Fish Consumption Among Pregnant Women in London, Ontario

Associations with Socio-demographic and Health and Lifestyle Factors

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ABSTRACT

Background: Intake of fish and omega-3 fatty acids is inversely related to adverse health outcomes; however, these relationships may be confounded by socio-economic status and health behaviours. This study's purpose was to describe the socio-demographic, health and lifestyle correlates of fish consumption among pregnant women.

Methods: Pregnant women (n=2394) completed a telephone interview between 10-22 weeks' gestation (London, Ontario, 2002-5) containing questions on socio-demographic, health and lifestyle variables; dietary intake was measured using a 106-item validated food-frequency questionnaire. Unadjusted and adjusted risk ratios were obtained using a modified Poisson regression model.

Results: Infrequent fish consumption, <1/week, was reported by 32% of women. After adjusting for age and education, infrequent fish consumption was associated with education <high school (RR=1.60; 95% CI 1.30-1.96); age (≤21: RR=1.53; 95% CI 1.17-2.02; 22-25: RR=1.41; 95% CI 1.11-1.78; and 26-34: RR=1.39; 95% CI 1.15-1.69); current smoking status (RR=1.20; 95% CI 1.00-1.43); average exercise duration <30 minutes (never: RR=1.22; 95% CI 1.06-1.39 and 1-29 minutes: RR=1.25; 95% CI 1.08-1.45); obesity (RR=1.19; 95% CI 1.01-1.41); and not meeting Canadian dietary guidelines for consumption of vegetables and fruit (RR=1.60; 95% CI 1.42-1.79), milk products (RR=1.19; 95% CI 1.05-1.36), and meat and alternatives (RR=1.89; 95% CI 1.69-2.12). Compared to frequent fish consumers, infrequent fish consumers were less likely to be moderate drinkers prior to pregnancy (RR=0.85; 95% CI 0.75-0.96).

Conclusion: Infrequent fish consumption was associated with lower socio-economic status and variables indicative of a less healthy lifestyle; these variables may act as confounders in studies evaluating fish consumption and health outcomes.

MeSH terms: Confounding factors (epidemiology); diet; fatty acids, omega-3; fishes; pregnancy

La traduction du résumé se trouve à la fin de l'article.

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Acknowledgements: The authors are grateful to Dr. Guangyong Zou for his assistance with the statistical analysis. This study was supported by a grant from the Canadian Institute of Health Research and Jessica Sontrop was supported by an Ontario Graduate Scholarship in Science and Technology.

Research on the health benefits of fish and omega-3 polyunsaturated fatty acid (n-3 PUFA) intake has increased substantially since the 1970s.¹ Fish consumption is the major source of long-chain n-3 PUFAs, namely, eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), in the Western diet² and is often used as a proxy measure for n-3 PUFA status, which requires more invasive and expensive methods to measure directly.

Fish consumption and n-3 PUFA status are inversely associated with adverse health outcomes. There is strong evidence from both observational and experimental research that n-3 PUFAs are protective against coronary heart disease³ and in several recent cohort studies, fish consumption was inversely associated with risk of ischemic stroke.⁴⁻⁶ There is some evidence to suggest that fish consumption and/or n-3 PUFA status are inversely associated with asthma,⁷ prostate cancer,⁸⁻¹⁰ digestive tract cancers,^{11,12} depression,¹³ social anxiety disorder,¹⁴ hostility,¹⁵ and neurodegenerative conditions such as Alzheimer's disease,¹⁶ dementia,¹⁷ and cognitive decline.^{18,19} Among pregnant women, fish consumption and n-3 PUFA status are inversely associated with pre-eclampsia²⁰ and positively associated with gestational age and birthweight;^{21,22} however, other studies report conflicting results,²³ or associations that were attenuated or lost statistical significance after adjustment for confounders.²⁴

While numerous studies have evaluated fish consumption as a beneficial exposure, only a few have examined the characteristics associated with frequent vs. infrequent fish consumption. These studies show positive associations between fish consumption and socio-economic status (SES) and healthy behaviours,²⁵⁻²⁷ which are important confounders in health outcomes research, and incomplete control may result in biased effect measures. Although the dietary patterns of pregnant women, and in particular, their intake of n-3 PUFAs have been well studied,^{28,29} no study to date has investigated the socio-demographic and lifestyle correlates of fish consumption among pregnant women. Thus, the purpose of this study was to examine fish consumption in relation to socio-demographic, health, and lifestyle variables in a community sample of preg-

nant women, and in particular, to determine whether women of lower SES who engage in unfavourable health behaviours are less likely to consume fish compared to women of higher SES with more favourable health behaviours.

METHODS

Sample and data source

The data for this cross-sectional study came from the Prenatal Health Project (PHP), a prospective cohort study designed to study the psychosocial, nutritional, endocrine, and infectious determinants of preterm birth (2002-2005). Participants were recruited from seven ultrasound clinics in London, Ontario and comprised a sample of English-speaking adult women between 10-22 weeks' gestation. Participants provided written consent and were given a food-frequency questionnaire (FFQ) to complete prior to a scheduled telephone interview conducted by a trained interviewer.

Measures

Information on intake of fish and other foods was obtained using a 106-item semi-quantitative FFQ designed to measure average food intake during the previous month. Many of the foods included in the FFQ were based on one developed for an American study of pregnant women.³⁰ We conducted a validity substudy (n=22) using 3-day food records and food codes from the Canadian Nutrient File;³¹ FFQ items were modified accordingly to reflect the dietary patterns of this population. Other studies have shown moderate to strong correlations between fish consumption measured from FFQs and blood concentrations of EPA and DHA in both pregnant and non-pregnant populations.^{28,32-34}

Fish consumption was measured by summing consumption frequencies across four categories of marine food: canned tuna fish (100g); dark meat fish, e.g., mackerel, salmon, sardines, or bluefish (100g); other fish (100g); and shrimp (3 medium), lobster (1/4 cup cooked), or scallops (3 medium) as a main dish. Fish consumption was dichotomized as <1/week and ≥1/week.²⁵ Participants indicated whether they had made dietary changes since learning they were pregnant or as a result of nausea or vomiting.

TABLE 1

Socio-demographic and Health and Lifestyle Characteristics of the Sample (n=2394)

Socio-demographic Variables (Sample Size)	n* (%)†
Age (years) (n=2394)	
≤21	169 (7.1%)
22-25	310 (12.9%)
26-34	1517 (63.4%)
≥35	398 (16.6%)
Marital Status (n=2393)	
Married	1822 (76.1%)
Common law	380 (15.9%)
Single/separated/divorced	191 (8.0%)
Number of Children (n=2394)	
0	1205 (50.3%)
1-2	1111 (46.4%)
≥3	78 (3.3%)
Highest Level of Completed Education (n=2386)	
Less than high school	129 (5.4%)
High school	555 (23.2%)
College diploma or university degree	1702 (71.1%)
Gross Annual Household Income (n=2394)	
≤\$29,999	285 (11.9%)
\$30,000-\$79,999	1140 (47.6%)
≥\$80,000	854 (35.7%)
No income/refused/didn't know	115 (4.8%)
Occupational Status (n=2345)	
Manual and unskilled workers	497 (20.8%)
Clerical and semi-skilled workers	551 (23.0%)
Semi-professionals	615 (25.7%)
Major and minor professionals	682 (28.5%)
Employment Status (n=2391)	
Employed	1888 (79.0%)
Unemployed	89 (3.7%)
Homemaker	258 (10.8%)
Other (including students)	156 (6.5%)
Health and Lifestyle Variables (Sample Size)	n* (%)†
Smoking Status (n=2391)	
Current smoker	249 (10.4%)
Former smoker	308 (12.9%)
Non-smoker	1834 (76.7%)
Pre-pregnancy Alcohol Consumption (n=2392)	
0 drinks/week	1304 (54.5%)
1-7 drinks/week	1026 (42.9%)
≥8 drinks/week	62 (2.6%)
Pre-pregnancy BMI (n=2290)	
Underweight (<18.5 kg/m ²)	101 (4.4%)
Normal (18.5-24.9 kg/m ²)	1385 (60.5%)
Overweight (25.0-29.9 kg/m ²)	505 (22.1%)
Obese (≥30.0 kg/m ²)	299 (13.1%)
Exercise (average duration) (n=2394)	
Never	700 (29.2%)
1-29 minutes at a time	520 (21.7%)
≥30 minutes at a time	1174 (49.0%)
Meets CFGHE: Grains (n=2374)	
No (<5 servings/day)	1613 (67.9%)
Yes (≥5 servings/day)	761 (32.1%)
Meets CFGHE: Vegetables & Fruit (n=2373)	
No (<5 servings/day)	659 (27.8%)
Yes (≥5 servings/day)	1714 (72.2%)
Meets CFGHE: Dairy (n=2381)	
No (<3 servings/day)	520 (21.8%)
Yes (≥3 servings/day)	1861 (78.2%)
Meets CFGHE: Meats and Alternatives (n=2381)	
No (<2 servings/day)	823 (34.6%)
Yes (≥2 servings/day)	1553 (65.4%)

* Frequencies may not sum to variable total due to missing values on some variables.

† Percent of variable total; percentages may not sum to 100 due to rounding.

Socio-demographic information included: date of birth; number of children; marital and employment status; highest level of completed education; gross annual household income (Canadian \$); and occupational status, which was derived from information on the current or most recent job title/description and was coded using the Hollingshead Occupational Scale³⁵

with help from the National Occupation Classification System.³⁶

Participants indicated the number of cigarettes smoked per day (before and during pregnancy) and were categorized as non-smokers, former smokers (smoker immediately prior to, but not during pregnancy), and current smokers. Other variables included pre-pregnancy alcohol consump-

TABLE II

Bivariate and Adjusted Analyses of Infrequent Fish Consumption in Relation to Socio-demographic Variables

Socio-demographic Variables	Percent who Consume Fish <1/week	Unadjusted RR (95% CI)*	Age & Education Adjusted RR (95% CI)†
Age (years)			
≤21	45.2	1.97 (1.54-2.51)	1.53 (1.17-2.02)
22-25	35.6	1.55 (1.23-1.96)	1.41 (1.11-1.78)
26-34	32.3	1.40 (1.16-1.71)	1.39 (1.15-1.69)
≥35	23.0	reference	reference
Marital Status			
Single/separated/divorced	35.8	1.16 (0.95-1.42)	n.s.
Common law	36.0	1.17 (1.00-1.36)	
Married	30.8	reference	
Number of Children			
0	32.3	n.s.	n.s.
1	33.3		
2	29.6		
≥3	22.4		
Highest Level of Completed Education			
Less than high school	55.8	1.88 (1.59-2.23)	1.60 (1.30-1.96)
High school	33.8	1.14 (0.99-1.31)	1.06 (0.92-1.23)
College diploma/university degree	29.7	reference	reference
Gross Annual Household Income			
≤\$29,999	34.5	1.24 (1.02-1.51)	n.s.
\$30,000-\$79,999	33.5	1.22 (1.06-1.39)	
≥\$80,000	27.5	reference	
Occupational Status			
Manual and unskilled workers	38.0	1.36 (1.15-1.61)	n.s.
Clerical and semi-skilled workers	31.6	1.13 (0.95-1.35)	
Semi-professionals	31.1	1.11 (0.94-1.32)	
Major and minor professionals	27.9	reference	
Employment Status			
Unemployed	39.8	1.30 (1.00-1.69)	n.s.
Other	38.1	1.24 (1.01-1.54)	
Homemaker	36.3	1.19 (0.99-1.41)	
Employed	29.6	reference	

* Modified Poisson regression; reference category: fish consumption ≥1/week.

† Modified Poisson regression; reference category: fish consumption ≥1/week. Age is adjusted for education; education is adjusted for age.

tion; pre-pregnancy body-mass index (BMI), calculated from self-reported height and weight ($BMI = \text{weight(kg)}/\text{height(m)}^2$);³⁷ and physical activity, where participants indicated whether and for how long at a time they exercised currently (never, 1-29, or ≥30 minutes) where exercise was defined as “planned recreational activities undertaken for fitness reasons.” FFQ responses were categorized according to minimum intake guidelines from Canada’s Food Guide to Healthy Eating (CFGHE).³⁸ FFQ items not part of CFGHE food groups were not included in this analysis.

Statistics

Explanatory variables included socio-demographic and health and lifestyle variables. Logistic regression for assessing the adjusted odds ratio is widely used when the event of a dichotomous outcome is rare; however, the relative risk may be overestimated when the outcome is common. Therefore, this study used the modified Poisson regression model, which allows the adjusted risk ratio to be estimated direct-

ly.³⁹ Risk ratios (RR) described the likelihood of consuming fish <1/week for a particular variable category relative to the likelihood of consuming fish ≥1/week in the referent category. Data were analyzed using SAS statistical software package Version 9 (SAS Institute, Inc.) and SPSS 14.0.

RESULTS

Of 3,656 eligible women approached to be in the PHP, 2,747 (75.1%) provided written consent. Of these, 2,421 completed the telephone interview (88.1% of recruited; 66.2% of eligible), for an overall response rate of 66.2%. Since recruitment lasted three years, some women were recruited twice for different pregnancies ($n=27$); one of each of these interviews was randomly excluded in order to preserve statistical independence, resulting in a final sample size of 2,394.

Infrequent fish consumption, <1/week, was reported by 32.0% of participants. Canned tuna was the most frequently consumed; 32.1% ate tuna ≥1/week, followed by other fish (15.3%), dark meat fish

(13.4%) and finally shrimp, lobster, and scallops (7.4%). The average age of participants was 30.1 years and 84% were born in Canada. While 92.4% reported taking a nutrient or vitamin supplement, only 31 (1.3%) participants used supplements containing n-3 PUFAs (e.g., flax seed oil, fish oil, or omega-3 supplements). With regards to dietary changes in general, 0.7% reported eating more fish since the start of pregnancy and 1.0% reported eating less. In response to nausea and/or vomiting caused by pregnancy, 1.5% reported eating less fish and 0.08% reported eating more fish.

Descriptive statistics for the socio-demographic and health and lifestyle variables are presented in Table I. The unadjusted and adjusted regression analyses of fish consumption and socio-demographic, health and lifestyle variables are presented in Tables II and III, respectively. With the exception of grain consumption, each of the health and lifestyle variables remained significantly associated with fish consumption after adjustment for age and education (Table III).

DISCUSSION

This is the first study to examine the characteristics associated with fish consumption in a community sample of pregnant women. After adjusting for age and education, infrequent fish consumption was associated with education <high school; younger age; current smoking status; physical inactivity; obesity; and not meeting CFGHE for consumption of vegetables and fruit, milk products, and meat and alternatives. Compared to frequent fish consumers, infrequent fish consumers were less likely to be moderate drinkers prior to pregnancy.

These results are consistent with other similar research in which positive associations were observed between fish consumption and indicators of SES, including education,^{25-27,40} occupational status,^{26,27} and income.²⁵ Positive associations were also observed between fish consumption and age,^{25,27} physical activity,²⁷ and intake of vegetables and fruit.^{25,27} In studies that used factor analysis to characterize dietary patterns, regular fish consumption was consistently identified as a component of healthy dietary patterns, which were also

high in vegetables, poultry, whole grains, legumes and low-fat dairy products.⁴¹⁻⁴⁴ In comparison, less healthy patterns were high in red and processed meats, high-fat dairy products, sweets, refined grains, and saturated fats. Healthy dietary patterns were also associated with higher SES and desirable profiles for smoking, BMI, physical activity, and several plasma biomarkers, including cholesterol. These studies highlight the problem of analyzing intakes of single foods or nutrients in relation to disease risk; such analyses fail to account for the potential correlations and interactions with other dietary components.⁴⁵ Thus it may be difficult to isolate the health effects of fish and n-3 PUFA intake from their relation to the diet as a whole in observational epidemiologic studies. It is clear, however, that not all of the apparent health benefits of fish consumption are the result of confounding; evidence from randomized controlled trials supports a beneficial role for n-3 PUFAs in treating cardiovascular disease,³ depression,¹³ and inflammatory disorders such as rheumatoid arthritis and inflammatory bowel disease.²

In this study, participants consumed an average of 1.7 fish servings/week (SD 1.9) or 22.8 g/day (SD 25.7). This is similar to two recent studies of Canadian and American pregnant women that used FFQs to measure fish consumption, which reported average servings/week of 1.5 (SD 0.9) and 1.7 (SD 1.6), respectively.^{28,46} Internationally, fish consumption is highly varied and Canada appears to be on the lower end of the spectrum.⁴⁷ In a comparison of 10 European countries, women in Spain and Norway consumed the most fish (approximately 62 g/day and 51 g/day, respectively) and women in The Netherlands and Germany consumed the least (approximately 13 g/day and 16 g/day, respectively).⁴⁸

The strengths of this study include its relatively large sample size, community-based recruitment strategy, and comprehensive measurement of socio-demographic, health and lifestyle variables; however, several limitations are of note. The semi-quantitative FFQ used in this study included pre-specified portion sizes, which required respondents to modify and adjust their frequency responses accordingly and as a result, some degree of misclassification is inevitable,⁴⁹ which may result in attenuated effect measures.⁵⁰ As well, self-report

TABLE III

Bivariate and Adjusted Analyses of Infrequent Fish Consumption in Relation to Health and Lifestyle Variables

Health and Lifestyle Variables	Percent who Consume Fish <1/week	Unadjusted RR (95% CI)*	Age & Education Adjusted RR (95% CI)†
Smoking Status			
Non-smoker	30.5	reference	reference
Former smoker	31.2	1.02 (0.85-1.22)	0.91 (0.76-1.10)
Current smoker	44.5	1.46 (1.25-1.71)	1.20 (1.00-1.43)
Pre-pregnancy Alcohol Consumption			
0 drinks/week	34.6	reference	reference
1-7 drinks/week	28.6	0.83 (0.73-0.94)	0.85 (0.75-0.96)
≥8 drinks/week	35.0	1.01 (0.71-1.44)	0.87 (0.61-1.23)
Pre-pregnancy BMI			
Underweight (<18.5 kg/m ²)	31.3	1.01 (0.75-1.37)	1.08 (0.68-1.25)
Normal (18.5-24.9 kg/m ²)	31.0	reference	reference
Overweight (25.0-29.9 kg/m ²)	31.7	1.02 (0.88-1.19)	1.03 (0.89-1.20)
Obese (≥30.0 kg/m ²)	36.8	1.19 (1.00-1.41)	1.19 (1.01-1.41)
Exercise (duration)			
Never	35.3	1.25 (1.09-1.43)	1.22 (1.06-1.39)
1-29 min	36.2	1.28 (1.11-1.48)	1.25 (1.08-1.45)
≥30 min	28.3	reference	reference
Meets CFGHE: Grains			
<5 servings/day	33.0	n.s.	n.s.
≥5 servings/day	30.0		
Meets CFGHE: Vegetables & Fruit			
<5 servings/day	44.8	1.65 (1.47-1.85)	1.60 (1.42-1.79)
≥5 servings/day	27.2	reference	reference
Meets CFGHE: Dairy			
<3 servings/day	37.7	1.24 (1.09-1.41)	1.19 (1.05-1.36)
≥3 servings/day	30.5	reference	reference
Meets CFGHE: Meats and Alternatives			
<2 servings/day	46.9	1.95 (1.74-2.18)	1.89 (1.69-2.12)
≥2 servings/day	24.1	reference	reference

* Modified Poisson regression; reference category: fish consumption ≥1/week.

† Modified Poisson regression adjusted for age and education; reference category: fish consumption ≥1/week.

data are often subject to systematic misreporting in the direction of more socially desirable responses, such as with smoking status and weight; however, in the case of smoking, research suggests that while pregnant smokers may under-report the number of cigarettes smoked, they do not deny smoking outright.^{51,52} Misreporting of dietary intake measured from FFQs among women follows predictable patterns: fat and total energy intake tend to be under-reported relative to protein and carbohydrate intake.^{49,53} Although this represents a potential source of measurement error, it may be lessened by the use of relative vs. absolute measures of intake.⁵⁴ Finally, information on physical activity only captured planned activities undertaken for fitness reasons, which excluded other forms of exercise such as house and yard work or walking to work.

There is some evidence to suggest that pregnant women consume less fish due to health advisories recommending the avoidance of certain fish species due to mercury exposure;⁵⁵ however, only 1% of participants in this study reported eating less fish since becoming pregnant and 0.7% reported eating more.

A growing body of research suggests that it is not solely the status of n-3 PUFAs that predicts health outcomes, but the ratio of n-6 to n-3 PUFAs, where a high ratio is positively associated with depression, inflammation, autoimmune diseases, and cardiovascular disease.^{2,13} Although n-6 PUFA intake was not measured in this study, future research should examine whether a high intake of n-6 PUFAs relative to n-3 PUFAs varies with socio-demographic and health and lifestyle factors.

This study found that infrequent fish consumption was associated with lower SES and variables indicative of a less healthy lifestyle in a large, representative sample of pregnant women in Southwestern Ontario. This information is important from a public health standpoint, but also to inform future research. SES is an important confounder in health research as it is a powerful predictor of morbidity, mortality, and healthy behaviours.^{56,57} Associations between fish consumption and several health and lifestyle variables persisted after control for age and education; thus future studies investigating health outcomes in relation to fish consumption should control for these variables

in order to protect against biased effect measures due to confounding.

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Received: June 14, 2006

Accepted: January 29, 2007

RÉSUMÉ

Contexte : La consommation de poisson et d'acides gras oméga-3 est inversement proportionnelle aux résultats sanitaires indésirables, mais le statut socioéconomique et les habitudes de santé pourraient être des facteurs confusionnels. Nous avons voulu décrire la corrélation entre le profil sociodémographique, l'état de santé et le mode de vie, d'une part, et la consommation de poisson, d'autre part, chez les femmes enceintes.

Méthode : De 2002 à 2005, des femmes enceintes entre la 10^e et la 22^e semaine de gestation (N=2 394) ont participé à une entrevue téléphonique à London (Ontario) sur des questions de nature sociodémographique, ainsi que sur la santé et le mode de vie; l'apport alimentaire des répondantes a été mesuré à l'aide d'un questionnaire validé sur la fréquence de consommation de 106 produits alimentaires. Les risques relatifs rajustés et non rajustés ont été calculés à l'aide d'un modèle de régression de Poisson modifié.

Résultats : Chez 32 % des femmes, la consommation de poisson était occasionnelle (moins d'une fois par semaine). Après normalisation des résultats selon l'âge et l'instruction, la consommation occasionnelle de poisson était associée à un faible niveau d'instruction (moins qu'un diplôme d'études secondaires) (RT=1,60; IC de 95 % = 1,30-1,96); à l'âge (21 ans ou moins : RT=1,53; IC de 95 % = 1,17-2,02; 22 à 25 ans : RT=1,41; IC de 95 % = 1,11-1,78; 26 à 34 ans : RT=1,39; IC de 95 % = 1,15-1,69); à l'usage actuel du tabac (RT=1,20; IC de 95 % = 1,00-1,43); à une période moyenne d'activité physique inférieure à 30 minutes (aucune activité : RT=1,22; IC de 95 % = 1,06-1,39; 1 à 29 minutes d'activité : RT=1,25; IC de 95 % = 1,08-1,45); à l'obésité (RT=1,19; IC de 95 % = 1,01-1,41); et au non-respect des directives canadiennes de consommation des fruits et des légumes (RT=1,60; IC de 95 % = 1,42-1,79), des produits laitiers (RT=1,19; IC de 95 % = 1,05-1,36) et des viandes et substituts (RT=1,89; IC de 95 % = 1,69-2,12). Par rapport aux femmes qui consommaient souvent du poisson, les consommatrices occasionnelles étaient moins susceptibles d'avoir eu une consommation d'alcool modérée avant de tomber enceintes (RT=0,85; IC de 95 % = 0,75-0,96).

Conclusion : La consommation occasionnelle de poisson était associée à un statut socioéconomique plus faible et à des variables indicatives d'un mode de vie moins sain; ces variables pourraient être des facteurs confusionnels dans les études qui portent sur la consommation de poisson et les résultats sanitaires.

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