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Original Article

Physician and patient characteristics affecting repeat use of abdominal ultrasound: A nationwide population-based study

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Abstract

Background: Ultrasound is a useful and popular imaging modality. Our aim was to assess the association between the use and repeat use of abdominal ultrasound and diagnosis, physicians, and hospital characteristics according to a Taiwanese national database.
Methods: The Taiwan National Health Insurance database contains data for approximately 22,134,270 insured individuals during 2004–2005 (>98% of the population in Taiwan). Patients who were scanned with abdominal ultrasound once or more during that period were identified. Associations between physicians, hospital characteristics, diagnoses, and repeat use of abdominal ultrasound were analyzed. Logistic regression with generalized estimating equations was used.
Results: A total of 2,319,164 abdominal ultrasound scans were performed (approximately 6.42% of the population in Taiwan). Among these, 38.34% received repeat examinations. Multiple logistic regression analysis showed that gastroenterologists [odds ratio (OR) = 1.07], male physicians, physicians younger than 40 years of age, and physicians in medical centers were more likely to use repeat abdominal ultrasound. The analysis also showed that male patients, older patients, patients with liver and biliary disease (OR = 1.17), and patients with other abdominal disease (OR = 1.37) were more likely to receive repeat abdominal ultrasound.
Conclusion: Our study shows that the use and repeat use of abdominal ultrasound is very high and is related to diagnosis and physician and hospital characteristics.

Keywords: abdominal ultrasound; diagnosis; healthcare; hospital; physician

1. Introduction

Ultrasound is a relatively inexpensive and safe diagnostic imaging technique. Recent advances and novel applications make ultrasound an even better initial imaging tool for a wide range of diseases. Ultrasound scans are performed in various specialties, and are usually categorized as general, abdominal, vascular, breast, echocardiography, obstetric, gynecological, or pediatric.[1] Abdominal ultrasound, like all ultrasound, is inexpensive and widely used, and is most commonly performed by radiologists, gastroenterologists, and a few other specialist physicians.

The overall utilization rate for all noninvasive diagnostic imaging increased by 3.8% from 1993 to 1999. Ultrasound use increased by 24.2% during this 6-year period.[2] Among the different types of medical imaging, conventional radiology accounts for the greatest proportion, with ultrasound in second place, followed by computed tomography (CT), nuclear

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imaging, magnetic resonance (MR) imaging, and bone densitometry.[2,3] For abdominal imaging, combined imaging use increased by 25% from 1996 to 2005. The greatest growth was for abdominal CT, followed by abdominal ultrasound (increased 12%).[4] This rapid growth in medical imaging and its associated costs are becoming major concerns for policy-makers and insurance companies.

Previous research has found that repeat scans account for nearly one-third of the enormous costs associated with radiological examinations.[5] Previous reports have also discussed possible factors affecting the repeat use of costly imaging modalities, including disease pattern, physician behavior (including self-referral), and hospital characteristics, with conflicting results.[5–8] Most of these studies were based on regional samples or samples from selected hospitals. In Taiwan, the healthcare of nearly the entire population (>98%) has been covered by the National Health Insurance (NHI) system since 1995.[9] This provides a relatively unique opportunity to study the factors affecting the use of abdominal ultrasound. In view of increasing healthcare cost for over-imaging, our study focused on the number and repeat use of abdominal ultrasound examinations.

In Taiwan, healthcare has mostly been provided by the NHI since 1995. Over the 17 years since its establishment, the NHI has provided quality medical service without exorbitant cost.[5] Total expenditure on health was 6.6% of GDP in 2009. Current life expectancy is 82 years for females and 76 years for males. The infant mortality rate is 4.3%.[10] The purpose of this study was to determine the associations between diagnoses, physicians, and hospital characteristics and the use of abdominal ultrasound examinations according to a nationwide database. The results may help to establish a reference for monitoring appropriate use of abdominal ultrasound.

2. Methods

2.1. Database and data acquisition

The 2004–2005 NHI data were obtained from the National Health Research Institute (NHRI). The NHRI database contains benefit claims for all medical care services for almost every Taiwanese individual (approximately 22,134,270), and includes registries of contracted medical facilities and board-certified physicians, and details of patient care orders. For this study, the NHRI provided de-identified data (for both patients and physicians) extracted from its 2004–2005 data set. The study was approved by the NHRI, and therefore informed consent and Institutional Review Board approval were waived.

2.2. Study population

All abdominal ultrasound examinations (inpatient, outpatient, and emergency services) were identified from the database. A total of 1,426,698 patients who received abdominal ultrasound during 2004 and had data available for analysis for the following year were identified from the data set. Among these, 545,452 had abdominal ultrasound performed more than once during that time and were categorized as the repeat group. The remaining 881,246 patients who received only one abdominal ultrasound during the year were categorized as the non-repeat group. After excluding patients with missing data, a total of 1,421,307 patients (545,007 repeat and 876,300 non-repeat groups) with complete data were used for further statistical analysis. The NHI reimbursed 750 NTD (approximately US$25) for each abdominal ultrasound during 2004–2005.[9]

For the repeat group, the last claims for abdominal ultrasound were subjected to further evaluation. Four time intervals were classified as follows to further evaluate the repeat group: (i) acute disease phase, 0–2 weeks; (ii) acute disease follow-up, 2 weeks–2 months; (iii) chronic disease follow-up, 2–7 months; and long-term follow-up of chronic disease, >7 months, in accordance with a study by Lee et al.[5]

Disease conditions were categorized into six different groups using the International Classification of Disease, 9th Revision, Clinical Modification (ICD-9-CM) diagnosis codes. The six disease groups were as follows: (1) liver and biliary disease (ICD-9: 155, 156, 570–579); (2) gastrointestinal disease (GI, ICD-9: 150–154, 530–566, 569, 578, 579); (3) other abdominal disease (other than liver and biliary disease, ICD-9: 157–159, 567, 568, 577); (4) genitourinary disease (GU, ICD-9: 580–629); (5) ill-defined disorder (ICD-9: 780–799); and (6) others (all other codes). The hepatobiliary group was further subdivided into hepatocellular carcinoma (HCC, ICD-9: 155), liver cirrhosis (ICD-9: 571), hepatitis (ICD-9: 070), other liver and biliary disease (ICD-9: 156, 570, 572–579), and others (all other codes) for further evaluation of hepatobiliary diseases. Contracted medical hospitals and clinics that performed the sonograms were classified according to their ownership and accreditation level (hospital characteristics). There were 215 public hospitals, 1572 private hospitals and clinics, and 79 not-for-profit hospitals in Taiwan. In terms of accreditation, 18 were certified medical centers (≥500 beds), 75 regional hospitals (≥250 beds), 391 district (community) hospitals (>250 beds), and 1382 clinics. Physician characteristics included specialty, age, and sex. Physician specialties were categorized into eight groups: gastroenterologist, internal medicine (other than gastroenterologist), surgeon, family physician, obstetrics and gynecology (OB/GYN), pediatrics, emergency physician, and others.

2.3. Statistical analysis

The key independent variables of interest were physician characteristics, varieties of disease, and hospital characteristics. The key dependent variable was repeat use of abdominal ultrasound for all inpatient, outpatient, and emergency services in all the hospitals and clinics in Taiwan. Univariate analysis was performed using a χ^2 test or Fisher exact test. Logistic regression with generalized estimating equations (GEE) was used for multivariate analysis to explore relationships between physician characteristics, patient disease, hospital characteristics, and repeat use of abdominal ultrasound. A two-sided p value of 0.001 or less was considered statistically significant.

The SAS statistical package (version 9.1, SAS Institute, Cary, NC, USA) was used for analysis.

3. Results

3.1. Descriptive data

During 2004, a total of 2,319,164 ultrasounds were performed for the selected 1,421,307 patients. The prevalence of abdominal ultrasound use was 6.42% (5.94% for females and 6.91% for males) among the whole population. The ultrasound use rate increased with age, with beneficiaries older than 65 years accounting for the highest percentage (15.87%). A total of 545,007 patients received a repeat abdominal ultrasound scan. The prevalence of repeat ultrasound was 2.46% among the whole study population (Table 1) and 38.34% among all patients who received abdominal ultrasound. The frequency of repeat ultrasound scans ranged from twice to 32 times. Most patients (338,054; 62.1%) were scanned twice per year. Approximately 14.8% (80,918) received more than four abdominal ultrasounds per year. Among the repeat scans, most were performed between 2 and 7 months (247,118, 45.3%) after the initial examination, followed by >7 months (160,034, 29.4%), 0–2 weeks (69,742, 12.8%), and 2 weeks–2 months (68,113, 12.5%). Most of the repeat abdominal ultrasound scans were performed in outpatient clinics (440,870, 80.9%).

3.2. Patient characteristics, diagnosis, and repeat use of abdominal ultrasound

For patients in the repeat scan group, 64.4% of the abdominal ultrasound scans were performed for the same disease category. Our data show that males and patients aged 45–64 years received more ultrasound and repeat scans than other groups ($p > 0.001$). Liver and biliary disease was the most common reason for use and repeat use of abdominal ultrasound; it also accounted for the second highest repeat scan rate (44.3%). All the differences were statistically significant ($p > 0.001$; Table 2). Among hepatobiliary disease diagnoses, the repeat scan rate was highest for HCC (81.7%), followed by liver cirrhosis (49.5%), and hepatitis (48.5%; Table 3).

Table 1
Prevalence of abdominal ultrasound scan (AUS) use in Taiwan.

Age	NHI beneficiaries	Patients receiving AUS		Patients receiving repeat AUS	
	n (%)	*n*	Rate (%)*	*n*	Rate (%)*
≤30 y	9,511,960 (42.97)	243,079	2.56	61,662	0.65
31–44 y	5,578,435 (25.20)	329,752	5.91	123,996	2.22
45–64 y	4,929,733 (22.27)	513,010	10.41	218,513	4.43
≥65 y	2,114,142 (9.55)	335,466	15.87	140,836	6.66
Total	22,134,270 (100.00)	1,421,307	6.42	545,007	2.46

*Mantel–Haenszel χ^2 test for trend, $p < 0.001$.

Table 2
Association between patient characteristics and use of abdominal ultrasound scan.

Characteristics	Total (n = 1,421,307)	Repeat group (n = 545,007)	p	Repeat rate (%)
Sex			<0.001	
Female	660,669 (46.5)	243,035 (44.6)		36.8
Male	760,638 (53.5)	301,972 (55.4)		39.7
Age			<0.001	
≤30 y	243,079 (17.1)	61,662 (11.3)		25.7
31–44 y	329,752 (23.2)	123,996 (22.8)		37.6
45–64 y	513,010 (36.1)	218,513 (40.1)		42.6
≥65 y	335,466 23.6	140,836 (25.8)		42.0
Disease categories			<0.001	
Liver, biliary	601,502 (42.3)	270,367 (49.6)		44.3
Others	237,024 (16.7)	94,775 (17.4)		40.0
GI	257,692 (18.1)	85,580 (15.7)		33.2
GU	203,346 (14.3)	62,246 (11.4)		30.6
Ill-defined disorder	113,822 (8.0)	28,133 (5.2)		24.7
Other abdominal	7921 (0.6)	3906 (0.7)		49.3

Association data are presented as *n* (%).

3.3. Hospital characteristics and repeat use of abdominal ultrasound

Of all the repeat scans, 67.4% were performed in the same hospital. Regional hospitals had the highest (535,775, 37.7%) total ultrasound and repeat ultrasound (206,567, 37.9%) use. However, medical centers had the highest repeat scan rate (43.4%, $p < 0.001$). In terms of hospital ownership, not-for-profit hospitals accounted for the highest total volume, repeat volume, and repeat scan rate ($p < 0.001$; Table 4).

3.4. Physician characteristics and repeat abdominal ultrasound

There were 14,858 physicians who ordered abdominal ultrasounds during 2004. Approximately 61.4% of the repeat examinations were orders from the same specialty and 45.2% were from the same doctor. Gastroenterologists ordered the most scans in terms of total volume, repeat volume, and repeat scan rate (45.4%). Surgeons were second in terms of total volume of ultrasounds ordered. The repeat scan rate per physician was 32.6% for male physicians and 31.4% for female physicians ($p < 0.001$). In terms of physician age, 7810 physicians aged < 40 years ordered most of the total and repeat ultrasounds (Table 4).

3.5. Differences between the repeat and non-repeat ultrasound groups

Multiple logistic regression analysis revealed that gastroenterologists [odds ratio (OR) = 1.57, 95% confidence interval (CI) = 1.54–1.59], male physicians (OR = 1.11, 95% CI = 1.09–1.12), physicians younger than 40 years (OR = 1.14, 95%CI = 1.13–1.15), and physicians in medical centers (OR = 1.50, 95%CI = 1.47–1.52) were more likely to use repeat abdominal ultrasound compared to other groups.

Table 3
Association of hepatocellular carcinoma (HCC), liver cirrhosis, and hepatitis with repeat use of abdominal ultrasound.

Disease category	Total	Repeat group		Logistic regression model	
	(n = 1,421,307)	(n = 545,007)		cOR (95% CI)	aOR (95% CI)
	n (%)	n	Rate (%)		
HCC	21,764 (1.5)	17,787	81.7*	9.51 (9.19–9.85)*	7.49 (7.23–7.76)*
Cirrhosis	297,219 (20.9)	146,968	49.5*	2.08 (2.06–2.10)*	2.18 (2.16–2.20)*
Hepatitis	75,094 (5.3)	36,447	48.5*	2.01 (1.98–2.04)*	2.35 (2.31–2.38)*
Other hepatobiliary	282,519 (19.9)	105,612	37.4*	1.27 (1.26–1.28)*	1.27 (1.26–1.29)*
Others	744,711 (52.4)	238,193	32.0*	Reference	Reference

aOR = adjusted odds ratio; CI = confidence interval; cOR = crude odds ratio.
*$p < 0.0001$.

Male patients (OR = 1.12, 95%CI = 1.11–1.12), patients older than 65 years (OR = 2.11, 95%CI = 2.08–2.13), and patients with liver and biliary disease (OR = 1.17, 95% CI = 1.16–1.19) or other abdominal disease (OR = 1.37, 95% CI = 1.31–1.43) were more likely to receive repeat abdominal ultrasound than other groups (Table 5).

4. Discussion

Ultrasound is safe, portable, and easy to perform, and has good temporal and spatial resolution. It is the second most widely used diagnostic imaging modality.[3] The cost of ultrasound inclusive of the technical fee and the purchase price of the ultrasound machine is lower than the costs for CT and MRI. However, its popularity encourages a higher volume of use, which negates its cost advantage. The reasons for high utilization of a variety of imaging modalities have been discussed previously, including repeat use,[5] diagnosis, and doctor behavior, with conflicting results.[6,8,11]

Abdominal ultrasound is an important diagnostic procedure for abdominal disease. Our nationwide data set shows that approximately 6.42% of the population in Taiwan received abdominal ultrasound over the course of 1 year. This may be related to the relatively low NHI reimbursement fee for each abdominal ultrasound, or other reasons related to disease, physician, or hospital characteristics. Lee et al used 2 weeks–7 months as an evaluation window to analyze repeat use of CT, MRI, and pelvic ultrasound to cover acute disease and follow-up examinations for chronic disease.[5] They demonstrated that 31% of all studies were repeat examinations and up to 45% of body CT scans were repeats. In our study, 38.34% of abdominal ultrasound scans within 1 year were

Table 4
Association of hospital and physician characteristics with the use of abdominal ultrasound.

Hospital and physician characteristics	Abdominal ultrasound scans		p	Repeat rate	Physicians	Repeat scans per physician
	Total	Repeat		(%)	(n)	
Hospital accreditation			<0.001			
Medical center	422,794 (29.7)	183,366 (33.6)		43.4	5068	44.9 ± 16.0
Regional hospital	535,775 (37.7)	206,567 (37.9)		38.6	4797	37.3 ± 14.6
District hospital	291,295 (20.5)	99,022 (18.2)		34.0	3036	33.7 ± 23.0
Clinic	171,443 (12.1)	56,052 (10.3)		32.7	1957	35.3 ± 29.3
Hospital ownership			<0.001			
Not-for-profit	578,266 (40.7)	238,609 (43.8)		41.3	5644	40.9 ± 17.0
Public	369,367 (26.0)	144,803 (26.6)		39.2	5150	39.4 ± 28.4
Private	473,674 (33.3)	161,595 (29.7)		34.1	4064	34.3 ± 27.8
Physician age			<0.001			
≤40 y	617,360 (43.4)	237,483 (43.6)		38.5	7810	34.9 ± 29.1
41–50 y	566,777 (39.9)	219,921 (40.4)		38.8	4673	29.9 ± 22.5
≥51 y	237,170 (16.7)	87,603 (16.1)		36.9	2375	29.6 ± 24.9
Physician sex			<0.001			
Male	1,322,593 (93.1)	512,112 (94.0)		38.7	13,200	32.6 ± 26.2
Female	98,714 (6.9)	32,895 (6.0)		33.3	1658	31.4 ± 30.0
Specialty			<0.001			
Gastroenterologist	484,566 (34.1)	219,809 (40.3)		45.4	1261	44.0 ± 19.6
Surgeon	186,890 (13.1)	75,326 (13.8)		40.3	2968	33.6 ± 27.2
Others	91,353 (6.4)	33,354 (6.1)		36.5	2061	33.0 ± 31.8
Other internal medicine	470,273 (33.1)	166,449 (30.5)		35.4	5061	33.5 ± 23.2
Family practice	97,480 (6.9)	30,145 (5.5)		30.9	1091	31.8 ± 26.6
OB/GYN	4669 (0.3)	1369 (0.3)		29.3	663	23.3 ± 30.0
Emergency	27,062 (1.9)	7153 (1.3)		26.4	751	30.2 ± 31.3
Pediatric	59,014 (4.2)	11,402 (2.1)		19.3	1002	16.5 ± 21.0

Table 5
Multivariate logistic regression for factors affecting repeat abdominal ultrasound.

Characteristic	Adjusted odds ratio (95% CI)	*p*
Sex		
Female	1.00	
Male	1.12 (1.11–1.12)	<0.001
Age		
≤30 y	1.00	
31–44 y	1.57 (1.55–1.59)	<0.001
45–64 y	1.99 (1.97–2.02)	<0.001
≥65 y	2.11 (2.08–2.13)	<0.001
Disease diagnosis		
Liver, biliary	1.17 (1.16–1.19)	<0.001
GI	0.70 (0.70–0.71)	<0.001
Other abdominal	1.37 (1.31–1.43)	<0.001
GU	0.65 (0.65–0.66)	<0.001
Ill-defined disorder	0.54 (0.54–0.55)	<0.001
Others	1.00	
Hospital accreditation		
Medical center	1.50 (1.47–1.52)	<0.001
Regional hospital	1.18 (1.16–1.20)	<0.001
District hospital	1.05 (1.04–1.07)	<0.001
Clinic	1.00	
Hospital ownership		
Public	0.94 (0.93–0.95)	<0.001
Private	0.93 (0.92–0.94)	<0.001
Not-for-profit	1.00	
Physician age		
≤40 y	1.14 (1.13–1.15)	<0.001
41–50 y	1.10 (1.09–1.11)	<0.001
≥51 y	1.00	
Physician sex		
Female	1.00	
Male	1.11 (1.09–1.12)	<0.001
Specialty		
Gastroenterologist	1.57 (1.54–1.59)	<0.001
Other internal medicine	1.20 (1.18–1.22)	<0.001
Surgeon	1.46 (1.44–1.49)	<0.001
OB/GYN	1.08 (1.01–1.16)	0.020
Pediatric	0.98 (0.95–1.01)	0.128
Emergency	0.84 (0.81–0.87)	<0.001
Family practice	1.00	
Others	1.27 (1.24–1.29)	0.001

repeats, and the most common repeat scan frequency was twice a year. Most of the second abdominal ultrasound examinations were performed between 2 and 7 months after the initial scan. Both studies reveal important data about the repeat use of abdominal scans, but the study by Lee et al was limited to one medical center, while we used a nationwide data set.

In our study, hepatobiliary disease incurred the highest need for repeat abdominal ultrasound. This is in accordance with the proper diagnostic procedure for such disease.[12,13] For diseases such as hepatic tumors, hepatic inflammation, choledocholithiasis,[14] and other hepatobiliary disease, abdominal ultrasound is the modality of choice for both screening and diagnosis.[15,16] In our study, the repeat scan rates for HCC, liver cirrhosis, and hepatitis were much higher than those for the other diseases, up to 81.7% higher for HCC. Abdominal ultrasound scans are essential for the diagnosis and follow-up of such disease, which may be the major reason for the high rate of use.[12] However, abdominal ultrasound scans can be performed by a variety of specialists, including gastroenterologists, who were heaviest users of the modality according to our data. Many researchers have investigated the role of radiologists in the seemingly excessive use of advanced medical imaging. Some are concerned that self-referral by radiologists will exacerbate the current situation,[4,11] while others have been more optimistic.[5,6] Similarly, behaviors such as self-referral by gastroenterologists may play a role in the use of abdominal ultrasound, especially repeat scans. However, details of the physicians who performed ultrasound scans were not included in the NHI data. A future study with more comprehensive data may be needed to pinpoint factors associated with this behavior. Surgeons and internal medicine physicians (non-gastroenterologist) were the second and third most frequent users of repeat abdominal ultrasound. All other disciplines, including OB/GYN, pediatrics, family physicians, emergency physicians, and others, accounted for only a small percentage of the total repeat scans.

Among the institutions, regional hospitals (37.7%) used ultrasound the most. This is different from previous data showing that CT and MRI were mostly used by medical centers.[8,17] The number of regional hospitals is greater than the number of medical centers in Taiwan, similar to other countries. Compared to CT and MRI, ultrasound is relatively inexpensive and accessible. Reimbursement for abdominal ultrasound is the same for all hospital and clinic levels in Taiwan. In this context, it is relatively easy to purchase and operate an ultrasound machine in a smaller institute. Our study shows that a total of 67.4% of repeat abdominal ultrasound scans were performed in the same hospital, 61.4% were referred from the same specialty, and 45.2% were from the same doctor. This suggests that repeat scanning may be used for follow-up of the same disease.

Physicians in medical centers are most likely to order repeat ultrasound scans. This may be related to their training, research requirements, or the solution of complicated medical problems. It has been reported that the demographic characteristics of physicians are related to higher use of costly imaging modalities such as CT and MRI.[18,19] Our study reveals that physicians younger than 40 years ordered the most ultrasound scans (43.6%), followed by physicians aged 41–50 years. This trend is similar to that reported in a previous study regarding advanced imaging modalities, which suggests that younger physicians are often better educated about advanced imaging modalities and their indications.[18] However, this notion is debatable. A higher rate of misuse of blood tests such as PSA was found among younger physicians.[20] Ultrasound has been developed since 1940–1950.[21,22] Senior physicians are likely to be as familiar with ultrasound as younger physicians are. Despite this seeming equality in familiarity with ultrasound, younger physicians still ordered more ultrasound scans. It is hard to clarify whether the use of ultrasound examinations among young physicians is proper or not owing to the lack of individual demographic information in our database. Further

study might be needed. Regardless of the cause, proper continuing medical education about up-to-date guidelines for ultrasound use might help to curb its growing use. A global budget system (GBS) policy was introduced in 2001–2002, and a hospital-based self-management (HBSM) policy was implemented in 2005 and revised in 2010. This significantly changed Taiwanese medical practice.[23] Of the contracted hospitals, 16.6% participated in the HBSM and received approximately 22.7% of the total reimbursement in 2004.[9] Our cross-sectional study used data collected during 2004, which means that health policy transition to GBS or HBSM should be non-significant. However, the global budget cap could still affect hospital policy and physician behavior. The long-term effect of policy changes on ultrasound use should be taken into consideration.

A limitation of our study is that there is no indicator of disease severity within the NHI database. However, we believe that since the data set covers the national population, analysis of differences in ultrasound use between different physicians, diagnoses, and hospitals and the resulting conclusions are still valid. Another limitation is that for such a large database, many factors would seem significant when analyzed using logistic regression with GEE. We attempted to compensate for this by considering only $p < 0.0001$ as clinically significant. This is a limitation that needs to be taken into consideration when the results are applied in practice.

On the basis of the study results, some recommendations can be made regarding abdominal ultrasound indications. While it is likely that the Taiwanese experience may not be duplicated in every other country, over the 17 years since its establishment, the Taiwan NHI has managed to provide quality medical service without exorbitant costs. In 2009, total health expenditure constituted only 6.6% of the Taiwanese GDP. Corresponding data were 8.3% for Japan, 9.3% for the UK, and 16.2% for the USA.[23] Despite this apparent disparity in health budgets, Taiwanese females can expect to live to 82 years of age, compared to 86 years in Japan, 82 years in the UK, and 81 years in the USA. Taiwanese male life expectancy is 76 years, on par with that in the USA, and slightly shorter than in Japan (80 years) and the UK (78 years). Infant mortality rates also follow this pattern: the rate in Taiwan is 4.1%, which is similar to that in the UK (4.6%); Japan has the lowest rate of 2.4%, while the USA has the highest rate of 6.4%.[10,24] These conclusions drawn from the Taiwanese NHI database may be useful in governmental review of healthcare policies in other countries.

In conclusion, this population-based study demonstrated that the repeat rate for abdominal ultrasound is related to hospital type, physician specialty, and the disease being examined. The popularity and relatively low cost of abdominal ultrasound might encourage its overall use. It is very important to use ultrasound properly, especially repeat scans, so that total expenditure is controlled. Our analysis revealed that the repeat rate for abdominal ultrasound is approximately 39% per year, and that a higher repeat rate (45% per year) is associated with hepatobiliary disease, gastroenteroenterologists, and medical centers.

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