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ORIGINAL ARTICLE

Is Weight Control Surgery Associated with Increased Risk of Newly onset Psychiatric Disorders? A Population-based, Matched Cohort Study in Taiwan

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Background: Morbid obesity is associated with various diseases, and the weight control surgery (WCS) is one of the treatments for morbid obesity. However, the association between the WCS and psychiatric disorders has yet to be elucidated. This study aimed to investigate the association between the WCS and the risk of developing psychiatric disorders. **Materials and Methods:** A total of 53,052 enrolled participants with 13,263 patients who received WCS and 39,789 controls with matched for sex and age, between January 1 and December 31, 2000, were selected from the National Health Insurance Research Database of Taiwan. After adjusting for confounding factors, Cox proportional hazards analysis was used to compare the risk of developing psychiatric disorders during 10 years of follow-up. **Results:** Of the study patients, 1170 (8.82%) developed psychiatric disorders when compared to 3490 (8.77%) in the control group. Cox proportional hazards regression analysis revealed that the study patients were more likely to develop psychiatric disorders (hazard ratio [HR]: 2.952, 95% confidence interval [CI] = 2.756–3.163, $P < 0.001$). After adjusting for gender, age, monthly income, urbanization level, geographic region, and comorbidities, the adjusted HR was 2.901 (95% CI = 2.701–3.115, $P < 0.001$). Among these psychiatric disorders, depressive disorders, bipolar disorders, and sleep disorders are with significantly increased risk. **Conclusions:** Patients who received the WCS have a higher risk of developing psychiatric disorders, and the risk was increased in the durations of <1 year and 1–3 years, especially within the duration of 1 year. Regular psychiatric follow-up might be needed for those patients.

Key words: Weight control surgery, psychiatric disorders, National Health Insurance Research Database, cohort study

INTRODUCTION

Obesity is a worldwide health problem and might well be associated with significant morbidity, such as diabetes mellitus (DM),[1] hypertension,[2] cardiovascular disease,[3,4] and increased mortality. For some patients with severe morbid obesity that failed to respond to diet control, medication treatment, or exercise, the weight control surgery (WCS) is a choice to reduce the body weight and consequent obesity-related morbidity or mortality, for example, the WCS could reduce the risk of DM and possibly other metabolic diseases in previous studies.[5,6]

From a psychiatric aspect, some researches showed psychiatric illness of up to 40%–60% in candidates for the WCS, including depressive disorder, anxiety disorders, substance use disorders, and psychosocial challenges in the perisurgery life adjustments.[7-11] Studies in regard to the psychosocial effects after the WCS varied. Several studies revealed better psychosocial quality of life and even memory function.[12-15] Nevertheless, the risk of newly onset psychiatric diagnoses after the WCS was, as yet, to be studied.

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The National Health Insurance (NHI) Program was launched in Taiwan in 1995, and as of June 2009, this included contracts with 97% of the medical providers with approximately 23 million beneficiaries or more than 99% of the entire population in Taiwan.[16] The National Health Insurance Research Database (NHIRD) uses the International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) codes to record diagnoses.[17] All diagnoses of psychiatric disorders were made by board-certified psychiatrists. Those diagnoses of morbid obesity that met the criteria are according to the WCS in Taiwan are according to the NHI 1991 consensus, as the following: a body mass index (BMI) (calculated as weight in kilograms divided by the square of height in meters) of 40 kg/m^2 or greater (or >35 kg/m^2 with obesity-related comorbidities) documented, high probability of failure of nonsurgical weight loss treatments after 6 months, and not related to treatable medical comorbidities or perioperative risks.[18,19] The Bureau of the NHI randomly reviews the records of 1 in 100 ambulatory care visits and 1 in 20 inpatient claims to verify the accuracy of the diagnoses.[20] Several studies have demonstrated the accuracy and validity of the diagnoses in the NHIRD.[21-23] Therefore, a nationwide, matched cohort, population-based, is suitable to investigate the association of the WCS and the risk of post-WCS psychiatric disorders.

MATERIALS AND METHODS

Data sources

In this study, we used data from the NHIRD to investigate the association between patients with morbid obesity who received the WCS and psychiatric disorders over a 10-year period, from the total hospitalization Longitudinal Health Insurance Database in Taiwan (2000–2010).

Study design and sampled participants

This study was a retrospective matched cohort design. Patients who received the WCS were selected from January 1 to December 31, 2000, according to ICD-9-CM codes: including malabsorptive procedures (high gastric bypass: ICD-9-CM OP44.31, "laparoscopic gastroenterostomy:" ICD-9-CM OP44.38, and "other gastroenterostomy without gastrectomy:" ICD-9-CM OP44.39) and restrictive procedures ("laparoscopic sleeve gastrectomy:" ICD-9-CM OP43.82, "open and other partial gastrectomy:" ICD-9-CM OP43.89, "laparoscopic gastroplasty:" ICD-9-CM OP44.68, "other repair of stomach:" ICD-9-CM OP44.69, "laparoscopic gastric restrictive procedure:" ICD-9-CM OP44.95, and "other operations on the stomach:" ICD-9-CM OP44.99). The patients who received the WCS before 2000 were excluded from the study. In addition, the patients diagnosed with psychiatric disorders such as dementia, depressive disorders, bipolar disorders, anxiety disorders, sleep disorders, eating disorders, and psychotic disorders, before 2000 or before the procedures for the WCS, were also excluded from the study. A total of 53,052 patients including the 13,263 subjects who received the WCS, and 39,789 in the age, gender, and index year, matched the control group without a history of receiving the WCS, was enrolled in this study [Figure 1].

The covariates included gender, age group (<18, 18–54, ≥55 years), geographical area of residence (North, Center, South, and East of Taiwan), urbanization level of residence (level 1–4), levels of hospitals as medical centers, regional hospitals, and local hospitals, and monthly income (in New Taiwan dollars; <18,000, 18,000–34,999, ≥35,000). The urbanization level of residence was defined according to the population and various indicators of the level of development. Level 1 was defined as a population of >1,250,000 and a specific designation as political, economic, cultural, and metropolitan development. Level 2 was defined as a population between 500,000 and 1,249,999 and as playing an important role in the political system, economy, and culture. Urbanization levels 3 and 4 were defined as a population between 149,999 and 499,999 and <149,999, respectively.[24]

Baseline comorbidities included DM (ICD-9-CM code: 250), hypertension (ICD-9-CM codes: 401.1, 401.9, 402.10, 402.90, 404.10, 404.90, 405.1, and 405.9), hyperlipidemia (ICD-9-CM code: 272.x), coronary artery disease (CAD, ICD-9-CM code: 410-414), and heart failure (HF, ICD-9-CM code: 428).

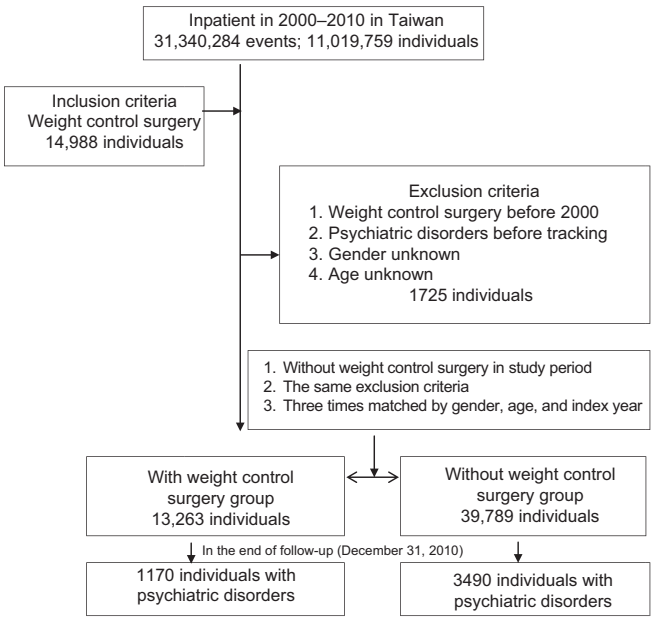

Figure 1: The flowchart of study sample selection from the National Health Insurance Research Database in Taiwan

Outcome measures

All of the study participants were followed from the index date until the onset of dementia (ICD-9-CM codes: 290.0, 290.10, 290.11, 290.12, 290.13, 290.20, 290.21, 290.3, 290.41, 290.42, 290.43, 290.8, 290.9, and 331.0), anxiety disorders (ICD-9-CM codes: 300.X), eating disorders (307.1 anorexia nervosa; 307.51 bulimia nervosa; and 307.59 other disorders of eating), depressive disorders (ICD-9-CM codes: 296.2, 296.3, 300.4, and 311), bipolar disorders (ICD-9-CM codes: 296.0X, 296.4X, 296.5X, 296.6X, 296.7X, and 296.8X), sleep disorders (ICD-9-CM codes: 307.4x and 780.5x), and psychotic disorders (ICD-9-CM codes: 295.xx, 297.xx, and 298.xx), withdrawal from the NHI program, or the end of 2010.

Statistical analysis

All analyses were performed using SPSS software version 22 (SPSS Inc., Chicago, Illinois, USA). Chi-square and *t*-tests were used to evaluate the distributions of categorical and continuous variables, respectively. Fisher's exact test for categorical variables was used to statistically examine the differences between the two cohorts. Multivariate Cox proportional hazards regression analysis was used to determine the risk of psychiatric disorders, and the results were presented as a hazard ratio (HR) with a 95% confidence interval (CI). The difference in the risk of psychiatric disorders, between the study and control groups, was estimated using the Kaplan–Meier method with the log-rank test. A two-tailed $P < 0.05$ was considered to indicate statistical significance.

Ethics approvals

This study was conducted in accordance with the Code of Ethics of the World Medical Association (Declaration of Helsinki). The Institutional Review Board (IRB) of the Tri-Service General Hospital approved this study (IRB No. 2-104-05-126 and IRB No. 1-104-05-145).

RESULTS

Table 1 shows the gender, age, comorbidities, urbanization and area of residence, and income of the study patients and controls. Compared to the controls, the study patients tended to have higher rates of DM and hyperlipidemia ($P < 0.001$) in medical centers or regional hospitals and more lived in higher urbanized regions and in the northern areas of Taiwan ($P < 0.001$).

Figure 2 shows the Kaplan–Meier analysis for the cumulative incidence of psychiatric disorders in the study and control groups, and the differences between the two groups were significant (log-rank test <0.001). In addition, at the 1st year of follow-up, the difference between the two groups became significant.

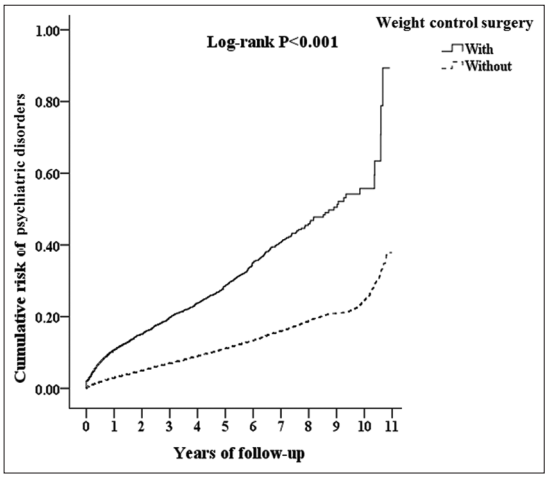

Figure 2: Kaplan–Meier for cumulative risk of psychiatric disorders stratified by weight control surgery injury with log-rank test

Table 2 shows that at the end of the follow-up, 1170 out of 13,263 in the study group (8.82%) and 3490 out of 39,789 (8.77%) in the control group developed psychiatric morbidity. Among these psychiatric disorders, depressive disorders and sleep disorders were higher in the patient group than the non-WCS control group (2.71% vs. 1.69%, $P < 0.001$ and 2.70% vs. 2.36%, $P = 0.015$, respectively). Conversely, dementia and anxiety disorders were lower than the non-WCS control group (2.01% vs. 2.96%, $P < 0.001$ and 0.89% vs. 1.16%, $P = 0.006$, respectively). In the patient group, hyperlipidemia was higher than the non-WCS control group, but DM and hypertension were lower than the control group. The patient group was more likely to be hospitalized during the summer or autumn seasons in medical centers or regional hospitals and lived in higher urbanized regions and in the northern areas of Taiwan ($P < 0.001$).

Table 3 shows the results of Cox regression analysis of the factors associated with the risk of developing psychiatric disorders. The crude HR was 2.952 (95% CI = 2.756–3.163, $P < 0.001$). After adjusting for age, gender, comorbidities, geographical area of residence, urbanization level of residence, and monthly income, the adjusted HR was 2.901 (95% CI = 2.70–3.115, $P < 0.001$). For the patients aged >55, the risk of developing psychiatric disorders was 2.086 times more than the patients aged <18. The patients of DM and HF tended to have a lower risk for developing psychiatric disorders. Patients with a residence in higher urbanization regions, who received the WCS in medical centers or regional hospitals and had higher monthly incomes, tended to have a lower risk for developing psychiatric disorders.

In the subgroups stratified by their gender, age, comorbidities, urbanization and region of residence, and

Table 1: Characteristics of study in the baseline

Variables	Weight control surgery			*P*
	Total, *n* (%)	With, *n* (%)	Without, *n* (%)	
Total	53,052	13,263 (25.00)	39,789 (75.00)	
Gender				
Male	30,336 (57.18)	7584 (57.18)	22,752 (57.18)	0.999
Female	22,716 (42.82)	5679 (42.82)	17,037 (42.82)	
Age (years)				
<18	532 (1.00)	133 (1.00)	399 (1.00)	0.999
18-55	22,644 (42.68)	5661 (42.68)	16,983 (42.68)	
>55	29,876 (56.31)	7,469 (56.31)	22,407 (56.31)	
DM				
Without	46,341 (87.35)	11,335 (85.46)	35,006 (87.98)	<0.001
With	6711 (12.65)	1928 (14.54)	4783 (12.02)	
Hypertension				
Without	44,982 (84.79)	11,222 (84.61)	33,760 (84.85)	0.260
With	8070 (15.21)	2041 (15.39)	6029 (15.15)	
Hyperlipidemia				
Without	51,423 (97.11)	12,534 (94.50)	38,889 (97.98)	<0.001
With	1529 (2.89)	729 (5.50)	800 (2.02)	
CAD				
Without	49,411 (93.14)	12,936 (97.53)	36,475 (91.67)	<0.001
With	3641 (6.86)	327 (2.47)	3314 (8.33)	
HF				
Without	51,952 (97.93)	13,128 (98.98)	38,824 (97.57)	<0.001
With	1100 (2.07)	135 (1.02)	965 (2.43)	
Location				
Northern Taiwan	22,739 (42.86)	6911 (52.11)	15,828 (39.78)	<0.001
Middle Taiwan	14,250 (26.86)	2882 (21.73)	11,368 (28.57)	
Southern Taiwan	13,106 (24.70)	3020 (22.77)	10,086 (25.35)	
Eastern Taiwan	2760 (5.20)	441 (3.33)	2319 (5.83)	
Outlets islands	197 (0.37)	9 (0.07)	188 (0.47)	
Urbanization level				
1 (the highest)	18,145 (34.20)	4,973 (37.50)	13,172 (33.10)	<0.001
2	23,209 (43.75)	5972 (45.03)	17,237 (43.32)	
3	3709 (6.99)	520 (3.92)	3189 (8.01)	
4 (the lowest)	7989 (15.06)	1798 (13.56)	6191 (15.56)	
Level of care				
Hospital center	19,222 (36.23)	6292 (47.44)	12,930 (32.50)	<0.001
Regional hospital	19,395 (36.56)	6088 (45.90)	13,307 (33.44)	
Local hospital	14,435 (27.21)	883 (6.66)	13,552 (34.06)	
Insured premium (NT$)				
<18,000	52,180 (98.36)	13,066 (98.51)	39,114 (98.30)	0.225

Contd...

Table 1: Contd...

Variables	Weight control surgery			*P*
	Total, *n* (%)	With, *n* (%)	Without, *n* (%)	
18,000-34,999	679 (1.28)	156 (1.18)	523 (1.31)	
≥35,000	193 (0.36)	41 (0.31)	152 (0.38)	

P (category variable: Chi-square/Fisher's exact test). DM=ICD-9-CM 250; Hypertension=ICD-9-CM 401.1, 401.9, 102.10, 402.90, 404.10, 404.90, 405.1, 405.9; Hyperlipidemia=ICD-9-CM 272; CAD=ICD-9-CM 410-414; HF=ICD-9-CM 428; Obesity: ICD-9-CM 278. NT$=New Taiwan Dollars; HF=Heart failure; CAD=Coronary artery disease; DM=Diabetes mellitus; ICD-9-CM=International Classification of Diseases, Ninth Revision, Clinical Modification

Table 2: Characteristics of study in the end of follow-up

Variables	Weight control surgery			*P*
	Total, *n* (%)	With, *n* (%)	Without, *n* (%)	
Total	53,052	13,263 (25.00)	39,789 (75.00)	
Psychiatric disorders				
Without	48,392 (91.22)	12,093 (91.18)	36,299 (91.23)	0.437
With	4660 (8.78)	1170 (8.82)	3490 (8.77)	
Dementia				
Without	51,607 (97.28)	12,997 (97.99)	38,610 (97.04)	<0.001
With	1445 (2.72)	266 (2.01)	1179 (2.96)	
Anxiety disorders				
Without	52,474 (98.91)	13,145 (99.11)	39,329 (98.84)	0.006
With	578 (1.09)	118 (0.89)	460 (1.16)	
Eating disorders				
Without	53,050 (100.00)	13,263 (100.00)	39,787 (99.99)	0.562
With	2 (0.00)	0	2 (0.01)	
Anorexia nervosa				
Without	53,050 (100.00)	13,263 (100.00)	39,787 (99.99)	0.562
With	2 (0.00)	0	2 (0.01)	
Bulimia nervosa				
Without	53,052 (100.00)	13,263 (100.00)	39,789 (100.00)	-
With	0	0	0	
Other disorders of eating				
Without	53,052 (100.00)	13,263 (100.00)	39,789 (100.00)	-
With	0	0	0	
Depressive disorders				
Without	52,020 (98.05)	12,904 (97.29)	39,116 (98.31)	<0.001
With	1032 (1.95)	359 (2.71)	673 (1.69)	
Bipolar disorders				
Without	52,025 (99.78)	12,321 (99.74)	39,704 (99.79)	0.315
With	117 (0.22)	32 (0.26)	85 (0.21)	
Sleep disorders				
Without	51,756 (97.56)	12,905 (97.30)	38,851 (97.64)	0.015
With	1296 (2.44)	358 (2.70)	938 (2.36)	
Psychotic disorders				

Contd...

Table 2: Contd...

Variables	Weight control surgery			*P*
	Total, *n* (%)	With, *n* (%)	Without, *n* (%)	
Without	52,661 (99.26)	13,178 (99.36)	39,483 (99.23)	0.076
With	391 (0.74)	85 (0.64)	306 (0.77)	
Gender				
Male	30,336 (57.18)	7584 (57.18)	22,752 (57.18)	0.999
Female	22,716 (42.82)	5679 (42.82)	17,037 (42.82)	
Age (years)				
<18	454 (0.86)	112 (0.84)	342 (0.86)	0.001
18-55	21,168 (39.90)	5473 (41.27)	15,695 (39.45)	
>55	31,430 (59.24)	7,678 (57.89)	23,752 (59.69)	
DM				
Without	45,604 (85.96)	11,487 (86.61)	34,117 (85.74)	0.007
With	7448 (14.04)	1776 (13.39)	5672 (14.26)	
Hypertension				
Without	44,729 (84.31)	11,482 (86.57)	33,247 (83.56)	<0.001
With	8323 (15.69)	1781 (13.43)	6542 (16.44)	
Hyperlipidemia				
Without	51,647 (97.35)	12,692 (95.69)	38,955 (97.90)	<0.001
With	1405 (2.65)	571 (4.31)	834 (2.10)	
CAD				
Without	49,374 (93.07)	12,873 (97.06)	36,501 (91.74)	<0.001
With	3678 (6.93)	390 (2.94)	3288 (8.26)	
HF				
Without	51,041 (96.21)	12,992 (97.96)	38,049 (95.63)	<0.001
With	2011 (3.79)	271 (2.04)	1740 (4.37)	
Location				
Northern Taiwan	22,273 (41.98)	6518 (49.14)	15,755 (39.60)	<0.001
Middle Taiwan	14,561 (27.45)	3135 (23.64)	11,426 (28.72)	
Southern Taiwan	13,107 (24.71)	3034 (22.88)	10,073 (25.32)	
Eastern Taiwan	2904 (5.47)	545 (4.11)	2359 (5.93)	
Outlets islands	207 (0.39)	31 (0.23)	176 (0.44)	
Urbanization level				
1 (the highest)	17,209 (32.44)	4577 (34.51)	12,632 (31.75)	<0.001
2	23,829 (44.92)	6163 (46.47)	17,666 (44.40)	
3	3755 (7.08)	624 (4.70)	3131 (7.87)	
4 (the lowest)	8259 (15.57)	1899 (14.32)	6360 (15.98)	
Level of care				
Hospital center	18,840 (35.51)	5451 (41.10)	13,389 (33.65)	<0.001
Regional hospital	21,400 (40.34)	6311 (47.58)	15,089 (37.92)	
Local hospital	12,812 (24.15)	1501 (11.32)	11,311 (28.43)	
Insured premium (NT$)				
<18,000	52,180 (98.36)	13,066 (98.51)	39,114 (98.30)	0.225

Contd...

Table 2: Contd...

Variables	Weight control surgery			*P*
	Total, *n* (%)	With, *n* (%)	Without, *n* (%)	
18,000-34,999	679 (1.28)	156 (1.18)	523 (1.31)	
≥35,000	193 (0.36)	41 (0.31)	152 (0.38)	

NT$=New Taiwan Dollars; HF=Heart failure; CAD=Coronary artery disease; DM=Diabetes mellitus

Table 3: Factors of psychiatric disorders in the end of follow-up using Cox regression

Variables	Crude HR	95% CI	*P*	Adjusted HR	95% CI	*P*
Weight control surgery						
Without	Reference			Reference		
With	2.952	2.756-3.163	<0.001	2.901	2.701-3.115	<0.001
Gender						
Male	1.062	1.001-1.126	0.045	1.047	0.986-1.111	0.132
Female	Reference			Reference		
Age (years)						
<18	Reference			Reference		
18-55	1.469	0.832-2.594	0.185	1.559	0.882-2.753	0.126
>55	1.769	1.003-3.118	0.049	2.086	1.182-3.680	0.011
DM						
Without	Reference			Reference		
With	0.883	0.818-0.953	0.001	0.864	0.799-0.936	<0.001
Hypertension						
Without	Reference			Reference		
With	1.020	0.953-1.092	0.565	1.050	0.977-1.129	0.183
Hyperlipidemia						
Without	Reference			Reference		
With	1.120	0.952-1.317	0.171	1.079	0.912-1.277	0.375
CAD						
Without	Reference			Reference		
With	0.967	0.877-1.067	0.506	1.056	0.953-1.169	0.297
HF						
Without	Reference			Reference		
With	0.639	0.545-0.748	<0.001	0.621	0.530-0.729	<0.001
Location						
Northern Taiwan	Reference			Had collinearity with urbanization level		
Middle Taiwan	1.138	1.061-1.221	<0.001	Had collinearity with urbanization level		
Southern Taiwan	1.035	0.960-1.115	0.371	Had collinearity with urbanization level		
Eastern Taiwan	1.346	1.204-1.506	<0.001	Had collinearity with urbanization level		
Outlets islands	0.751	0.444-1.271	0.286	Had collinearity with urbanization level		
Urbanization level						
1 (the highest)	0.738	0.679-0.802	<0.001	0.894	0.815-0.980	0.017
2	0.755	0.701-0.815	<0.001	0.867	0.801-0.939	<0.001
3	0.796	0.706-0.897	<0.001	0.838	0.744-0.945	0.004

Contd...

Table 3: Contd...

Variables	Crude HR	95% CI	*P*	Adjusted HR	95% CI	*P*
4 (the lowest)	Reference			Reference		
Level of care						
Hospital center	0.670	0.621-0.724	<0.001	0.638	0.585-0.696	<0.001
Regional hospital	0.819	0.765-0.878	<0.001	0.755	0.704-0.811	<0.001
Local hospital	Reference			Reference		
Insured premium (NT$)						
<18,000	Reference			Reference		
18,000-34,999	0.389	0.266-0.568	<0.001	0.404	0.276-0.589	<0.001
≥35,000	0.241	0.078-0.747	0.014	0.270	0.087-0.838	0.023

HR=Hazard ratio; CI=Confidence interval; Adjusted HR=Adjusted variables listed in the table; NT$=New Taiwan Dollars; HF=Heart failure; CAD=Coronary artery disease; DM=Diabetes mellitus

monthly income, we found that the male study patients were 2.684 times ($P < 0.001$), female 3.188 times ($P < 0.001$), higher than the control group, respectively. For the study patients aged 18–55 and > 55 years, we found that the risk of developing psychiatric disorders was 4.250 times ($P < 0.001$) and 2.421 times ($P < 0.001$) than the control group. Despite the comorbidity of DM, hypertension, hyperlipidemia, CAD, or HF, the urbanization or area of residence, or the levels of hospitals of the WCS, the number of patients was higher than the control group in their risk of developing psychiatric disorders [Table 4].

In the 13,263 patients who received the WCS, 8155 received malabsorptive procedures, 6721 received restrictive procedures, and 1613 received both malabsorptive and restrictive procedures. No matter whether single or combined WCS the patients received, the overall risk of psychiatric disorders was higher than the non-WCS control group [Table 5].

Table 6 shows that the study patients had an increased risk of developing depressive disorders, bipolar disorders, and sleep disorders than the control groups (adjusted HR 4.240, 2.724, and 3.386, $P < 0.001$, respectively).

The study patients were at increased risk of psychiatric disorders within 3 years after enrollment as adjusted HR 2.230 (%95 CI: 1.937–2.568, $P < 0.001$) in the duration <1 year after enrollment and 1.117 (%95 CI: 1.005–1.312, $P = 0.003$) in 1–3 years after enrollment. After 3 years, the adjusted HR was 1.105 (%95 CI: 0.951–1.284, $P = 0.190$). For depressive disorders, bipolar disorders, and sleep disorders, the individual adjusted HRs were significant in the durations of <1 year and 1–3 years [Table 6].

DISCUSSION

In our study, the WCS was associated with an increased risk in newly onset psychiatric disorders. Even after adjusting for comorbidities and other covariates, the overall adjusted HR was 2.901 (95% CI = 2.701–3.115, $P < 0.001$). In other words, the study patient group had an almost 2.9-fold increased risk of developing psychiatric disorders. The Kaplan–Meier analysis revealed that the study patients had a significantly lower 10-year psychiatric disorder-free survival rate than the controls. In addition, it took 1 year to achieve a significantly adjusted HR, and therefore, 10 years appears to be a reasonable period to follow-up on patients who received the WCS. Among the psychiatric disorders, depressive disorders, bipolar disorders, and sleep disorders were associated with the WCS. Most of the previous studies for the psychiatric morbidity related to patients who had received WCS were to compare the prevalence or incidence of the patients before and after their surgery.[7-9,11] This is the first population-based study for newly onset psychiatric disorders after the WCS.

A crucial question is that whether the increased risk of the newly onset psychiatric disorders after the WCS is related to morbid obesity or the WCS. One meta-analysis study found a reciprocal association between obesity and depression.[25] The stigma of overweight or obesity might create negative impacts on the social, psychological, and physical health[26,27] or even increase the risk of major depressive disorders[28] for those targeted. However, the latter study also found that obesity might show some protective effects on alcohol abuse and drug dependence.[28] On the other hand, several other studies found the higher risk of suicide rates, self-harm emergencies, anxiety, mood, or substance use disorders, after the WCS then before the surgery.[29-31] In our study, we have excluded the patients and controls with psychiatric disorders before the follow-up period; the patients who received the WCS are associated with higher risk in overall psychiatric disorders than the control group, especially in depressive disorders, bipolar disorders, and sleep disorders. Even though we could not evaluate the body weight loss or the BMI decrease in this claim database study, a 5-year follow-up study found that the patients who received the WCS

Table 4: Factors of psychiatric disorders in the end of follow-up stratified by variables listed in the table using Cox regression

Variables	Weight control surgery						Ratio	Adjusted HR	95% CI	*P*
	With			Without						
	Event	PYs	Rate (/10^5 PYs)	Event	PYs	Rate (/10^5 PYs)				
Total	1170	14,442.55	8101.06	3490	47,845.11	7294.37	1.111	2.901	2.701-3.115	<0.001
Gender										
Male	667	5835.70	11,429.65	2132	19,861.72	10,734.22	1.065	2.684	2.448-2.944	<0.001
Female	503	8606.84	5844.19	1358	27,983.39	4852.88	1.204	3.188	2.849-3.567	<0.001
Age (years)										
<18	6	142.33	4215.56	6	161.31	3719.55	1.133	2.762	0.683-11.163	0.154
18-55	489	4896.32	9987.09	744	8944.14	8318.30	1.201	4.250	3.740-4.829	<0.001
>55	675	9403.90	7177.87	2740	38,739.66	7072.86	1.015	2.421	2.218-2.643	<0.001
DM										
Without	1008	12,382.01	8140.84	2861	38,458.87	7439.12	1.094	2.900	2.686-3.133	<0.001
With	162	2060.54	7862.02	629	9386.24	6701.30	1.173	2.163	1.755-2.665	<0.001
Hypertension										
Without	1124	12,208.62	9206.61	3293	36,089.21	9124.61	1.009	3.183	2.946-3.440	<0.001
With	46	2233.93	2059.15	197	11,755.90	1675.75	1.229	1.704	1.395-2.082	<0.001
Hyperlipidemia										
Without	1140	14,255.38	7996.98	3369	46,343.53	7269.62	1.100	2.933	2.730-3.152	<0.001
With	30	187.17	16,028.21	121	1501.58	8058.18	1.989	2.159	1.126-4.139	0.021
CAD										
Without	1124	13,719.33	8192.82	3093	39,457.74	7838.77	1.045	2.946	2.737-3.171	<0.001
With	46	723.21	6360.53	397	8387.37	4733.31	1.344	2.106	1.544-2.873	<0.001
HF										
Without	1148	13,923.64	8244.97	3352	41,851.98	8009.18	1.029	2.921	2.718-3.140	<0.001
With	22	518.91	4239.66	138	5993.12	2302.64	1.841	2.188	1.358-3.462	0.001
Urbanization level										
1 (the highest)	375	5451.32	6879.07	879	13,667.49	6431.32	1.070	3.290	2.885-3.753	<0.001
2	535	6322.02	8462.49	1490	21,996.77	6773.72	1.249	3.197	2.873-3.559	<0.001
3	86	1001.33	8588.58	282	3869.78	7287.24	1.179	3.399	2.631-4.390	<0.001
4 (the lowest)	174	1667.87	10,432.47	839	8311.06	10,094.98	1.033	1.790	1.507-2.125	<0.001
Level of care										
Hospital center	424	5892.80	7195.22	854	15,744.98	5423.95	1.327	3.829	3.371-4.349	<0.001
Regional hospital	560	6880.35	8139.12	1480	27,344.03	5412.52	1.504	2.834	2.546-3.154	<0.001
Local hospital	186	1669.39	11,141.79	1156	11,422.77	10,120.14	1.101	1.905	1.627-2.231	<0.001
Insured premium (NT$)										
<18,000	1163	14,223.60	8176.55	3467	46,980.78	7379.61	1.108	2.900	2.700-3.115	<0.001
18,000-34,999	7	179.16	3907.12	20	738.63	2707.72	1.443	3.864	1.542-9.685	0.004
≥35,000	0	39.79	0.00	3	125.70	2,386.63	0.000	0.000	-	0.943

PYs=Person-years; Adjusted HR=Adjusted hazard ratio=Adjusted for variables listed in Cox sheet; CI=Confidence interval; NT$=New Taiwan Dollars; HF=Heart failure; CAD=Coronary artery disease; DM=Diabetes mellitus

had weight loss at 5 years being 28.3% + 8.9% kgw, and the decrease of the mean BMI was 37.5 ± 6.1–27.1 + 4.3 kgw/m^2.[32] This may suggest that the WCS plays an important role in increasing the risk of developing psychiatric disorders even

Table 5: Factors of psychiatric disorders in the end of follow-up stratified by type of bariatric surgery using Cox regression

Type of weight control surgery	Weight control surgery						Ratio	Adjusted HR	95% CI	*P*
	With			Without						
	Event	PYs	Rate (/10^5 PYs)	Event	PYs	Rate (/10^5 PYs)				
Total	1170	14,442.55	8101.06	3490	47,845.11	7294.37	1.111	2.901	2.701-3.115	<0.001
Malabsorptive procedures	633	7165.61	8833.86	3490	47,845.11	7294.37	1.211	2.710	2.480-2.961	<0.001
Restrictive procedures	610	7613.12	8012.48	3490	47,845.11	7294.37	1.098	2.031	1.852-2.226	<0.001
Only malabsorptive procedures	560	6829.43	8199.81	3490	47,845.11	7294.37	1.124	2.913	1.894-3.765	<0.001
Only restrictive procedures	537	7276.94	7379.48	3490	47,845.11	7294.37	1.012	1.997	1.226-2.649	<0.001
Both	73	336.18	21,714.56	3490	47,845.11	7294.37	2.977	4.395	2.648-5.045	<0.001

PYs=Person-years; Adjusted HR=Adjusted hazard ratio: Adjusted for the variables listed in Cox sheet; CI=Confidence interval

Table 6: Factors of subgroups of psychiatric disorders in the end of follow-up using Cox regression

Subgroups of psychiatric disorders	Weight control surgery						Ratio	Adjusted HR	95% CI	*P*
	With			Without						
	Event	PYs	Rate (/10^5 PYs)	Event	PYs	Rate (/10^5 PYs)				
Total (years)	1170	14,442.55	8101.06	3490	47,845.11	7294.37	1.111	2.901	2.701-3.115	<0.001
<1	723	1630.29	44,347.94	827	3659.15	22,600.88	1.962	2.230	1.937-2.568	<0.001
1-3	224	3045.40	7355.36	876	13,934.38	6286.61	1.170	1.117	1.055-1.312	0.003
≥3	223	9766.86	2283.23	1787	30,251.88	5907.07	0.387	1.105	0.951-1.284	0.190
Depressive disorders (years)	359	14,442.55	2485.71	673	47,845.11	1406.62	1.767	4.240	3.690-4.873	<0.001
<1	225	1630.29	13,801.23	170	3659.15	4645.89	2.971	3.235	2.461-4.254	<0.001
1-3	71	3045.40	2331.39	166	13,934.38	1191.30	1.957	1.678	1.264-2.227	0.004
≥3	63	9766.86	645.04	337	30,251.88	1113.98	0.579	1.390	0.963-2.096	0.152
Bipolar disorders (year)	32	14,442.55	221.57	85	47,845.11	177.66	1.247	2.724	1.768-4.195	<0.001
<1	16	1630.29	981.42	31	3659.15	847.19	1.158	3.487	1.520-7.998	0.003
1-3	9	3045.40	295.53	22	13,934.38	157.88	1.872	1.613	0.729-3.565	0.238
≥3	7	9766.86	71.67	32	30,251.88	105.78	0.678	0.719	0.374-1.383	0.323
Sleep disorders (years)	358	14,442.55	2478.79	938	47,845.11	1960.49	1.264	3.386	2.971-3.859	<0.001
<1	228	1630.29	13,985.24	206	3659.15	5629.72	2.484	2.225	1.696-2.918	<0.001
1-3	70	3045.40	2298.55	248	13,934.38	1779.77	1.291	1.576	1.283-1.935	<0.001
≥3	60	9766.86	614.32	484	30,251.88	1599.90	0.384	0.957	0.832-1.651	0.101
Dementia	266	14,442.55	1841.78	1179	47,845.11	2464.20	0.747	0.985	0.513-2.518	0.513
Anxiety disorders	118	14,442.55	817.03	460	47,845.11	961.44	0.850	0.889	0.692-1.142	0.357
Eating disorders	0	14,442.55	0.00	2	47,845.11	4.18	0.000	0.000	-	0.896
Anorexia nervosa	0	14,442.55	0.00	2	47,845.11	4.18	0.000	0.000	-	0.896
Bulimia nervosa	0	14,442.55	0.00	0	47,845.11	0.00	-	-	-	-
Other disorders of eating	0	14,442.55	0.00	0	47,845.11	0.00	-	-	-	-
Psychotic disorders	85	14,442.55	588.54	306	47,845.11	639.56	0.920	0.998	0.414-2.364	0.172

PYs=Person-years; Adjusted HR=Adjusted hazard ratio: Adjusted for the variables listed in Cox sheet; CI=Confidence interval

though these patients might have significant body weight loss after the surgery.

Psychological stressors, somatic concerns, depressive and anxious moods, and even emotional eating might contribute to the increased risk of overall psychiatric disorders, especially mood and sleep disorder after bariatric surgery.[33-38] In our study, the patients with a residence in higher urbanization regions, who received the WCS in medical centers or

regional hospitals and had higher monthly incomes, tended to have a lower risk for developing psychiatric disorders. Socioeconomic disadvantages might be another reason for the increase in newly onset psychiatric disorders in patients who received the WCS.

Some previous studies found that postsurgical eating disorders were associated with less weight loss after surgery, adding to the literature suggesting that disordered eating after surgery is related to suboptimal weight loss.[39,40] In our study, no postsurgical eating disorders were found. A possible reason is that the presurgery psychiatric screening might have excluded the patients with potential risk of eating disorders.[41]

A regular psychiatric follow-up might be important for the patients who received the WCS, with the finding as an increased risk of overall psychiatric disorders, especially mood and sleep disorders in this group. It should be noted that a preliminary study suggests that adherence to postoperative psychiatric follow-up is associated with greater postoperative weight loss.[42]

The risk of psychiatric disorders after WCS was increased in the durations of <1 year and 1–3 years, especially within the duration of 1 year. This might imply that clinicians should pay attention to mental health in patients who have had received WCS, especially within 3 years, and especially within the duration of 1 year, after the surgery. Furthermore, these findings also hint that the risk of obesity-related psychiatric disorders could decrease with the time passed, after ≥3 years of follow-up. Besides, most trials followed participants for only 1 or 2 years, the long-term effects such as recurrence of obesity after the surgery were unknown,[43] and therefore, a long-term follow-up study, for at least ≥3 years of study period, is needed to clarify the potential association between risk of psychiatric disorders and recurrent obesity after WCS.[25-28]

Study limitations

There are several limitations to this study. First, insurance claims data have been used in studies for patients who received the WCS; however, data on actual body weights and the BMI of individual patients were not available in the NHIRD. Second, the role of other nonsurgical obesity treatments, which were not covered by the NHI reimbursements, was not able to be clarified in this study. Third, patients with higher socioeconomic levels might well have more access to medical resources and better psychosocial care to prevent them from developing psychiatric disorders.

CONCLUSIONS

Patients who received the WCS have a higher risk of developing psychiatric disorders, and the risk was increased in the durations of <1 year and 1–3 years, especially within the duration of 1 year. Regular psychiatric follow-up might be needed for those patients.

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Conflicts of interest

There are no conflicts of interest.

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