Tzu Chi Medical Journal 2019; 31(1): 29–34

Original Article

# Ovo-lactovegetarian diet as a possible protective factor against gallbladder polyps in Taiwan: A cross-sectional study

*Hao-Wen Liu, Cheng-Yu Chen**

Department of Family Medicine, Taipei Tzu Chi Hospital, Buddhist Tzu Chi Medical Foundation, New Taipei, Taiwan

## Abstract

**Objective:** Gallbladder polyps (GBPs) are an increasingly common incidental finding and 3% to 8% of GBPs become malignant. A poor prognosis is expected in patients with gallbladder cancer. No studies have considered the relationship between diet and the development of GBPs in the Taiwanese population. The objective of this study was to investigate whether a vegetarian diet protects against GBP development. **Materials and Methods:** This cross-sectional study included 11,717 individuals who received a health checkup at Taipei Tzu Chi Hospital (New Taipei City, Taiwan) between October 2011 and October 2016. All individuals completed questionnaires that collected data about their characteristics, dietary patterns, and lifestyle. Physical examinations were conducted, and blood chemistry tests were performed. The presence of GBPs was determined using ultrasonography. We subsequently evaluated the association between diet and GBP prevalence using multivariate analysis. **Results:** The prevalence of GBPs for the entire group was 8.3%. GBPs were significantly less common in the vegetarian groups (vegans 9.0%, ovo-lacto vegetarians 7.5%, and semi-vegetarians 7.2%) compared with the omnivore group (9.6%) ($P = 0.002$). Step-wise logistic regression revealed that an ovo-lacto vegetarian diet was a possible protective factor (odds ratio = 0.83, $P = 0.015$). **Conclusions:** The study findings showed a strong negative association between an ovo-lacto vegetarian diet and GBP occurrence.

**Keywords:** *Gallbladder polyps, Hepatitis B, Metabolic syndrome, Taiwan, Vegetarian diet patterns*

**Received** : 04-Sep-2017
**Revised** : 01-Nov-2017
**Accepted** : 14-Nov-2017

## Introduction

Any lesion projecting from the surface of the gallbladder wall mucosa into the gallbladder interior is defined as a gallbladder polyp (GBP) [1]. Although most GBPs are benign lesions, there is still a 3% to 8% chance of a polyp becoming malignant [2]. A poor prognosis has been noted in patients with gallbladder cancer [2]. When a GBP is larger than 1 cm, the prevalence of malignancy rises markedly, and cholecystectomy is usually suggested [3]. When gallbladder cancer produces symptoms, it is often at an incurable stage [2]. Thus, GBPs have important clinical significance. Nonetheless, there are few studies of the prevalence of and risk factors for GBPs [4-6].

GBPs are nonspecific and asymptomatic in most patients [2]. Due to the increasing the use of abdominal ultrasounds in health checkups, and the symptomology of GBPs, they are becoming a common incidental finding [7,8]. The prevalence of GBPs differs between countries and areas, with percentages ranging from 0.3% to 9.9%. The prevalence of GBP in Taiwan (9.5%) is high, and the risk factors for the development of GBPs are not clearly established. The reported risk factors for GBP are male sex [3,6-9], old age [4,5], and chronic hepatitis B viral infection [5,8,9]. Previous studies have also identified metabolic syndrome factors (including obesity, high body mass index [BMI], dyslipidemia, and glucose intolerance) as risk factors for GBPs [2-6,8-12].

A vegetarian diet has been shown to have positive effects on metabolic characteristics and reduce the risk of development of metabolic syndrome in many studies [13-20]. In addition, the role of diet has been associated with the incidence of gallbladder cancer [21]. One study in Taiwan reported that 2.3% of men and 4.4% of women over 45 years of age were vegetarians in 1993–1996 [22]. In Taiwan, as in other Asian countries,

**Address for correspondence:*
Dr. Cheng-Yu Chen,
Department of Family Medicine, Taipei Tzu Chi Hospital,
Buddhist Tzu Chi Medical Foundation, 289, Jianguo Road, Xindian District, New Taipei, Taiwan.
E-mail: sho913@hotmail.com

Access this article online

Quick Response Code:

Website: www.tcmjmed.com

DOI: 10.4103/tcmj.tcmj_16_18



**How to cite this article:** Liu HW, Chen CY. Ovo-lacto vegetarian diet as a possible protective factor against gallbladder polyps in Taiwan: A cross-sectional study. Tzu Chi Med J 2019;31(1):29-34.

many people choose a vegetarian diet due to religious beliefs and health issues. There are no data on the prevalence of and the risk factors for GBPs in the general vegetarian population. We hypothesized that vegetarianism could be a protective factor against GBPs in the general population of Taiwan. In our cross-sectional study, we aimed to verify this hypothesis.

## Materials and methods

### Study participants

In this cross-sectional study, participants were enrolled from the health examination center at Taipei Tzu Chi Hospital (New Taipei City, Taiwan), which was founded by the Buddhist Compassion Relief Tzu Chi Foundation. We assessed those who received a paid advanced health checkup package (including physical examination, serial blood tests, abdominal sonography, and tumor marker testing) from October 2011 to October 2016. Patients who had previously undergone a cholecystectomy were excluded from the study. The study was conducted in accordance with the Declaration of Helsinki and was approved by the Local Ethics Committee of the institution (05-XD20-048). Informed written consent was waived because the study was a retrospective data analysis. Strengthening the Reporting of Observational Studies in Epidemiology guidelines were followed in this study.

### Clinical assessment

After the patient had fasted for at least 8 h, abdominal ultrasound was performed by a well-trained specialist in gastroenterology with a GELogiq S7 ultrasound machine (Seongnam-Si, Korea). A diagnosis of GBP was made when hyperechoic and immobile echoes projecting from inside the GB wall into the lumen were observed without an acoustic shadow [2]. The size of the largest polyp and the total number of polyps were recorded.

A structured questionnaire was administered by a trained nurse when each participant first visited our health examination center. The self-reporting questionnaire included questions about patient characteristics, alcohol consumption, betel nut chewing, cigarette smoking, medical history, amount of exercise per week, and dietary patterns. If participants had consumed any alcohol in the past 12 months, had ever chewed betel nuts, or had ever used tobacco, a "yes" response was recorded for the respective variable. Physical inactivity was defined as < 30 min/week of exercise [23]. Levels of exercise were classified into four groups for comparative purposes: (1) <30 min/week, (2) 30–60 min/week, (3) 60–180 min/week, and (4) >180 min/week. For comparative purposes, age was grouped into five categories: <30 years, 30–39 years, 40–49 years, 50–59 years, and > 60 years.

The dietary patterns of the participants were reported using a self-reporting questionnaire, which was also completed at the first visit. Participants were asked whether they were vegans, ovo-lacto vegetarians, semi-vegetarians, or omnivores. Dietary patterns were defined as follows: ovo-lacto vegetarian (consuming eggs or dairy products or both, but no other animal products), semi-vegetarian (consuming plant-based food in principle, with occasional meat products, no more than once a week), vegan (plant-based foods only), or omnivore (consuming both plants and animals).

An automatic electronic meter (SECA GM-1000, Seoul, Korea) was used to measure height and weight. BMI was determined by dividing the weight (kg) by the height ($m^2$). For comparative purposes, BMIs were grouped into six categories according to the definitions of the Health Promotion Administration (HPA) and the Ministry of Health and Welfare (MOHW) in Taiwan. That is, a BMI <18.5 kg/$m^2$ is underweight, >18.5 kg/$m^2$ and <24 kg/$m^2$ is normal weight, >24 kg/$m^2$ and <27 kg/$m^2$ is overweight, >27 kg/$m^2$ and <30 kg/$m^2$ is mild obesity, >30 kg/$m^2$ and <35 kg/$m^2$ is moderate obesity, and >35 kg/$m^2$ is severe obesity [24]. We measured the waist circumference (WC) at the mid-level between the lower edge of the rib cage and the iliac crest, with participants in a standing position. Body fat percentages were recorded using a bioelectrical impedance analyzer (TANITA TBF-410GS, Tokyo, Japan). Abdominal obesity was defined using the Taiwan HPA MOHW definition. That is, a WC of >90 cm in men and a WC of >80 cm in women was classified as abdominal obesity. Body fat percentages were categorized into two groups using the Taiwan HPA MOHW definition: >30% and <30% in women, and >25% and <25% in men [25]. An automatic blood pressure machine (Welch Allyn 53000, New Jersey, U. S. A.) was used to measure blood pressure.

Blood was drawn after at least 8 h of fasting. Measures included glucose, serum total cholesterol (TCH), triglycerides (TG), high-density lipoprotein-cholesterol (HDL-C), and low-density lipoprotein-cholesterol (LDL-C) (Dimension RXL Max integrated chemistry system, Siemens, Erlangen, Germany). The hemoglobin A1C (HbA1C) concentration was determined using Variant II (Bio-Rad, Richmond, CA, USA). Fasting glucose levels were categorized into two groups [24]: ≥100 mg/dL and <100 mg/dL. TCH levels were divided into three categories according to the National Cholesterol Education Program Adult Treatment Panel III report [26,27]: ≥240 mg/dL, ≥200 mg/dL, but <240 mg/dL, and >200 mg/dL. For LDL-C [26], there were four categories: >190 mg/dL, >160 mg/dL but <190 mg/dL, >130 mg/dL but <160 mg/dL, and <130 mg/dL. For HDL-C [26], there were two categories: <40 mg/dL and ≥40 mg/dL in men, and <50 mg/dL and ≥50 mg/dL in women. For TG, there were two categories: <150 mg/dL and >150 mg/dL.

Serum virus markers included hepatitis B virus surface antigen (HBsAg) and anti-hepatitis C virus (anti-HCV) antibody were checked by immunoassay analyzer (ARCHITECT PLUS i2000SR Immunoassay Analyzer, Abbott, IL, USA).

### Statistical analysis

Variables are expressed as mean ± standard deviation or number (%). We used a Chi-square test for categorical variables and Fisher's exact test to analyze categorical values <5. For continuous variables, we applied one-way ANOVA with Scheffe *post hoc* tests. The results of the univariate analysis were expressed as odds ratios (ORs) and 95% confidence intervals (CIs). A value of $P < 0.05$ indicated statistical significance and all variables significantly associated with GBP in the univariate analysis were included in the multivariate analysis. Step-wise logistic regression was performed for estimating

the possible risk factors for GBP, and other confounding variables were adjusted. We used SPSS software (version 22, IBM, Armonk, NY, USA) to analyze all data.

## Results

Of the 11,717 over 18 years old participants included in this study, 41.4% (4854) were men and 58.6% (6863) were women. Of these, 3749 were omnivores, 1128 were vegans, 6451 were ovo-lacto vegetarians, and 389 were semi-vegetarians. The baseline clinical characteristics of the participants are shown in Table 1. The smoking, alcohol drinking, and betel nut chewing rates were significantly lower in the vegan and ovo-lacto vegetarian groups than in the semi-vegetarian and omnivore groups ($P < 0.001$) [Table 1]. The vegans had the highest mean age of all groups. The omnivores had a higher BMI, a larger WC, higher body fat, higher glucose levels (fasting glucose, HbA1c), and a higher lipid profile (TCH, LDL, TG) than the other groups. The crude prevalence of GBP was 8.3% (972) in this study. There was a significant difference in the prevalence of GBPs according to the dietary pattern as follows: Omnivores 9.6%, vegans 9.0%, ovo-lacto vegetarians 7.5%, and semi-vegetarians 7.2% [Table 1].

Table 2 shows crude risks determined using univariate analysis. The following factors were significantly associated with GBPs: male sex (OR = 1.87, 95% CI = 1.64–2.13), positive smoking status (OR = 1.31, 95% CI = 1.08–1.58), high diastolic blood pressure (OR = 1.00, 95% CI = 1.00–1.01), 4) high BMI (OR = 1.21, 95% CI = 1.0–1.4 for ≥24.0 kg/m$^2$ and <27.0 kg/m$^2$), large WC (OR = 0.84, 95% CI = 0.74–0.96), HBsAg positivity (OR = 1.49, 95% CI = 1.25–1.78), high TCH (OR = 0.63, 95% CI = 0.47–0.85 for ≥240 mg/dL; OR = 0.76, 95% CI = 0.65–0.90 for ≥200 mg/dL and <240 mg/dL), high LDL (OR = 0.71, 95% CI = 0.54–0.93), and ovo-lacto vegetarianism (OR = 0.76, 95% CI = 0.66–0.87). However, GBPs were not associated with age, alcohol consumption, betel nut chewing, level of exercise, systolic blood pressure, body fat, anti-HCV positivity, or levels of HDL and TG.

On step-wise logistic regression, male sex and HBsAg positivity were independent risk factors for GBPs, while TCH level between ≥200 mg/dL and <240 mg/dL, and ovo-lacto vegetarianism were possible protective factors for GBP [Table 2]. There were no significant associations between polyp number and size and the different dietary patterns [Supplementary Table 1].

## Discussion

GBPs are common in the Chinese population [8,9]. The study showed that different dietary patterns might influence the prevalence of GBPs. Multivariate logistic regression analysis showed that an ovo-lacto vegetarian diet (OR = 0.76, 95% CI = 0.66–0.87) was a possible protective factor against GBPs. This was the first study which focused on the association between GBPs and different vegetarian diets in Taiwan.

There is only one previous similar study in which GBP prevalence and risk factors were compared between Korean Buddhists (vegetarians) and omnivores [27]. The findings from our study were different from those in this 2015 Korean study [27], which compared Korean Buddhist priests and the general population and found that the incidence of GBPs was not significantly associated with vegetarianism. However, our participants were mostly volunteers from the Buddhist Tzu Chi Foundation and were not Buddhist priests. The Buddhist priests in the Korean study lived an ascetic and communal life

**Table 1: Comparison of characteristics between different diet groups**

| Characteristic | Vegan group (*n*=1128) | Ovo-lactovegetarian group (*n*=6451) | Semi-vegetarian group (*n*=389) | Omnivore group (*n*=3749) |
|---|---|---|---|---|
| Age (years)±SD* | 62.2±9.6 | 59.1±9.1 | 59.3±9.3 | 59.3±10.4 |
| Sex, female (%)* | 729 (64.6) | 4287 (66.5) | 221 (56.8) | 1626 (43.4) |
| Smoking (%)* | 80 (7.1) | 572 (8.9) | 47 (12.1) | 693 (18.5) |
| Alcohol (%)* | 93 (8.2) | 724 (11.2) | 87 (22.4) | 1076 (28.7) |
| Betel nuts (%)* | 39 (3.5) | 194 (3.0) | 18 (4.6) | 206 (5.5) |
| Physical inactivity (%)* | 312 (27.7) | 1683 (26.0) | 103 (26.5) | 902 (24.1) |
| Systolic pressure (mmHg)* | 122.0±16.7 | 121.0±15.3 | 122.1±15.0 | 123.5±15.5 |
| Diastolic pressure (mmHg)* | 71.7±11.3 | 72.3±13.4 | 75.8±31.3 | 74.4±11.0 |
| BMI (kg/m$^2$)* | 23.1±3.4 | 23.2±3.3 | 23.5±3.2 | 24.3±3.5 |
| Waist (cm)* | 82.1±9.4 | 81.7±9.2 | 83.1±9.2 | 85.1±9.6 |
| Body fat (%)* | 25.5±7.9 | 26.3±7.5 | 26.0±7.7 | 26.1±7.7 |
| HBsAg positive (%) | 152 (13.5) | 843 (13.1) | 50 (12.9) | 428 (11.4) |
| Anti-HCV positive (%) | 31 (2.7) | 138 (2.1) | 7 (1.8) | 80 (2.1) |
| HbA1c (%)* | 5.70±0.9 | 5.64±0.8 | 5.63±0.7 | 5.76±0.9 |
| Fasting glucose (mg/dL)* | 100.0±25.3 | 99.8±21.4 | 101.5±21.1 | 105.1±27.3 |
| Total cholesterol (mg/dL)* | 176.6±33.8 | 182.7±35.4 | 192.6±36.8 | 191.7±37.0 |
| HDL-C (mg/dL)* | 50.0±14.1 | 50.8±14.5 | 50.7±14.9 | 49.9±15.7 |
| LDL-C (mg/dL)* | 112.7±29.2 | 116.7±30.2 | 125.1±31.3 | 123.8±31.6 |
| TG (mg/dL)* | 106.2±64.8 | 108.1±67.8 | 116.0±77.3 | 117.9±75.2 |
| Gallbladder polyps (%)* | 101 (9.0) | 483 (7.5) | 28 (7.2) | 360 (9.6) |

*Statistically significant. HBsAg: Hepatitis B virus surface antigen, HCV: Hepatitis C virus, HbA1c: Hemoglobin A1c, TG: Triglycerides, BMI: Body mass index, HDL-C: High-density lipoprotein-cholesterol, LDL-C: Low-density lipoprotein-cholesterol, SD: Standard deviation

**Table 2: Univariate and multivariate analysis of possible risk factors for gall bladder polyps**

| Variable | Gallbladder polyps | | Univariate analysis, OR (95% CI) | *P* | Multivariate analysis, OR (95% CI) | *P* |
|---|---|---|---|---|---|---|
| | Yes (*n*=972), *n* (%) | No (*n*=10,745), *n* (%) | | | | |
| Age (years) | | | | | | |
| <30 | 3 (0.3) | 23 (0.2) | 1.000 | | | |
| 30-49 | 20 (2) | 244 (2.3) | 0.878 (0.290-2.658) | 0.818 | | |
| 40-49 | 156 (16.0) | 1236 (11.5) | 1.008 (0.354-2.873) | 0.987 | | |
| 50-59 | 364 (37.4) | 3768 (35.1) | 0.838 (0.295-2.364) | 0.735 | | |
| >60 | 429 (44.1) | 5474 (50.9) | 0.688 (0.243-1.945) | 0.481 | | |
| Sex | | | | | | |
| Male | 541 (55.7) | 4313 (40.1) | 1.872 (1.640-2.137) | <0.001* | 1.832 (1.542-2.178) | <0.001* |
| Female | 431 (44.3) | 6432 (59.9) | 1.000 | | 1.000 | |
| Smoking | | | | | | |
| Current, previous | 143 (14.7) | 1249 (11.6) | 1.311 (1.088-1.581) | 0.004* | 0.917 (0.750-1.121) | 0.399 |
| Never | 829 (85.3) | 9496 (88.4) | 1.000 | | 1.000 | |
| Alcohol | | | | | | |
| Current, previous | 174 (17.9) | 1806 (16.8) | 1.079 (0.909-1.281) | 0.384 | | |
| Never | 798 (82.1) | 8939 (83.2) | 1.000 | | | |
| Betel nut | | | | | | |
| Current, previous | 42 (4.3) | 415 (3.9) | 1.124 (0.813-1.555) | 0.480 | | |
| Never | 930 (95.7) | 10,330 (96.1) | 1.000 | | | |
| Exercise (/week) | | | | | | |
| <30 min | 236 (24.3) | 2764 (25.7) | 1.000 | | | |
| 30-60 | 418 (44.3) | 4171 (38.8) | 1.174 (0.994-1.387) | 0.060 | | |
| 60-180 | 176 (18.1) | 2194 (20.4) | 0.940 (0.767-1.151) | 0.547 | | |
| >180 | 130 (13.3) | 1531 (15.1) | 0.994 (0.796-1.243) | 0.961 | | |
| Systolic pressure (mmHg) | 122.4±15.1 | 122.0±15.7 | 1.002 (0.997-1.008) | 0.435 | | |
| Diastolic pressure (mmHg) | 74.2±10.6 | 73.0±13.8 | 1.005 (1.001-1.018) | 0.015* | 1.002 (0.997-1.006) | 0.433 |
| BMI (kg/m$^2$) | | | | | | |
| <18.5 | 33 (3.4) | 479 (4.5) | 0.803 (0.558-1.155) | 0.237 | 0.856 (0.591-1.240) | 0.411 |
| ≥18.5, <24 | 509 (52.3) | 5931 (55.2) | 1.000 | | 1.000 | |
| ≥24, <27 | 287 (29.5) | 2763 (25.7) | 1.210 (1.040-1.408) | 0.014* | 1.136 (0.960-1.345) | 0.137 |
| ≥27, <30 | 100 (10.2) | 1109 (10.3) | 1.051 (0.840-1.314) | 0.665 | 1.014 (0.781-1.317) | 0.915 |
| ≥30, <35 | 37 (3.8) | 393 (3.7) | 1.097 (0.774-1.555) | 0.603 | 1.188 (0.808-1.745) | 0.381 |
| ≥35 | 6 (0.6) | 70 (0.6) | 0.999 (0.432-2.310) | 0.998 | 0.937 (0.396-2.219) | 0.883 |
| Waist (cm) | | | | | | |
| ≥80 (female), ≥90 (male) | 389 (40) | 4735 (44.1) | 0.847 (0.741-0.968) | 0.015 | 0.938 (0.791-1.113) | 0.465 |
| <80 (female), <90 (male) | 583 (60) | 6010 (55.9) | 1.000 | | 1.000 | |
| Body fat (%) | | | | | | |
| ≥30 (female), ≥25 (male) | 343 (35.3) | 4038 (37.6) | 0.906 (0.790-1.039) | 0.157 | | |
| <30 (female), <25 (male) | 629 (64.7) | 6707 (62.4) | 1.000 | | | |
| HBsAg positive | 167 (17.2) | 1306 (12.2) | 1.498 (1.255-1.787) | <0.001* | 1.540 (1.287-1.844) | <0.001* |
| Anti-HCV positive | 15 (1.5) | 241 (2.2) | 0.683 (0.404-1.155) | 0.155 | | |
| HbA1c (%) | 5.7±0.9 | 5.7±0.8 | 0.978 (0.905-1.058) | 0.584 | | |
| Fasting glucose (mg/dL) | | | | | | |
| ≥100 | 390 (40.1) | 4320 (40.2) | 0.997 (0.872-1.139) | 0.961 | | |
| <100 | 582 (59.9) | 6425 (59.8) | 1.000 | | | |
| Total cholesterol (mg/dL) | | | | | | |
| ≥240 | 51 (5.3) | 807 (7.5) | 0.638 (0.476-0.855) | 0.003* | 0.729 (0.464-1.148) | 0.173 |
| ≥200, <240 | 210 (21.6) | 2763 (25.7) | 0.767 (0.654-0.900) | 0.001* | 0.785 (0.628-0.981) | 0.033* |
| <200 | 711 (73.1) | 7175 (66.8) | 1.000 | | | |
| HDL-C (mg/dL) | | | | | | |
| <50 (female), <40 (male) | 404 (41.6) | 4308 (40.1) | 1.063 (0.930-1.214) | 0.371 | | |
| ≥50 (female), ≥40 (male) | 568 (58.4) | 6437 (59.9) | 1.000 | | | |
| LDL-C (mg/dL) | | | | | | |
| ≥190 | 13 (1.3) | 198 (1.9) | 0.694 (0.394-1.224) | 0.207 | 1.033 (0.502-2.125) | 0.930 |
| ≥160, <190 | 60 (6.2) | 892 (8.3) | 0.711 (0.541-0.935) | 0.015* | 1.006 (0.682-1.482) | 0.978 |
| ≥130, <160 | 233 (24) | 2611 (24.3) | 0.944 (0.808-1.103) | 0.467 | 1.142 (0.930-1.403) | 0.205 |

*Contd...*

**Table 2: Contd...**

| Variable | Gallbladder polyps | | Univariate analysis, OR (95% CI) | *P* | Multivariate analysis, OR (95% CI) | *P* |
|---|---|---|---|---|---|---|
| | Yes (*n*=972), *n* (%) | No (*n*=10,745), *n* (%) | | | | |
| <130 | 666 (68.5) | 7044 (65.6) | 1.000 | | 1.000 | |
| TG (mg/dL) | | | | | | |
| ≥150 | 189 (19.4) | 2177 (20.3) | 0.950 (0.805-1.121) | 0.544 | | |
| <150 | 783 (80.6) | 8568 (79.7) | 1.000 | | | |
| Diet | | | | | | |
| Vegan group | 101 (10.4) | 1027 (9.6) | 0.926 (0.735-1.167) | 0.514 | 0.997 (0.786–1.264) | 0.978 |
| Ovo-lactovegetarian group | 483 (49.7) | 5968 (55.5) | 0.762 (0.660-0.879) | <0.001* | 0.830 (0.715–0.965) | 0.015* |
| Semi-vegetarian group | 28 (2.9) | 361 (3.4) | 0.730 (0.490-1.089) | 0.123 | 0.775 (0.518–1.159) | 0.215 |
| Omnivore group | 360 (37) | 3389 (31.5) | 1.000 | | 1.000 | |

*Statistically significant. Data are shown as *n* (%) or mean±SD. HBsAg: Hepatitis B virus surface antigen, HBV: Hepatitis B virus, HCV: Hepatitis C virus, HbA1c: Hemoglobin A1c, TG: Triglycerides, BMI: Body mass index, HDL-C: High-density lipoprotein-cholesterol, LDL-C: Low-density lipoprotein-cholesterol, SD: Standard deviation, OR: Odds ratio, CI: Confidence interval

with little exercise and they had higher BMIs, blood pressures, and HbA1C, and TG levels than the general population [27]. In Yang *et al*.'s study, a Chinese lacto-vegetarian diet was found to exert favorable effects on metabolic parameters [16]. Weaver's study also reported that a lactovegetarian diet provided greater health benefits and reduced health risks compared with a vegan diet [28]. The benefits probably depend on the dietary calcium-to-protein ratio that is comparable between lactovegetarians and vegans [29]. Further studies are needed to identify what it is in the ovo-lacto vegetarian diet that helps prevent GBPs.

T with increasing numbers of people receiving health-screening examinations and abdominal ultrasounds, the rate of incidental detection of GBPs has increased in recent years [3,8]. In our cross-sectional study, the prevalence of GBPs was 8.3%, which is less than that reported in a previous study based in another hospital in Taiwan (9.5%) [8].

There was a large proportion of ovo-lacto vegetarians in this study (55%). The second largest group was the omnivores (32%), followed by vegans (10%), and semi-vegetarians (3%). The prevalence of GBPs was the highest in omnivores (9.6%) and the lowest in vegetarians (7.7%) [Table 1]. The size of GBPs and the number of GBPs was similar to that in a previous study [4]. There were no significant differences for different dietary patterns [Supplementary Table 1].

This study also found that omnivores had a higher BMI, larger WC, higher body fat, higher glucose levels (fasting glucose, HbA1c), and a higher lipid profile (TCH LDL, TG) than the vegetarian diet groups. Many previous studies, including those from the Western and Eastern populations, have demonstrated that a vegetarian diet is associated with a more favorable profile of metabolic risk factors and a lower risk of metabolic syndromes [13-20]. Although the etiology is not fully understood, studies assessing the risk factors and pathogenesis of GBPs have suggested that multiple metabolic disorders are associated with the development of GBPs [3-6,8-10,12].

Cholesterol polyps are the most common type and account for 60%–90% of all GBPs [30]. However, in a previous study, blood cholesterol concentration was not found to be an independent risk factor for GBPs [4,6,12]. Interestingly, we found that a TCH level between ≥200 mg/dL and <240 mg/dL (OR = 0.78, 95% CI = 0.62–0.98) was a protective factor for GBPs in the present study. This finding has not been reported previously [5,9] and thus, further trials are needed for confirmation.

This study found hepatitis B virus infection was an independent risk factor for GBPs, and this finding is consistent with previous studies [4-6,8]. Hepatitis B infection may lead to an inflammatory reaction and cause abnormalities of the gallbladder wall with bile composition [31]. However, the pathophysiology of GBPs and the relationship between GBPs and hepatitis B infection remains unclear.

Step-wise logistic regression found that male sex (OR = 1.83, 95% CI = 1.54–2.17) was an independent risk for GBPs in this study. Many previous studies have demonstrated an association between sex and GBPs [5,6,12]. However, other studies have revealed no difference between the sexes in the prevalence of GBPs [4,7].

There were a few limitations to this study. First, there may have been a selection bias, in that our participants were mostly volunteers from the Buddhist Tzu Chi Foundation motivated to have a health check-up, and they may not be representative of the general population. However, due to the high percentage of vegetarians in this population, it provided us with an opportunity to evaluate the risk factors for GBPs with different dietary patterns, especially different vegetarian diet patterns. Second, there was no detailed information on portion size, number of calories consumed, nutrient composition of foods consumed by the participants, or duration of the dietary regimen. Third, this study had a cross-sectional design, and hence, causality could not be established because the temporal relationship between a vegetarian diet and GBPs is uncertain. Nevertheless, this is the first study to show an association between GBPs and different dietary patterns in Taiwanese patients.

## Conclusions

The development of GBPs was significantly associated with male sex and HBsAg positivity. An ovo-lacto vegetarian diet may be a protective factor for the development of GBPs.

### Financial support and sponsorship

Research Projects sponsored by Taipei Tzu Chi Hospital (TCRD-TPE-106-18).

### Conflicts of interest

There are no conflicts of interest.

## References

1. Christensen AH, Ishak KG. Benign tumors and pseudotumors of the gallbladder. Report of 180 cases. Arch Pathol 1970;90:423-32.
2. Lee KF, Wong J, Li JC, Lai PB. Polypoid lesions of the gallbladder. Am J Surg 2004;188:186-90.
3. Yang HL, Sun YG, Wang Z. Polypoid lesions of the gallbladder: Diagnosis and indications for surgery. Br J Surg 1992;79:227-9.
4. Jørgensen T, Jensen KH. Polyps in the gallbladder. A prevalence study. Scand J Gastroenterol 1990;25:281-6.
5. Lim SH, Kim DH, Park MJ, Kim YS, Kim CH, Yim JY, et al. Is metabolic syndrome one of the risk factors for gallbladder polyps found by ultrasonography during health screening? Gut Liver 2007;1:138-44.
6. Segawa K, Arisawa T, Niwa Y, Suzuki T, Tsukamoto Y, Goto H, et al. Prevalence of gallbladder polyps among apparently healthy Japanese: Ultrasonographic study. Am J Gastroenterol 1992;87:630-3.
7. Hayashi Y, Liu JH, Moriguchi H, Takenawa H, Tazawa J, Nakayama E, et al. Prevalence of polypoid lesions of the gallbladder in urban and rural areas of Japan: Comparison between 1988 and 1993. J Clin Gastroenterol 1996;23:158-9.
8. Lin WR, Lin DY, Tai DI, Hsieh SY, Lin CY, Sheen IS, et al. Prevalence of and risk factors for gallbladder polyps detected by ultrasonography among healthy Chinese: Analysis of 34 669 cases. J Gastroenterol Hepatol 2008;23:965-9.
9. Xu Q, Tao LY, Wu Q, Gao F, Zhang FL, Yuan L, et al. Prevalences of and risk factors for biliary stones and gallbladder polyps in a large Chinese population. HPB (Oxford) 2012;14:373-81.
10. Pandey M, Khatri AK, Sood BP, Shukla RC, Shukla VK. Cholecystosonographic evaluation of the prevalence of gallbladder diseases. A university hospital experience. Clin Imaging 1996;20:269-72.
11. Choi YS, Do JH, Seo SW, Lee SE, Oh HC, Min YJ, et al. Prevalence and risk factors of gallbladder polypoid lesions in a healthy population. Yonsei Med J 2016;57:1370-5.
12. Chen CY, Lu CL, Chang FY, Lee SD. Risk factors for gallbladder polyps in the Chinese population. Am J Gastroenterol 1997;92:2066-8.
13. Kim SY, Lee HS, Lee YS, Chung KW, Jang BK, Chung WJ, et al. Prevalence and risk factors of gallbladder polyp in adults living in Daegu and Gyeongbuk provinces. Korean J Gastroenterol 2006;48:344-50.
14. Amini M, Esmaillzadeh A, Shafaeizadeh S, Behrooz J, Zare M. Relationship between major dietary patterns and metabolic syndrome among individuals with impaired glucose tolerance. Nutrition 2010;26:986-92.
15. Rizzo NS, Sabaté J, Jaceldo-Siegl K, Fraser GE. Vegetarian dietary patterns are associated with a lower risk of metabolic syndrome: The adventist health study 2. Diabetes Care 2011;34:1225-7.
16. Yang SY, Li XJ, Zhang W, Liu CQ, Zhang HJ, Lin JR, et al. Chinese lacto-vegetarian diet exerts favorable effects on metabolic parameters, intima-media thickness, and cardiovascular risks in healthy men. Nutr Clin Pract 2012;27:392-8.
17. Chiang JK, Lin YL, Chen CL, Ouyang CM, Wu YT, Chi YC, et al. Reduced risk for metabolic syndrome and insulin resistance associated with ovo-lacto-vegetarian behavior in female Buddhists: A case-control study. PLoS One 2013;8:e71799.
18. Turner-McGrievy G, Harris M. Key elements of plant-based diets associated with reduced risk of metabolic syndrome. Curr Diab Rep 2014;14:524.
19. Sabaté J, Wien M. A perspective on vegetarian dietary patterns and risk of metabolic syndrome. Br J Nutr 2015;113(Suppl 2):S136-43.
20. Pimenta AM, Toledo E, Rodriguez-Diez MC, Gea A, Lopez-Iracheta R, Shivappa N, et al. Dietary indexes, food patterns and incidence of metabolic syndrome in a Mediterranean cohort: The SUN project. Clin Nutr 2015;34:508-14.
21. Panda D, Sharma A, Shukla NK, Jaiswal R, Dwivedi S, Raina V, et al. Gall bladder cancer and the role of dietary and lifestyle factors: A case-control study in a North Indian population. Eur J Cancer Prev 2013;22:431-7.
22. Tzeng MS, Kao MD, Yeh WT, Pan WH. Food consumption frequency and eating habit among Taiwanese – NAHSIT 1993-96. Nutr Sci J 1999;24:59-80.
23. NHS Atlas of variation in healthcare. Department of Health. 2015. pp 94-5. Available from: http://fingertips.phe.org.uk/documents/Atlas_2015%20Compendium.pdf. [Last accessed on 2018 Mar].
24. Pan WH, Flegal KM, Chang HY, Yeh WT, Yeh CJ, Lee WC, et al. Body mass index and obesity-related metabolic disorders in Taiwanese and US whites and blacks: Implications for definitions of overweight and obesity for Asians. Am J Clin Nutr 2004;79:31-9.
25. Pasco JA, Holloway KL, Dobbins AG, Kotowicz MA, Williams LJ, Brennan SL, et al. Body mass index and measures of body fat for defining obesity and underweight: A cross-sectional, population-based study. BMC Obes 2014;1:9.
26. National Cholesterol Education Program (NCEP) Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel III). Third report of the national cholesterol education program (NCEP) expert panel on detection, evaluation, and treatment of high blood cholesterol in adults (Adult treatment panel III) final report. Circulation 2002;106:3143-421.
27. Jo HB, Lee JK, Choi MY, Han IW, Choi HS, Kang HW, et al. Is the prevalence of gallbladder polyp different between vegetarians and general population? Korean J Gastroenterol 2015;66:268-73.
28. Weaver CM. Should dairy be recommended as part of a healthy vegetarian diet? Point. Am J Clin Nutr 2009;89:1634S-7S.
29. Weaver CM, Proulx WR, Heaney R. Choices for achieving adequate dietary calcium with a vegetarian diet. Am J Clin Nutr 1999;70:543S-8S.
30. Sandri L, Colecchia A, Larocca A, Vestito A, Capodicasa S, Azzaroli F, et al. Gallbladder cholesterol polyps and cholesterolosis. Minerva Gastroenterol Dietol 2003;49:217-24.
31. Yang HL, Kong L, Hou LL, Shen HF, Wang Y, Gu XG, et al. Analysis of risk factors for polypoid lesions of gallbladder among health examinees. World J Gastroenterol 2012;18:3015-9.

**Supplementary Table 1: Characteristics of gall bladder polyps**

| Characteristic | Vegan group (*n*=101) | Ovo-lactovegetarian group (*n*=483) | Semi-vegetarian group (*n*=28) | Omnivore group (*n*=360) | *P* |
|---|---|---|---|---|---|
| Polyp number | | | | | |
| Single | 66 (65.3) | 334 (69.1) | 17 (60.7) | 253 (70.2) | 0.614 |
| Multiple | 35 (34.7) | 149 (30.9) | 11 (39.3) | 107 (29.8) | |
| Polyp size (mm) | | | | | |
| <5 | 78 (77.2) | 359 (74.3) | 22 (78.5) | 272 (75.5) | 0.738 |
| 5-10 | 21 (20.7) | 116 (24.0) | 6 (21.5) | 86 (23.8) | |
| ≥10 | 2 (2.1) | 8 (1.7) | 0 | 2 (0.7) | |