BDA The Association of UK Dietitians
THE OFFICIAL JOURNAL OF THE BRITISH DIETETIC ASSOCIATION
Journal of Human Nutrition and Dietetics

RESEARCH PAPER

A nested case–control study on dietary fat consumption and the risk for gallstone disease

A. Bertola Compagnucci,[1] H. A. Perroud,[2] S. M. Batallés,[3] R. Villavicencio,[3] A. Brasca,[3] D. Berli[4] & S. M. Pezzotto[1]

[1]Instituto de Inmunología, Facultad Ciencias Médicas, Consejo de Investigaciones, Universidad Nacional de Rosario, Rosario, Argentina
[2]Instituto de Genética, Facultad Ciencias Médicas, Universidad Nacional de Rosario, CONICET, Rosario, Argentina
[3]Fundación Dr JR Villavicencio, Rosario, Argentina
[4]Cátedra de Gastroenterología, Facultad Ciencias Médicas, Universidad Nacional de Rosario, Rosario, Argentina

Keywords
case–control study, dietary fat, ethnicity, gallstones disease.

Correspondence
S. M. Pezzotto, Facultad de Ciencias Médicas, UNR, Santa Fe 3100 – 2000 Rosario, Argentina.
Tel.: +54 341 4804569
Fax: +54 341 4804569
E-mail: spezzot@unr.edu.ar

How to cite this article
Bertola Compagnucci A., Perroud H.A., Batallés S.M., Villavicencio R., Brasca A., Berli D. & Pezzotto S.M. (2015) A nested case–control study on dietary fat consumption and the risk for gallstone disease. *J Hum Nutr Diet*.
doi:10.1111/jhn.12332

Abstract

Background: Gallstone disease (GD) incidence and prevalence rates differ between populations. Diet and lifestyle may be involved in GD development. To our knowledge, no study to date has evaluated quantitative data on diet when studying the relationship between fat consumption levels and GD in an Argentinean population. The present study aimed to assess the association between dietary fat intake and GD.
Methods: A nested case–control study design was applied. Data were taken from subjects who participated in a previous cross-sectional study carried out in a random sample of asymptomatic people in Rosario, Argentina. Participants underwent a personal interview, and current weight and height, ancestor's ethnicity, and socio-economic status were recorded. Applying a food-frequency questionnaire and a food photography atlas, quantitative dietary data were estimated by combining the intake frequency, portion size and food composition. Logistic regression analysis was used to compute odds ratios and 95% confidence intervals adjusted by age, sex, ancestor's ethnicity, body mass index and daily total energy intake as potential confounders.
Results: In total, 114 patients were studied (49 cases and 65 controls), without any statistically significant differences for age, sex, socio-economic status, body mass index and ancestry. The mean energy intake was higher in cases than in controls, and significant differences were found for dietary fat consumption. Obese or overweight people have a higher GD risk than subjects with normal weight. Increased GD risks were associated with high intakes of energy, total fat, and saturated and monounsaturated fatty acids.
Conclusions: According to our results, total fat, saturated and monounsaturated fatty acids high intakes are associated with increased GD risk.

Introduction

Gallstone disease (GD) is an important cause of morbidity around the world. Epidemiological studies have been carried out in different countries to assess GD prevalence, showing that its rates differ among populations [1–5]. These differences are stronger when comparing Eastern and Western populations, suggesting that ethnicity may play a major role in their differences [2,3,6]. However, in a study reporting GD prevalence in different ethnic groups living in the USA, GD rates were high for American Indians, followed by Hispanic and non-Hispanic whites, and were lower for non-Hispanic black women. Moreover, GD prevalence was similar between Hispanic and non-Hispanic white men but was lower for all other ethnic male groups [7]. In a study carried out in New Zealand [8], the ethnic groups with the highest GD prevalence rates were Europeans (51%), followed by Asians (23%) and Maori/Pacific individuals (18%).

In Argentina, there are no epidemiological studies showing the actual prevalence of GD on its population, with a high proportion of European immigrant descendants, until a cross-sectional study with a representative sample population was conducted in the city of Rosario [9]. GD was diagnosed in 20.5% of the population and was more frequent in females. It was positively associated with age and body mass index (BMI) in both sexes, and with hypertriglyceridaemia and the number of pregnancies in women. Prevalence rates were also compared among subjects with different ethnic origins regarding ancestors' nationalities, and with rates reported in European populations. Patients with Italian or Spanish ancestors have higher GD prevalence rates than those described in studies carried out in Italy and Spain, for all age groups [9]. For young people (20–39 years old), it was found that GD prevalence rates were lower either for Italian or Spanish groups than those from the other groups. These differences disappeared when considering groups of older subjects. This may be because, over time, immigrants behaviours may become more alike the population in the country where they live [10].

Some external factors (i.e. diet and lifestyle) are probably involved in GD development [11]. Some studies suggest that obesity and diets high in energy, cholesterol, fatty acids or carbohydrates, which are characteristic of the Western diet, increase GD risk. By contrast, diets with high levels of fibre, ascorbic acid, unsaturated fat, vegetables, protein, nuts and calcium intake appear to reduce GD risk [11–15]. After the Second World War, the Western diet was spread throughout the world, leading to changes in the traditional diets of countries where GD is currently a prevalent disease. For example, a shift from pigment to cholesterol stones was observed in Asian countries after this dietary change [2]. Gallstones have also become increasingly prevalent in Saudi Arabia after the acquisition of a Western-type diet [16]. In Japan, gallstone incidence has risen significantly in the last 50 years, representing a period in which there was an increase in fat intake and a decrease in carbohydrate and crude fibre consumption [17]. In a cross-sectional study carried out in Iran, a low GD prevalence was found. It may be because the Iranian population has a diet characterised by vegetables, cereals, flour, fruit and dairy products [18,19].

By considering the Argentinean diet characteristics, the food pattern consumption of GD patients was analysed in a previous study [20]. It was found that total energy; cholesterol and protein mean intakes are higher than the respective National Recommendations (RDAs). When analysing the percentage contributed by macronutrients to total energy value, protein accounted for 18%, fat accounted for 41% and carbohydrate accounted for 41%. If these results are compared with the RDAs, it is observed that the contribution of fat to the total energy intake is excessive.

The present study aimed to assess the influence of dietary fat consumption levels on GD risk in Rosario, Argentina.

Materials and methods

A nested case–control study was carried out among participants from a cross-sectional study aiming to investigate GD prevalence in randomly selected adults living in Rosario City. Rosario is the third largest city in Argentina. Almost all of its inhabitants descend from immigrants, mainly from Italy, Spain, other European countries and the Middle East. The studied sample from which the cases and controls were selected is described elsewhere [9]. Data collection was carried out between January and December 2014.

Diagnostic method

Ultrasound in the right upper quadrant is the best method to diagnose GD. This non-invasive, safe and widely available, low cost practice has more than 95% sensitivity and specificity to detect gallbladder stones [5,21]. At the health centre, all fasting subjects were studied by an ultrasound examination of the upper abdomen (liver, gallbladder, biliary duct, pancreas, spleen and kidneys). Subjects were examined in the supine, prone, left decubitus, and standing positions.

Case subject definition and identification

Cases of GD were defined as those subjects whose cholelithiases were diagnosed at the time of the previous study, or had evidence of cholecystectomy for gallstones. Gallstones were defined as the presence of one or more echogenic movable structures within the gallbladder in the ultrasound study. Cases of cholecystectomy were defined as those subjects with a cholecystectomy background, absence of a gallbladder in the ultrasound study and the presence of a surgical scar.

Control subject selection for the nested case–control study

Control subjects were randomly selected from all subjects without GD diagnostic in the previous cross-sectional study. A new ultrasound examination was carried out in these subjects (23 controls went on to become cases after the new ultrasound study), generating a disproportion between numbers of cases and controls.

The interview

Cases and controls were interviewed using a personal structured questionnaire. The interview was designed to collect information about the subject demographic variables, ethnicity of their ancestors, socio-economic status, physical activity, smoking habit, current weight and height, and usual diet. BMI was calculated as weight (kg) divided by squared height (m). Healthy weight was defined as a BMI between 18.5 and 24.9 kg/m^2, overweight was defined as a weight between 25 and 30 kg/m^2 and a weight >30 kg/m^2 was defined as obese.

Dietary measurements

Food intake was measured with a 210-item Food-Frequency Questionnaire (FFQ) that has been developed and validated for estimating essential nutrients in Argentina [22]. A standardised photographic atlas was used to determine food portions [23]. The reference period of the dietary intake was five years before diagnosis for cases and usual diet before interview for controls. On average, each interview lasted 45 min.

The FFQ is one of the best methods of quantifying dietary intake in epidemiological studies, providing valid and representative information on the usual frequency of food intake. It allows the classification of people based on their food or nutrient intake levels. It is a low cost instrument and is structured to facilitate data analysis [24–26].

All the information provided by the FFQ was analysed with NUTRIO, version 2, comprising software developed by an Argentinean research group [27]. It determines each participant's macro and micronutrient intake through food composition tables and using a seasonality factor to adjust the intake frequencies of seasonal foods. It also allows total energy intake to be obtained. The dietary information thus calculated included each person's usual daily intake of energy, total fat, saturated fatty acids, monounsaturated fatty acids and polyunsaturated fatty acids.

Ethical considerations

The project was reviewed and approved by the Ethics Committee of the School of Medicine, National University of Rosario. The investigation was performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki and its later amendments. Prior to their inclusion in the study, written informed consent was obtained from all of the participants.

Statistical analysis

Descriptive data are presented as the Mean ± Standard deviation (SD) or proportions, as appropriate. Continuous measures were compared between groups using an independent sample Student's *t*-test. The normal distribution of data was analysed using a Shapiro–Wilk test, with an accepted significance level >0.05. Categorical variables were analysed using chi-squared or Fisher's exact test, where appropriate. Nutrients were analysed both as continuous variables and as categorical variables. The daily Mean ± Standard deviation (SD) values for total energy intake and macro- and micronutrient intakes were calculated. Statistical differences in daily macro- and micronutrient average intakes between cases and controls were evaluated using linear models, adjusting for total energy consumption.

Unconditional logistic regression adjusting for potential confounders was used to estimate specific nutrient consumption effects on GD risk by quantifying odds ratios (OR) and corresponding 95% confidence intervals (CI). Subjects were stratified according to their dietary fat consumption levels (lower or higher than the median of the control group) and the group of subjects with low consumption was established as reference value for the OR calculation. Possible confounders were evaluated based on changes in estimates of association, and likelihood ratio tests of nested models. Characteristics previously associated with GD in the former cross-sectional study, sex, age and BMI, were included in the models as covariates. Total energy intake was also included. Other potential confounders were evaluated but not included in the final models because they had little or no impact on ORs (i.e. inclusion of these factors in the final models changed point estimates for ethnicity by ≤10%). To test for interaction between two risk factors, a cross-product term was added to the logistic model and a likelihood ratio test between the model with and without the cross-product term was conducted.

$P < 0.05$ (two-sided) was considered statistically significant. Statistical analyses were performed using STATA, version 9.1 (Stata Corp., College Station, TX, USA).

Results

A total of 114 patients (49 cases and 65 controls) were included in the present study. The distribution of selected demographic and potential confounding factors by disease status is summarised in Table 1. There were no between-group differences in age, sex, socio-economic status, BMI and ancestry.

No differences were found between cases and controls according to socio-economic status. Furthermore, when analysing the ethnicity group, no differences were found

Table 1 Basic demographic data and characteristics of cases and controls

Characteristic	Cases (*n* = 49)	Controls (*n* = 65)	*P*
Age (years), mean (SD)	50.5 (14.0)	52.5 (15.6)	0.478
Body mass index (kg m^{-2}), mean (SD)	27.8 (5.5)	26.9 (6.4)	0.459
Sex, *n* (%)			
Male	17 (34.7%)	24 (36.9%)	0.806
Female	32 (65.3%)	41 (63.1%)	
Socio-economic status, *n* (%)			
Low	25 (51.0%)	24 (36.9%)	0.142
Middle	14 (28.6%)	17 (26.2%)	
High	10 (20.4%)	24 (36.9%)	
Ancestor's ethnicity, *n* (%)			
Italian	11 (22.4%)	14 (21.5%)	0.854
Spanish	6 (9.2%)	6 (12.2%)	
Others	32 (65.3%)	45 (69.2%)	

between Italian or Spanish descendents, or those of any other country.

Nutrient consumption is shown in Table 2. Overall, energy intake was higher in the cases. Significant statistical differences were found for all nutrients that were studied.

When means were adjusted for total energy intake, no significant differences were found for daily cholesterol and polyunsaturated fatty acid consumption (Table 3).

No differences were found between cases and controls regarding sex, ethnic group and socio-economic status. Regarding BMI, obese (BMI > 30 kg/m^2) or overweight (BMI = 25–30 kg/m^2) people have a higher GD risk (OR = 2.20; 95% CI = 1.03–4.72; P = 0.044) than those with a normal weight (BMI < 25 kg/m^2).

When subjects were stratified according to their consumption levels with respect to energy consumption, a significant increase in the risk for individuals with high energy consumption was found (OR = 2.22; 95% CI = 1.0420–4.7392; P = 0.039).

Table 2 Crude daily energy, cholesterol and fat consumption [mean (SD)] in cases and controls

	Cases (*n* = 49)	Controls (*n* = 65)	*P*
Total energy (MJ)	13.51 (4.57)	11.30 (3.42)	0.004
Cholesterol (mg)	516.3 (225.7)	423.0 (190.1)	0.019
Total fat (g)	142.9 (57.8)	107.5 (46.9)	<0.0001
Monounsaturated fatty acids (g)	56.6 (24.0)	41.4 (21.0)	<0.0001
Polyunsaturated fatty acids (g)	21.6 (9.2)	15.9 (8.6)	0.001
Saturated fatty acids (g)	59.7 (26.1)	44.1 (21.2)	0.001

Table 3 Daily cholesterol and fat mean consumption [mean (SD)] in cases and controls, adjusted for total energy intake

	Cases (*n* = 49)	Controls (*n* = 65)	*P*
Cholesterol (mg)	468.0 (143.5)	459.3 (141.6)	0.931
Total fats (g)	127.6 (20.3)	118.9 (20.0)	0.001
Monounsaturated fatty acids (g)	50.3 (11.2)	46.1 (10.4)	0.001
Polyunsaturated fatty acids (g)	19.6 (6.3)	17.4 (6.4)	0.165
Saturated fatty acids (g)	53.1 (11.2)	49.0 (11.2)	0.001

Table 4 presents the ORs for GD risk by level of intake of fat from foods. After adjusting for possible confounding variables, a significantly increased risk for GD was found with respect to those with a low intake of the following micronutrients: total fat, monounsaturated fatty acids and saturated fatty acids. Trends without significance were observed for high cholesterol and polyunsaturated fatty acid consumption.

The chance of effect modification in the associations between GD and dietary constituents by sex, BMI and total energy intake was also investigated. No statistically significant interactions were observed for the above potential effect modifiers with respect to the relation between GD and fat intake.

Discussion

Gallstone disease is multifactorial. Environmental risk factors have been identified in many studies, although the influence of diet is still unclear. The identification and control of modifiable risk factors may possibly provide a chance for cholelithiasis prevention.

Nested case–control studies are generally used when disease outcome has been obtained for all cohort subjects, although it is too expensive or difficult to collect and/or process information on covariates of interest for the entire cohort. By sampling a small proportion of the nondiseased subjects, there is high cost efficiency for assessing associations between exposures and disease [28]. In the present study, each total assessment lasted 60 min, on average. The advantages of applying a nested case–control design include convenience, cost-efficiency, high validity and analytic flexibility. By only measuring the covariate in as many participants as necessary, the cost and effort of exposure assessment is reduced. Generally, the only disadvantages of nested case–control studies are the reduced precision and power as a result of the sampling of controls, and the possibility of errors in the sampling design or its implementation [29]. However, the use of this design reduces selection bias because cases and

Table 4 Adjusted odds ratio (OR) and 95% confidence interval (CI) for high cholesterol and fat consumption levels

	OR adjusted for total energy intake			OR adjusted for total energy intake, sex and body mass index		
	OR	*P*	95% CI	OR	*P*	95% CI
Cholesterol (>420 mg)	1.984	0.149	0.782–5.036	1.989	0.156	0.7690–5.147
Total fat (>108 g)	4.447	0.006	1.527–12.954	4.947	0.006	1.566–15.633
Monounsaturated fatty acids (>42 g)	4.410	0.006	1.524–12.765	4.431	0.010	1.429–13.748
Polyunsaturated fatty acids (>17 g)	1.982	0.151	0.779–5.040	1.905	0.191	0.725–5.008
Saturated fatty acids (>44.5 g)	4.313	0.006	1.519–12.247	4.913	0.005	1.606–15.031

controls are sampled from the same population. In the present study, participant and nonparticipant characteristics did not show significant differences, reducing the possibility of the occurrence of selection bias. Furthermore, nutritional information was assessed by an investigator who was blind to case status, aiming to avoid information bias.

Diet may play a role in GD aetiology and may account for some of the worldwide and ethnic variations in GD prevalence rates. A Japanese study conducted between 1971 and 1999 found that the prevalence of GD was correlated with daily energy intake [30]. The association between GD and dietary fat is controversial. However, a high intake of polyunsaturated and monounsaturated fats appears to reduce gallstone disease in the context of an energy-balanced diet [31]. In Argentina, no previous studies analysing diet as a GD risk factor have been carried out. The present nested case–control study conducted within a cross-sectional representative sample in Rosario shows that a high intake of total fat, monounsaturated fatty acids and saturated fatty acids is associated with an increased risk for GD. These results are consistent with reports from other studies conducted in developed countries in the 1990s. A case–control study carried out in Spain found that patients with GD had a higher energy intake and saturated and monounsaturated fat consumption, and a lower consumption of fibre, magnesium and folate, than controls. Particularly, the same study showed that women with GD had a higher consumption of total fat, monounsaturated, saturated and cholesterol than controls [32]. Another case–control study carried out in France found significant differences for energy intake, carbohydrate and saturated fat consumption. When performing risk analysis by stratifying the intake into categories, significant results were obtained for the highest level of total fat intake. In the univariate analysis, total energy intake, total fat and saturated fat intake were considered as GD risk factors, whereas the multivariate analysis showed a significant risk only for total energy intake [33]. Two studies carried out in Italy evaluated diet as a risk factor for cholelitiasis. In a case–control study that considered both diet and physical activity in relation to GD risk, a high consumption of either monounsaturated fat or cholesterol was found to be a protective factor against GD. Moreover, the multiple logistic regression analysis considering both dietary and nondietary variables found that a high saturated fat intake was a risk factor, whereas a high consumption of monounsaturated fat was a protective factor for GD [34]. The MICOL study, an Italian large cross-sectional study, detected a significant negative association between energy intake and risk of cholelithiasis in men, although no significant statistical associations were found for total cholesterol, total fat and saturated and monounsaturated fats when considering both sexes [35]. In men from the Nurse′s Health study, the association between fatty acid consumption and GD was also studied. It was found that men in the highest quintile of trans-fatty acid intake have a 24% increased risk compared to men in the lowest quintile, after adjusting for multiple potential confounding factors [36]. When the effect of cis unsaturated fat intake on GD risk in men was analysed, the relative risk was 0.85 for the group in the highest quintile consumption level compared to men in the lowest quintile, after adjusting for multiple potential confounding variables [31]. Unfortunately, in the present study, we were unable to search for these types of fat.

Many studies have also been carried out in developing countries. In a study from Saudi Arabia in the 1990s, it was found that cases of cholecystectomies have increased by a 978% in the last 30 years. It was proposed that this increase could not be explained by the increase in inhabitants, suggesting that it may be a result of the increment in energy and fat consumption [16]. In a case–control study conducted in India, total energy intake was higher in cases than in controls and the same observation was made for fat consumption, although only in men [37]. In a recent case–control study conducted in India, multivariate analysis shows that total fat intake was a risk factor for GD, although unsaturated fat did not show to be a protective factor for GD [38]. Moreover, an experimental study carried out with patients who received a modified diet 30 days before cholecystectomies (one group with sunflower oil and other with olive oil) showed that controlling the dietary fat intake did not affect the saturation of cholesterol or the bile acid profile in the gallbladder. However, the cholesterol saturation index decreased significantly in patients receiving the olive oil diet. By contrast, for patients in the sunflower group, their bile was oversaturated [39]. In Argentina, sunflower oil is the most widely used oil type.

In the present study, the increased ORs associated with high dietary fat intake were significant for total, saturated and monounsaturated fats, although there was no evidence that total polyunsaturated fatty acid consumption was associated with an increased risk. A possible explanation for these findings might be the dietary pattern of the Argentinean population. In a previous study investigating the dietary pattern in a sample of patients with GD, it was found that the consumption of total fat and dietary cholesterol significantly exceeded recommendations [20]. Our results should be compared with those of studies carried out in Italy and/or Spain, two countries from which most of our ancestors originate. However, no significant differences were found among the different ethnic groups, leading to the conclusion that the genesis of GD is more likely associated with environmental factors.

Conflict of interests, source of funding and authorship

The authors declare that they have no conflicts of interest.
Fundación Dr JR Villavicencio funded the cost of the ultrasonographic studies.
ABC and HAP contributed equally to the present study. ABC, AB and SMP conceived and designed the study ABC, HAP, SMB, RV, DB and SMP carried out the data collection, analyses and interpretation. ABC, HAP and SMP wrote the manuscript. All authors critically reviewed the manuscript and approved the final version submitted for publication.

References

1. Acalovschi M (2001) Cholesterol gallstones: from epidemiology to prevention. *Postgrad Med J* **77**, 221–229.
2. Stinton LM & Shaffer EA (2012) Epidemiology of gallbladder disease: cholelithiasis and cancer. *Gut Liv* **6**, 172–187.
3. Lammert F & Sauerbruch T (2005) Mechanisms of disease: the genetic epidemiology of gallbladder stones. *Nat Clin Pract Gastroenterol Hepatol* **2**, 423–433.
4. Walton TJ & Lobo DN (2009) Gallstones. *Surgery (Oxford)* **27**, 19–24.
5. Portincasa P, Moschetta A & Palasciano G (2006) Cholesterol gallstone disease. *Lancet* **368**, 230–239.
6. Kim MH, Lim BC, Myung SJ *et al.* (1999) Epidemiological study on Korean gallstone disease: a nationwide cooperative study. *Dig Dis Sci* **44**, 1674–1683.
7. Everhart JE (2001) Gallstones and ethnicity in the Americas. *J Assoc Acad Minor Phys* **12**, 137–143.
8. Stringer MD, Fraser S, Gordon KC *et al.* (2013) Gallstones in New Zealand: composition, risk factors and ethnic differences. *ANZ J Surg* **83**, 575–580.
9. Brasca AP, Pezzotto SM, Berli D *et al.* (2000) Epidemiology of gallstone disease in Argentina: prevalences in the general population and European descendants. *Dig Dis Sci* **45**, 2392–2398.
10. Stronks K (2003) Public health research among immigrant populations: still a long way to go. *Eur J Epidemiol* **18**, 841–842.
11. Shaffer EA (2006) Gallstone disease: epidemiology of gallbladder stone disease. *Best Pract Res Clin Gastroenterol* **20**, 981–996.
12. Cuevas A, Miquel JF, Reyes MS *et al.* (2004) Diet as a risk factor for cholesterol gallstone disease. *J Am Coll Nutr* **23**, 187–196.
13. Gaby AR (2009) Nutritional approaches to prevention and treatment of gallstones. *Altern Med Rev* **14**, 258–267.
14. Mendez-Sanchez N, Zamora-Valdes D, Chavez-Tapia NC *et al.* (2007) Role of diet in cholesterol gallstone formation. *Clin Chim Acta* **376**, 1–8.
15. Tseng M, Everhart JE & Sandler RS (1999) Dietary intake and gallbladder disease: a review. *Public Health Nutr* **2**, 161–172.
16. Tamimi TM, Wosornu L, al-Khozaim A *et al.* (1990) Increased cholecystectomy rates in Saudi Arabia. *Lancet* **336**, 1235–1237.
17. Kameda H, Ishihara F, Shibata K *et al.* (1984) Clinical and nutritional study on gallstone disease in Japan. *Jpn J Med* **23**, 109–113.
18. Farzaneh Sheikh Ahmad E, Zavvareh HT, Gharadaghi J *et al.* (2007) Prevalence and characteristics of gallstone disease in an Iranian population: a study on cadavers. *Hepatobiliary Pancreat Dis Int* **6**, 509–512.
19. Djazayery A & Marchesich R (2002) *Nutrition Country Profiles* – IRAN January 23, 2002 FAO, Rome, Italy. Available at: ftp://ftp.fao.org/ag/agn/nutrition/ncp/irnmap.pdf
20. Bertola Compagnucci A, Perroud H, Villavicencio R *et al.* (2012) Patrón de consumo de alimentos en personas con enfermedad colelitiásica. *Arch Latinoam Nutr* **62**, 234–241.
21. Johnson D (2006) Gallstone. *Medicine* **35**, 116–120.
22. Navarro A, Osella AR, Guerra V *et al.* (2001) Reproducibility and validity of a food-frequency questionnaire in assessing dietary intakes and food habits in epidemiological cancer studies in Argentina. *J Exp Clin Cancer Res* **20**, 365–370.

23. Navarro A, Cristaldo PE, Diaz MP *et al.* (2000) Food photography atlas: its suitability for quantifying food and nutrient consumption in nutritional epidemiological research in Cordoba, Argentina. *Rev Fac Cien Med Univ Nac Cordoba* **57**, 67–74.
24. Willett W (1998) *Nutritional Epidemiology*, 2nd edn. Cary, NC: Oxford University Press.
25. Willett WC & Hu FB (2006) Not the time to abandon the food frequency questionnaire: point. *Cancer Epidemiol Biomarkers Prev* **15**, 1757–1758.
26. Serra Majen L & Aranceta J (2007) *Nutrición y Salud Publica: Métodos, bases científicas y aplicaciones*, 2nd edn. Barcelona:Editorial Masson.
27. Peyrano M, Gigena J, Muñoz S *et al.* (1998) A computer software system for the analysis of dietary data in cancer epidemiological research. In: Int Proc Div, 17th International Cancer Congress. pp. 381–384 [Moraes M, Brentani R & Bevilacqua R, editors]. Italy: Monduzzi Editor.
28. Langholz B. (2005) Case–control study, nested. In: *Encyclopedia of Biostatistics*. pp. 646–655 [Colton PAT, editor]. Chichester: John Wiley & Sons.
29. Wacholder S (2009) Bias in full cohort and nested case–control studies? *Epidemiology* **20**, 339–340.
30. Tsunoda K, Shirai Y & Hatakeyama K (2004) Prevalence of cholesterol gallstones positively correlates with per capita daily calorie intake. *Hepatogastroenterology* **51**, 1271–1274.
31. Tsai CJ, Leitzmann MF, Willett WC *et al.* (2004) The effect of long-term intake of cis unsaturated fats on the risk for gallstone disease in men: a prospective cohort study. *Ann Intern Med* **141**, 514–522.
32. Ortega RM, Fernandez-Azuela M, Encinas-Sotillos A *et al.* (1997) Differences in diet and food habits between patients with gallstones and controls. *J Am Coll Nutr* **16**, 88–95.
33. Caroli-Bosc FX, Deveau C, Harris A *et al.* (1999) Prevalence of cholelithiasis: results of an epidemiologic investigation in Vidauban, southeast France. General Practitioner's Group of Vidauban. *Dig Dis Sci* **44**, 1322–1329.
34. Misciagna G, Centonze S, Leoci C *et al.* (1999) Diet, physical activity, and gallstones – a population-based, case–control study in southern Italy. *Am J Clin Nutr* **69**, 120–126.
35. Attili AF, Scafato E, Marchioli R *et al.* (1998) Diet and gallstones in Italy: the cross-sectional MICOL results. *Hepatology* **27**, 1492–1498.
36. Tsai CJ, Leitzmann MF, Willett WC *et al.* (2005) Long-term intake of trans-fatty acids and risk of gallstone disease in men. *Arch Intern Med* **165**, 1011–1015.
37. Tandon RK, Saraya A, Paul S *et al.* (1996) Dietary habits of gallstone patients in Northern India. *J Clin Gastroenterol* **22**, 23–27.
38. Sachdeva S, Khan Z, Ansari MA *et al.* (2011) Lifestyle and gallstone disease: scope for primary prevention. *Indian J Community Med* **36**, 263–267.
39. Yago MD, Gonzalez V, Serrano P *et al.* (2005) Effect of the type of dietary fat on biliary lipid composition and bile lithogenicity in humans with cholesterol gallstone disease. *Nutrition* **21**, 339–347.

