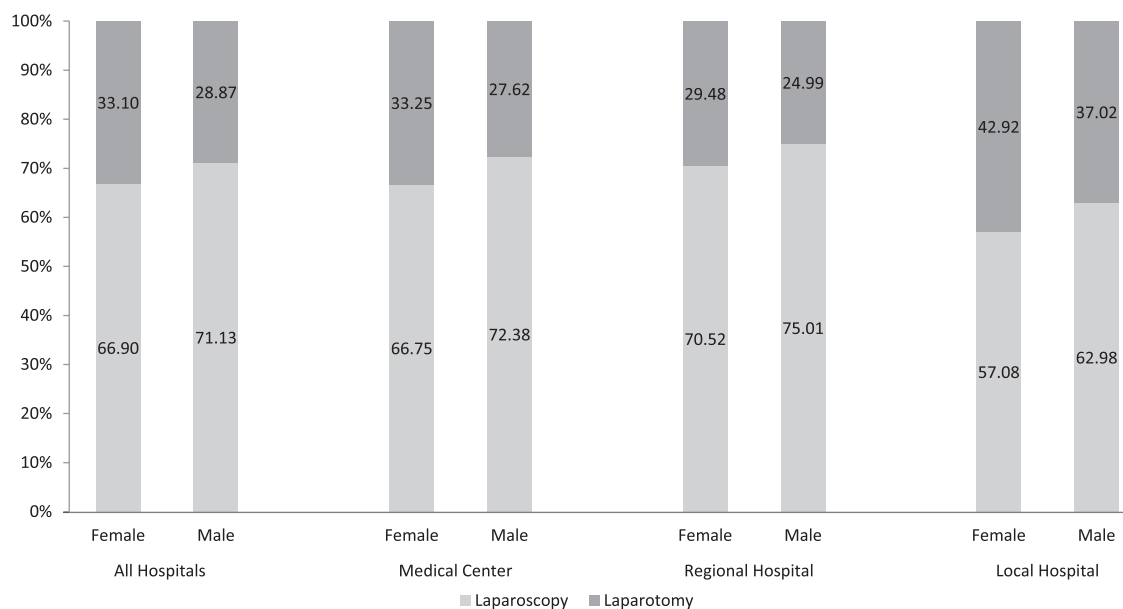
Fig. 3. Tendency to choose a type of surgery for benign ovarian tumors according to surgeon age at three hospital accreditation levels, 1999–2009.

compared to younger surgeons ( $<40$  years). Female surgeons had a lower probability of performing laparoscopy. Similar trends occurred among medical centers, regional hospitals, and local hospitals, with all  $p$  values  $< 0.0001$ , except for surgeons aged 40–44 years (Table 2).

## Discussion

According to a population-based nationwide database, our observational study revealed an increase in the annual number of

laparoscopic procedures compared to no change in the number of laparotomies for benign ovarian tumors, as evidenced by a log-linear regression test. We offer evidence of increasingly common use of laparoscopy for gynecologic surgery. This is in accordance with a review by Canis et al, who found that laparoscopy is the preferred surgical approach for benign ovarian pathology [8]. The benefits of laparoscopy were illustrated in a systematic review of randomized trials comparing laparoscopy to laparotomy [15]. Laparoscopic surgery is significantly less costly, requires a shorter operative time, and results in less



**Note:** Contrast coefficient for the trend analysis:  $p < 0.0001$ .

Fig. 4. Tendency to choose a type of surgery for benign ovarian tumors according to surgeon gender at three hospital accreditation levels, 1999–2009.

Table 2

Multiple logistic regression for predicting laparoscopy for benign ovarian tumors among hospitals at three accreditation levels.

	Medical centers		Regional hospitals		Local hospitals		All	
	OR (95% CI)	<i>p</i>	OR (95% CI)	<i>p</i>	OR (95% CI)	<i>p</i>	OR (95% CI)	<i>p</i>
Patient age								
<30 y	Reference		Reference		Reference		Reference	
30–39 y	0.84 (0.80–0.88)	<0.0001	0.90 (0.85–0.94)	<0.0001	1.12 (1.06–1.19)	<0.0001	0.93 (0.90–0.96)	<0.0001
40–49 y	0.64 (0.61–0.67)	<0.0001	0.70 (0.66–0.74)	<0.0001	0.84 (0.79–0.90)	<0.0001	0.73 (0.71–0.75)	<0.0001
≥50 y	0.40 (0.38–0.43)	<0.0001	0.40 (0.37–0.44)	<0.0001	0.63 (0.56–0.70)	<0.0001	0.47 (0.45–0.49)	<0.0001
Surgeon age								
<40 y	Reference		Reference		Reference		Reference	
40–44 y	0.95 (0.90–1.00)	0.0696	0.99 (0.93–1.05)	0.7812	0.60 (0.56–0.64)	<0.0001	0.85 (0.82–0.88)	<0.0001
45–49	0.72 (0.68–0.76)	<0.0001	0.62 (0.580.65)	<0.0001	0.66 (0.62–0.71)	<0.0001	0.64 (0.62–0.67)	<0.0001
≥50 y	0.51 (0.49–0.54)	<0.0001	0.56 (0.52–0.59)	<0.0001	0.57 (0.53–0.61)	<0.0001	0.53 (0.51–0.55)	<0.0001
Surgeon gender								
Male	Reference		Reference		Reference		Reference	
Female	0.70 (0.66–0.73)	<0.0001	0.69 (0.65–0.74)	<0.0001	0.69 (0.62–0.77)	<0.0001	0.74 (0.71–0.77)	<0.0001

CI = confidence interval; OR = odds ratio.

perioperative blood loss, a shorter hospital stay, and shorter convalescence time compared to laparotomy [15]. This study and our previous studies point to a significant increase in the use of laparoscopy for benign gynecologic conditions including hysterectomies, ectopic pregnancies, and benign ovarian tumors during the past 15 years in Taiwan [11,12]. We observed similar increasing trends in the use of laparoscopy in medical centers and local hospitals, but not regional hospitals. The popularity of the minimally invasive approach profoundly affects choices for gynecologic surgery.

In accordance with our previous studies, we again found that use of either laparotomy or laparoscopy differed according to patient age and surgeon age and gender among hospitals of different accreditation levels [11,12]. Multiple logistic regression analysis revealed that older patients (≥50 years, followed by those aged 40–49 and 30–39 years, compared to women aged <30 years), had a lower chance of undergoing laparoscopy. This finding may be attributable to higher expectations for quality of life, patient self-esteem, body image, and self-consciousness among women of different age groups [12]. This study, as well as our previous study, confirmed that patient age is one of the factors that should be taken into account when selecting an appropriate surgery type [11,12]. Similar trends were observed among hospitals of different accreditation levels. Although a laparotomy may initially seem advantageous for the surgeon, the large abdominal incision, prolonged hospital stay, increased postoperative analgesic requirements, and increased morbidity are disadvantages for patients [16]. Elderly surgeons (aged >45 years in medical centers and regional hospitals, and aged >40 years in local hospitals) had a lower probability of performing laparoscopy. The fact that surgeon age affects surgical choices is possibly explained by the influence of training background [11,12].

Laparoscopy was more commonly used among all hospitals at the three accreditation levels. Medical centers and local hospitals showed similar trends for increased use of laparoscopy to treat benign ovarian tumors, but regional hospitals did not. The reason for this phenomenon remains unclear. It is possible that regional hospitals already had a high tendency to

choose laparoscopy in the initial study years so we could not discern an increasing trend. Moreover, we found that the proportion of laparoscopy and laparotomy differed among hospitals of different accreditation levels. The service volume for benign ovarian tumors decreased in local hospitals and increased in regional hospitals during the 11-year span. Service volume shifts were noted from local hospitals to regional hospitals, with a concomitant decrease in numbers at local hospitals, due to either an accreditation level change for local clinics or cessation of clinical service. Another possible reason is patient preference for a higher accreditation level (i.e., move from local to regional hospitals). Our previous study also revealed a higher likelihood of performing laparoscopy for hysterectomy among gynecologists with a high-volume practice [17]. It is also possible that service volume affects the choice of surgery type. This finding suggests that differences in practice patterns and surgical treatment decisions may explain variations in the use of laparoscopy. Patients in regional hospitals, followed by medical centers, had a higher probability of receiving laparoscopy compared to those in local hospitals. Surgeons in hospitals of different accreditation levels may have different specialized surgical training, including apprenticeship-style training, curriculum- and case-based programs, or independent and integrated specialty training programs [18]. There were some minor differences among these hospitals, such as a non-significant difference for regional hospital due to service volume changes. Therefore, in addition to patient condition, the choice of surgical procedure depends, to some extent, on the hospital visited [19,20].

The strength of this study is its categorization of surgical trends for choosing laparoscopy according to patient age and surgeon age and gender among different hospital accreditation levels. This excluded at least some of the confounding factors, such as surgeon age differences at different hospital accreditation levels or patient age differences at different hospital accreditation levels. Owing to its retrospective and observational nature, the study has some inherent limitations. Mis-coding because of coding by medical affairs personnel instead of surgeons themselves is a possibility. Moreover, the exact



diagnoses were heterogeneous, ranging from epithelial ovarian tumors to tubo-ovarian abscesses. In addition, the exact procedures performed were not specified (e.g., salpingo-oophorectomy, marsupialization of an ovarian cyst, wedge resection of the ovary, local excision or destruction of ovary) and incidental intraoperative findings of malignancy and the conversion rate to laparotomy were not reported. Despite these limitations, the study provides a descriptive analysis of changing surgical trends for benign ovarian tumors and influential variables (patient age and surgeon age and gender) among hospitals of different accreditation levels according to an 11-year population-based nationwide database.

In conclusion, our study offers population-based nationwide observations that there has been considerable change in the choice of surgical approach for benign ovarian tumors in Taiwan over the past 11 years. Laparoscopy is preferred over laparotomy among hospitals of three different accreditation levels, and has become the standard surgical approach. An increasing trend for choosing laparoscopy occurred in medical centers and local hospitals, but not regional hospitals. Service volume shifts from local hospitals to regional hospitals were noted. Use of laparoscopy differed according to patient age and surgeon and gender among hospitals at three accreditation levels.

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