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Anthropometric Measurements, Physical Activity, and the Risk of Symptomatic Gallstone Disease in Chinese Women

Lifang Hou, MD, PhD, Xiao-Ou Shu, MD, PhD, Yu-Tang Gao, MD, Bu-Tian Ji, MD, PhD, Jocelyn M. Weiss, PhD, Gong Yang, MD, PhD, Hong-Lan Li, MD, PhD, Aaron Blair, PhD, Wei Zheng, MD, PhD, and Wong-Ho Chow, PhD

Department of Preventive Medicine, Northwestern University, Chicago (L.H.); Occupational and Environmental Epidemiology Branch, Division of Cancer Epidemiology and Genetics, National Cancer Institute, NIH, DHHS, Bethesda, MD (L.H., B.-T.J., J.M.W., A.B., W.-H.C.); Center for Health Service Research, Vanderbilt University, Nashville, TN (X.-O.S., W.Z); and Shanghai Cancer Institute, Shanghai, China (Y.-T.G., G.Y., H.-L.L.)

Abstract

PURPOSE—Gallstone disease is more common among overweight individuals, particularly in women. We conducted a cross-sectional case-control study of Chinese women nested in the Shanghai Women's Health Study (SWHS) to evaluate the association of gallstone disease with body mass index (BMI), waist to hip ratio (WHR), and physical activity (PA).

METHODS—The study included 8,485 women with self-reported, physician-diagnosed, prevalent gallstone disease and 16,970 frequency-matched controls by birth year and age at gallstone diagnosis (4-year intervals). Information on height, weight history, waist and hip circumferences, physical activities, and other exposures was obtained by in-person interview.

RESULTS—Usual BMI (p trend < 0.001) and WHR (p trend < 0.001) were both related to a high prevalence of gallstone disease, and a significant interaction between BMI and WHR on gallstone risk was found (odds ratio [OR]=3.82, 95% CI [95% confidence interval] 2.47–5.23 for those with both highest BMI and WHR relative to those with lowest BMI and WHR, p interaction = 0.03). Gallstone risk was positively associated with cumulative occupational sitting time (p trend = 0.01) and inversely associated with occupational cumulative energy expenditure (p trend = 0.03) as well as with household PA (p trend = 0.02).

CONCLUSIONS—Our findings further support that overall and central excessive adiposity is an independent risk factor for gallstones in women. In addition, regardless of adiposity level, being physically active may ameliorate the risk of this disease.

Keywords

Body Mass Index; Gallstone Disease Risk; Physical Activity; Waist-to-Hip Ratio

INTRODUCTION

Gallstones present a major disease burden, affecting approximately 10% to 20% of the U.S. population (1). Gallstone disease is also an important public health problem in some Asian countries, including China (2,3), where cholecystectomy to remove gallstones is one of the

most common surgical procedures, accounting for 11.5% of all hospitalizations between 1985 and 1995 (4). In addition, gallstones are strongly associated with gallbladder cancer and considered an intermediate step in gallbladder cancer pathogenesis (5). Data from the population-based tumor registry in urban Shanghai, China indicate that gallbladder cancer incidence has increased more rapidly than any other malignancy in this area (6). The increasing prevalence of obesity and cholesterol stones in Shanghai seems at least partly responsible for the rising incidence of gallbladder cancer in Shanghai (7). It was known that pigment stones predominate in developing regions of the world, especially in Asia (8). However, in China, during the past few decades, there has been an increase in cholesterol stones and a decrease in pigment stones (4,8–10), probably related to increasing obesity and a more westernized diet (containing more fat) and lifestyle (physically inactive) (8,11).

Overweight and obesity are well-established risk factors for gallstone disease (12,13). Central obesity, measured by waist-to-hip ratio (WHR), is independently related to risk after taking into account total adiposity, as measured by body mass index (BMI) (14–16). High central obesity and BMI are two independent risk factors for metabolic conditions, such as insulin resistance, hyperinsulinemia, reduced number of insulin receptors, and low plasma high-density lipoprotein (HDL) cholesterol and therefore may play important roles in the etiology of gallstone disease (17). Similarly, physical inactivity is a putative risk factor for gallstone disease (18), but its effect independent of BMI or central obesity is not yet well defined. In the present study, we examined the effect of BMI, WHR, and physical activity on the prevalence of gallstone disease in a large population of women in Shanghai, China.

METHODS

Study Subjects

This cross-sectional case-control study is nested in the Shanghai Women's Health Study (SWHS), a population-based prospective cohort study. A detailed description of the study design, study population, and data collection has been previously published elsewhere (19). Briefly, the SWHS includes 74,942 women, between 40 and 70 years of age, who permanently resided in seven communities of Shanghai. Participants were recruited between March 1997 and May 2000; the participation rate was 92.7%. Gallstone disease status was based on self-report of having ever been diagnosed with gallstones by a physician and age at which the disease was first diagnosed. Cases that were first diagnosed under the age of 16 years were excluded to ensure that only adult cases were included in the analysis. Two controls were randomly selected from the cohort and were matched to each case by year of birth (same year) and age at diagnosis of cases (4-year period). A total of 8,477 gallstone cases and 16,954 controls were included in this analysis. The study was approved by the Institutional Review Board of all study centers in both China and the United States.

Data Collection

Study participants were interviewed in person by trained interviewers, using a structured questionnaire, to elicit information on demographic background, socioeconomic status (income and education), tobacco and alcohol use, dietary habits, menstrual and reproductive history, history of hormone use, medical history, residential history, exposure to second-hand smoke, occupational history, and physical activity history, including household, commuting, and leisure-time physical activities.

Dietary Assessment

Dietary intakes were assessed using a validated 76-item food frequency questionnaire (FFQ), which was previously shown to capture more than 86% of the intake of foods commonly consumed in Shanghai (20–22). Specific questions in the FFQ assessed the

frequency of consumption (i.e., daily, weekly, monthly, yearly, or never) and the amount of raw food items typically eaten in lians (where 1 lian is equal to 50 g) or jins (where 1 jin is equal to 500 g). For seasonal foods, subjects were asked to describe their consumption based on market availability and total months of consumption per year. Fat or fatty acid intakes from different food sources were estimated by summing the products of the amount of foods consumed and the (micro-) nutrient content of each food according to the Chinese Food Composition Table (20).

Anthropometric Assessment

Data on adult height and weight history, including usual adult weight and weight at various age periods, were collected at the baseline interview. In addition, interviewers measured several anthropometric dimensions, including standing height, body weight, and circumferences of waist and hip. BMI was calculated as the usual adult weight (measured in kilograms)/adult height (measured in square meters). WHR and waist circumference were used as measures of central adiposity. Decile and quintile categories of usual BMI, waist circumference, and WHR at interview were determined by using cut-points among the controls. Weight change was assessed by the difference in self-reported weight between the ages of 20 and 50 years.

Physical Activity Measurement

Physical activity assessment was based on occupational, housework, commuting, and leisure activities. Detailed information on these activities is obtained by using a validated questionnaire (23). Occupational physical activity levels were estimated by lifetime cumulative energy expenditure (measured in kilojoules per minute) for more than 300 specific jobs (24). For each job, the workplace name, title, major work products, and years spent at each job were obtained. The index of lifetime average energy expenditure was calculated by multiplying the energy expenditure of each job with years on the job, summing the product values over all jobs in lifetime, and dividing the sum by total years of employment. Detailed methods in assigning occupational physical activity levels were reported elsewhere (24). The information on occupational titles was also used to calculate occupational sitting time (25). Housework activity was assessed by the hours per day spent on housework. For commuting physical activity, participants reported minutes per day spent for the round trip to and from work on different means of commuting, including walking, riding on a bus, riding a motorcycle, and riding a bicycle. Information on other transportation physical activities, including walking and cycling for other reasons, was also collected. The total intensity of commuting or other transportation physical activities was estimated by the number of hours spent per day on each activity multiplied by its typical energy expenditure, expressed as metabolic equivalents (METs) to yield a MET hour per day score (26,27). The following MET values were used for activities performed in commuting physical activity: walking (3.3 METs), cycling (4.0 METs), and 1.0 for riding on a bus. For leisure-time physical activity, up to three exercise activities were reported for the 5-year period before the interview, and quantitative data were obtained for each activity reported (i.e., type/intensity, duration, years of participation). The total energy expenditure for leisure-time physical activity was also estimated by the MET (26,27). Categories for all physical activity variables were grouped based on the distributions in the control group.

Statistical Analysis

Odds ratios (ORs) and 95% confidence intervals (95% CIs) for prevalence of gallstone by different obesity measurements were calculated using conditional logistic regression adjusting for year of birth, age at diagnosis, education (elementary and less, middle school, high school, and college or above), annual family income (<10,000, 10,000–20,000, 20,000–30,000, and 30,000+ Chinese yuans), total calorie intake, total fat intake, number of full-

term pregnancies, and menopausal status. Risk estimates were further adjusted for passive smoking, age at menarche, and age at first birth, age at menopause, female hormone use, history of hypertension, and history of diabetes, in order to evaluate potential confounding by these factors. With and without adjustment for the abovementioned hormone-related factors in our analyses produced comparable results. We have presented the results from the hormone factors-adjusted models since estrogen is thought to diminish gallbladder motility, a major risk factor for gallstone diseases. Tests for trend were performed by assessing the significance of a linear effect in median values for each category in the logistic regression model (28). Statistical significance for interactions was assessed by the likelihood-ratio test comparing the models with and without the interaction term (29). All tests were two-sided, with p values of less than 0.05 considered to be statistically significant. Individuals with missing values were excluded from specific analyses. The Stata statistical package was used for all analyses (Stata Corp., College Station, TX; release 9.0).

RESULTS

Gallstone cases and controls were similar with respect to distributions by age group and marital status. Cases were more likely to have higher education levels, higher family income than controls, and to be premenopausal (Table 1). Among controls, waist circumference ($r = 0.83$, $p < 0.001$) and WHR ($r = 0.46$, $p < 0.001$) were significantly associated with BMI (data not shown in tables).

Usual BMI was significantly associated with gallstone risk (p trend < 0.0001) (Table 2). Women in the highest BMI decile had a 2.2-fold increased risk (95% CI: 1.9–2.4) of gallstones compared with those in the lowest decile. WHR was also associated with gallstone risk (p trend < 0.0001), with women in the highest WHR decile having a 2.5-fold increased risk (95% CI: 2.2–2.8) compared to those in the lowest decile. The effects of BMI and WHR on gallstone risk were not meaningfully changed after further adjustment for each other, as well as after adjusting for physical activity, or other potential risk factors. Although the evaluations on BMI at age 20 did not reveal consistent patterns with respect to the risk, the results for BMI at age 50 were comparable to those for usual BMI (data not shown).

Table 3 shows the risk of gallstone disease cross-classified by WHR and BMI quintiles. An excess gallstone risk was associated with a higher WHR regardless of BMI, and with a higher BMI regardless of WHR. The highest excess risk of gallstones was for women in the highest BMI and WHR quintiles (OR = 3.82, 95% CI: 2.47–5.23) compared with those in the lowest BMI and WHR quintiles (p for interaction = 0.03).

Gallstone risk was inversely associated with occupational cumulative energy expenditure (p trend = 0.03), with women in the highest quartile of energy expenditures having a 20% lower risk (95% CI: 0.7–0.9) of gallstones (Table 4). Consistent with this finding, occupational sitting time was positively associated with gallstone risk (p trend = 0.01), with those in the highest quartile of sitting time having a 30% excess risk (95% CI: 1.1–1.4). Likewise, gallstone risk decreased with increasing hours of housework per day (p trend = 0.02), with a 30% reduction in risk (95% CI: 0.6–0.8) among those who spent 4 hours or more on housework daily. No association was observed for commuting physical activity, including daily time spent on walking, biking, or taking the bus to work, or for leisure-time physical activity (data not shown in Table 4). The association between physical activity and gallstone risk was not modified by BMI (p for interaction = 0.12) or WHR (p for interaction = 0.21) (data not shown in tables).

In addition, the stratified analysis on BMI, WHR, sitting time, and HPA by year of diagnosis of gallstones (e.g., <5 years vs. ≥5 years before baseline) as well as by cholecystectomy status produced similar results (data not shown).

DISCUSSION

In this relatively lean female Chinese population, we found that both BMI and WHR were associated with gallstone disease. Occupational and household physical activity levels were inversely related to gallstones and were independent of BMI and WHR. Our results add further evidence to the published data that overall and central excessive adiposity are two independent risk factors for gallstones in women. In addition, regardless of adiposity level, being physically active may ameliorate the risk of this disease.

Obesity is a well-established risk factor for developing gallstones, particularly in women. Previous studies have shown that compared with normal weight women (BMI < 24 kg/m²), obese women (BMI ≥30 kg/m²) have at least a two-fold increased risk of gallstone disease (12,13). In the U.S. Nurses Health Study (13), when compared with women with normal weight, obese women had a two-fold excess risk of symptomatic gallstones, and extremely obese women (BMI ≥45 kg/m²) had a seven-fold excess risk. The association between central adiposity and gallstone disease has also been evaluated. WHR was positively correlated with gallstone prevalence in two population-based ultrasonographic surveys conducted in England (14) and in the United States (15). In addition, two cross-sectional studies using self-reported gallstone histories reported significantly increased risks of gallstones for women with higher central adiposity (16). In contrast to the findings from our study and these previous studies, WHR were not related to gallstone disease in two studies conducted in Mexican and Japanese populations (30,31).

The mechanism by which obesity increases the risk of gallstone diseases is still unclear. It has been suggested that obesity may be associated with gallstone disease through excessive hepatic secretion of cholesterol, resulting in bile supersaturated with cholesterol (32). Hyperinsulinemia may also be linked to increased hepatic cholesterol secretion and cholesterol supersaturation of bile by upregulating hepatocyte low-density lipoprotein receptors or by activating hydroxymethylglutaryl coenzyme A reductase (33). In addition, some studies have reported impairment of gallbladder motility among the obese (34,35). Hypomotility causes incomplete and infrequent emptying of the contents of the gallbladder, leading to stasis of bile and crystal formation (1). Furthermore, a few biologically plausible pathways by which central adiposity may be linked to gallstone formation have been proposed (36,37). Visceral fat that accumulates in the abdomen is more metabolically active and thus increases hepatic exposure to unesterified fatty acids and decreases insulin sensitivity, and intra-abdominal fat mass was positively associated with gallbladder volume (38).

The protective effect of physical activity on gallstones is consistent with several recent epidemiological studies (18,39–41), although some earlier studies have been inconclusive (42–44). Physical activity may exert its protective effect by increasing gallbladder motility (45,46), which reduces levels of biliary cholesterol and helps prevent cholesterol from precipitating in the bile (39). Specifically, physical activity has been shown to influence a number of hormones including catecholamines, prostaglandins, endorphins, and many pancreatic and gastrointestinal hormones that can increase gallbladder motility (47). Furthermore, physical activity reduces whole gut transit time, which is thought to aid in the proper physiological functioning of the gallbladder, including motility (48).

Several strengths of this study should be noted as well. First, the population-based case-control design and high participation rate (92.7%) reduces potential selection biases. Second, our study is one of the largest studies of gallstone disease with 8,477 cases, which allowed us to evaluate the risk factors, particularly BMI and WHR, at a very detailed level. Third, the use of standardized measurements taken by trained interviewers ensures that the anthropometric variables used in this study are comparable among study participants. Fourth, the detailed information on demographic and other exposure factors that was collected allowed us to minimize confounding by other risk factors. Finally, our study population consists of a large number of subjects with normal and below average BMI, thus increasing the statistical power for studying the effect of central adiposity among non-obese subjects.

There are several potential limitations in our study. Because of the cross-sectional nature of data, the temporality of the observed associations cannot be determined and no causal inferences can be made. Self-reported gallstones are subject to misclassification; however, we expect that it would be non-differential since both cases and controls may have had silent gallstones. One major limitation of our study is the potential disease effect on the reporting and measurement of overall as well as central obesity. As diagnosis of gallstone can change patients' diet, causing wasting and weight loss, cases might be expected to have lower body weight than controls. However, we found that cases actually had a higher BMI and WHR than controls, suggesting that both weight and waist circumference in our cases had not been greatly affected by gallstones. In addition, when analyses were performed using self-reported data for weight at age 50 (7 years earlier than the mean age of diagnosis) as well as when analyses were stratified by year of diagnosis of gallstone (e.g., <5 years vs. ≥5 years before baseline), the results were comparable to those reported in this article (data not shown). Another major concern for this study is the potential error in dietary assessment. The FFQ used in this study, however, was validated for its ability to estimate dietary intakes, including total caloric intake and total fat intake (22), and because of the prospective design of this study, the potential error in dietary assessment is likely to be random. In addition, although we attempted to measure all conceivable confounding effects, we cannot exclude the possibility that there is residual confounding or unknown confounders.

In summary, our study further supports that BMI and WHR are positively associated with gallstone disease, independently of each other, among middle-aged and elderly Chinese women. In contrast, physical activity was inversely related to gallstone risk. Together these modifiable risk factors may point to strategy for the prevention of gallstone disease and its less common but more deadly sequela, gallbladder cancer.

Selected Abbreviations and Acronyms

BMI	body mass index
CI	confidence interval
OR	odds ratio
PA	physical activity
WHR	waist to hip ratio

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TABLE 1

Demographic characteristics of cases and controls

Characteristics	Cases, No. (%)	Controls, No. (%)	<i>p</i> Value
Total number of subjects	8,477	16,954	
Age, yr			
40–49	2473 (29.2)	4942 (29.2)	
50–59	2311 (27.3)	4659 (27.5)	
60–65	2131 (25.1)	4245 (25.0)	
66–70	1562 (18.4)	3108 (18.3)	0.985
Education level			
≤Elementary school	1321 (13.8)	2334 (15.6)	
Middle school	2146 (23.4)	3974 (25.3)	
High school	2526 (30.5)	5169 (29.8)	
College +	2482 (32.3)	5474 (29.3)	0.001
Monthly income (yuans)			
<10,000	1492 (17.6)	3106 (18.3)	
10,000–19,999	3162 (37.3)	6482 (38.2)	
20,000–29,999	2312 (27.3)	4491 (26.5)	
>30,000	1507 (17.8)	2873 (17.0)	0.036
Marital status			
Married	7311 (86.3)	14618 (86.2)	
Other	1166 (13.8)	2336 (13.8)	0.959
No. of full-term pregnancies			
0–1	1619 (19.1)	3267 (19.3)	
2	1894 (22.3)	3867 (22.8)	
3	1898 (22.4)	3756 (22.2)	
4	1524 (18.0)	3049 (18.0)	
5–12	1542 (18.2)	3015 (17.8)	0.863
Menopausal status			
Premenopausal	5585 (65.9)	10540 (62.2)	
Postmenopausal	2892 (34.1)	6411 (37.8)	0.001

TABLE 2

Risk of gallstone disease associated with usual BMI and WHR

	Cases, No. (%)	Controls, No. (%)	OR (95% CI)*	OR (95% CI)†
Deciles of BMI‡				
D0	604 (7.1)	1694 (10.0)	(Reference)	(Reference)
D1	638 (7.5)	1688 (10.0)	1.1 (0.9–1.2)	1.0 (0.9–1.1)
D2	698 (8.2)	1726 (10.2)	1.1 (1.0–1.3)	1.0 (0.9–1.2)
D3	721 (8.5)	1687 (10.0)	1.2 (1.1–1.4)	1.1 (0.9–1.2)
D4	830 (9.8)	1638 (9.7)	1.5 (1.3–1.7)	1.3 (1.1–1.4)
D5	905 (10.7)	1733 (10.2)	1.5 (1.3–1.7)	1.3 (1.1–1.5)
D6	874 (10.3)	1694 (10.0)	1.5 (1.3–1.7)	1.3 (1.1–1.4)
D7	935 (11.0)	1694 (10.0)	1.6 (1.4–1.8)	1.3 (1.2–1.5)
D8	1082 (12.8)	1687 (9.7)	1.9 (1.7–2.2)	1.6 (1.4–1.8)
D9	1183 (14.0)	1701 (10.0)	2.2 (1.9–2.4)	1.7 (1.5–1.9)
<i>p</i> for trend			<0.001	<0.001
Deciles of WHR§				
D0	526 (6.2)	1633 (9.6)	(Reference)	(Reference)
D1	669 (7.9)	1759 (10.4)	1.2 (1.0–1.4)	1.1 (1.0–1.3)
D2	758 (8.9)	1661 (9.8)	1.4 (1.3–1.6)	1.4 (1.2–1.5)
D3	680 (8.0)	1485 (8.8)	1.5 (1.3–1.7)	1.4 (1.2–1.6)
D4	888 (10.5)	1883 (11.1)	1.5 (1.3–1.7)	1.4 (1.2–1.5)
D5	885 (10.4)	1750 (10.3)	1.6 (1.4–1.9)	1.4 (1.3–1.6)
D6	909 (10.7)	1765 (10.4)	1.7 (1.5–1.9)	1.5 (1.3–1.7)
D7	929 (11.0)	1617 (9.5)	1.9 (1.7–2.2)	1.6 (1.4–1.8)
D8	1031 (12.2)	1692 (10.0)	2.1 (1.8–2.3)	1.7 (1.5–1.9)
D9	1202 (14.2)	1709 (10.1)	2.5 (2.2–2.8)	1.9 (1.7–2.2)
<i>p</i> for trend			<0.001	<0.001

OR = odds ratio; CI = confidence interval; BMI = body mass index; WHR = waist-to-hip ratio.

* Adjusted for year of birth, age at diagnosis, education, family income, total caloric intake, total fat intake, number of full-term pregnancies, and menopausal status.

† In addition to variables mentioned above, also adjusted for BMI or WHR.

‡ Cut-off point for deciles of BMI: D0, 0–20.08; D1, 20.08–21.37; D2, 21.37–22.31; D3, 22.31–23.19; D4, 23.19–24.03; D5, 24.03–24.94; D6, 24.94–25.92; D7, 25.92–27.07; D8, 27.07–28.80; D9, 28.80–48.96.

§ Cut-off point for deciles of WHR: D0, 0–0.75; D1, 0.75–0.77; D3, 0.77–0.79; D4, 0.79–0.8; D5, 0.8–0.81; D6, 0.81–0.83; D7, 0.8272727–0.8421053; D8, 0.84–0.86; D9, 0.86–0.89; D9, >0.89.

TABLE 3
Risk of gallstone disease in relation to WHR and usual BMI in Shanghai, China, 1997–2000

	Quintile of usual BMI*									
	Q1		Q2		Q3		Q4		Q5	
	Ca/Co	OR (95% CI)†	Ca/Co	OR (95% CI)†	Ca/Co	OR (95% CI)†	Ca/Co	OR (95% CI)†	Ca/Co	OR (95% CI)†
WHR§										
Q1	466/1558	1.00	284/832	1.05 (0.96–1.16)	218/485	1.28 (1.17–1.42)	1.28 (1.17–1.42)	1.31 (1.20–1.45)	86/206	1.66 (1.20–1.45)
Q2	346/789	1.25 (1.14–1.37)	318/869	1.24 (1.09–1.47)	324/643	1.76 (1.45–12.08)	1.76 (1.45–12.08)	1.69 (1.40–2.03)	211/338	2.31 (1.89–2.83)
Q3	209/550	1.28 (1.17–1.40)	358/789	1.57 (1.33–1.84)	423/873	1.70 (1.45–1.98)	1.70 (1.45–1.98)	1.84 (1.57–2.12)	380/641	2.22 (1.88–2.62)
Q4	141/333	1.41 (1.29–1.56)	266/552	1.71 (1.41–2.04)	391/749	1.88 (1.59–2.22)	1.88 (1.59–2.22)	1.76 (1.51–2.06)	605/839	2.74 (2.36–3.19)
Q5	80/152	1.68 (1.53–1.85)	193/371	1.87 (1.51–2.30)	379/621	2.29 (1.94–2.71)	2.29 (1.94–2.71)	2.55 (2.20–2.96)	983/1364	3.82 (2.47–5.23)
<i>p</i> for trend¶		<0.001		<0.001		<0.001		<0.001		<0.001
<i>p</i> for interaction										0.03

WHR = Waist-to-hip ratio; BMI = body mass index; Q = quintile; Ca/Co = cases/controls; OR = odds ratio; CI = confidence interval.

* Cut-off point for quintile of BMI: Q1, <21.36; Q2, 21.36–23.23; Q3, 23.23–24.97; Q4, 24.97–27.12; Q5, >27.12.

† Adjusted for year of birth, age at diagnosis, education, family income, total caloric intake, total fat intake, number of full-term pregnancies, and menopausal status.

‡ *p* for trend across BMI categories within each group of WHR.

§ Cut-off point for quintile of WHR: Q1, <0.77; Q2, 0.77–0.80; Q3, 0.80–0.83; Q4, 0.83–0.86; Q5, >0.86.

¶ *p* for trend across WHR categories within each group of BMI.

TABLE 4

Risk for gallstone disease associated with physical activities

Physical activity	Cases, No. (%)	Controls, No. (%)	OR (95% CI)*	p for trend
Occupational physical activity (OPA) physical activity				
Cumulative energy expenditure (kJ/min) [†]				
Q1	2430	4441	(Reference)	
Q2	2099	3942	1.0 (0.9–1.1)	
Q3	2103	4428	0.9 (0.8–1.0)	
Q4 (high)	1844	4142	0.8 (0.7–0.9)	0.03
Cumulative sitting time (hours over lifetime) [‡]				
Q1	2069	4594	(Reference)	
Q2	2019	4087	1.1 (1.0–1.2)	
Q3	2078	3985	1.2 (1.1–1.3)	
Q4 (high)	2310	4287	1.3 (1.1–1.4)	0.01
HPA (hours per day) [§]				
Q1	1621	2925	(Reference)	
Q2	2636	5277	0.9 (0.8–1.0)	
Q3	2106	4159	0.9 (0.9–1.0)	
Q4 (high)	2114	4593	0.7 (0.6–0.8)	0.02

Q = Quartile; HPA = Housework Physical Activity; for other abbreviations, see Table 2.

* Adjusted for year of birth, age at diagnosis, education, family income, total caloric intake, total fat intake, BMI, WHR, menopausal status, and the number of full-term pregnancies.

[†] Cut-off points for quartile of cumulative energy expenditure: Q1, 0; Q2, 0–109; Q3, 109–270; Q4, ≥270.

[‡] Cut-off points for quartile of cumulative sitting time: Q1, 0–28; Q2, 28–64; Q3, 64–112; Q4, ≥112.

[§] Cut-off points for quartile of housework hours: Q1, 0; Q2, 0–1; Q3, 2–3; Q4, ≥4.