Does consumption of different categories of seafood affect birthweight? The HUMIS study.

Rosa F. Fristad[1], Merete Eggesbø[1], Hein Stigum[1], Per Magnus[1]

[1]Norwegian Institute of Public Health, Oslo

Introduction

Seafood is an important part of a healthy diet. Polyunsaturated fatty acids present in seafood play an essential role in the development of the central nervous system, of special importance to the brain development. The long chain n-3 fatty acids have also been reported to increase gestational length[1]. Fish intake during pregnancy has been associated with both increased birthweight and gestational length[2,3]. Birthweight is considered to be a predictor of a number of disorders in infant and adult life.

However, negative effects may arise in connection with fish and shellfish intake. Seafood can be a major source of environmental contaminants, and correspondingly, adverse effects on pregnancy outcomes have been reported[4,5,6]. In contrast, in a publication review carried out on the relationship between PCBs and related chemicals on several pregnancy outcomes, Kimbrough & Krouskas claim that none of the reviewed studies provided evidence on the existence of adverse effects on birthweight[7].

Distinction between consumption of different types of seafood and its relation to pregnancy outcomes is scarce in the literature. Since the source of environmental contaminants is mainly in the marine fat, and that fat content potentially differ in the various categories of seafood items, it is plausible that different categories of seafood may have distinct health effects on fetal growth and gestational length.

The objective of this study was to investigate the consumption of three major categories of seafood (fatty fish, lean/half-fatty fish and shellfish), potentially differing in their content of environmental toxicants, and its effects on pregnancy outcomes, specifically, birthweight and gestational length.

Materials and Methods

This study is based on the “The human milk study, HUMIS”, a population-based birth cohort of Norwegian women. We used a sample of 645 mothers consecutively recruited 1-2 weeks after birth when they were visited at home by a health visitor, during 2003. Four counties in Norway were included: Rogaland, Telemark, Troms and Østfold. The mothers were given a questionnaire to fill out when the child was 1 month of age. The questionnaire provided information about the mothers socio-economic status, pregnancy complications and outcomes and nutritional habits during the last year. Only singleton births were used in the analysis.

Outcome variables and covariates: The outcome variables were birthweight, in grams obtained in the questionnaire and gestational length, in days, calculated using the expression: (birth date – term date) + 280. Information on the consumption of fish/shellfish was obtained during the last year. The mothers indicated the number of fishmeals (dinner meal and/or bread meal, the latter estimated as half a portion of the dinner meal) consumed : 1) never, 2) per week, 3) per month or 4) per year. The measures were converted to the number of fish/shellfish dinner meals per year. Maternal seafood intake was categorised as: (~~(~~a) fatty fish - mackerel, salmon, trout and herring; (~~(~~b) half-fat/lean fish - halibut, flounder, codfish, coal-fish, haddock, pike, perch and processed fish, ex. Fish sticks, pudding and (~~(~~c) shellfish - mussel, prawn and crab.

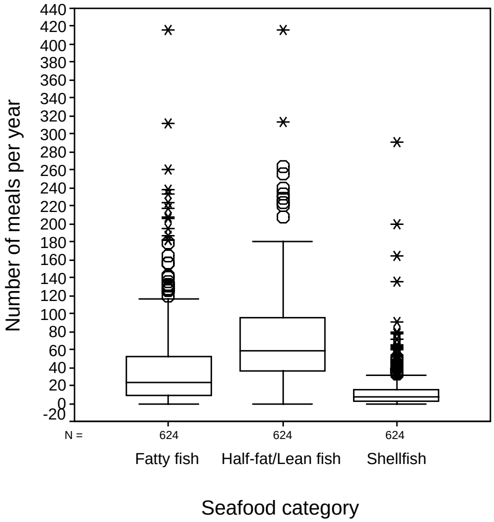
Possible confounders of birthweight were considered: maternal age, calculated at the time of child birth; educational level, (9 school years, 10-11 years, 12 years, 13-15 years, ≥16 years); height, measured in centimetres; body mass index (BMI) before pregnancy, BMI = weight (kg) / [(height (m) x height (m)]; daily smoking, no/yes; nationality, not Norwegian/Norwegian; parity, 0/1; gender of the child and cod liver oil intake (yes/no).

Statistical methods: T-tests were used for comparison of mean birthweight and mean gestation length and linear regression to investigate the relationship between birthweight and the intake of seafood. The regression models were tested for homogeneity of variances and possible departure from linearity. Potential confounders were included in the analysis. Robustness to outliers was tested using delta-beta plots. The statistical data program - SPSS for Windows (v.11.0) was used.

Results and Discussion

Frequency of seafood intake: Half-fat/lean fish was consumed often with a median of 57 meals or less per year (once a week) (Fig.1). Fatty fish and shellfish were consumed more seldom with a median of 24 meals and 7 meals of per year, respectively (Fig.1). All distributions are skewed with a few mothers showing high seafood consumption.

Figure 1: Seafood consumption according to seafood category among 624 pregnant women.



Gestational length: Shellfish and half-fat/lean fish intake and daily smoking did not have a significant effect on gestational length. On the contrary, consumption of fatty fish significantly decreased gestational length: -0,03 days decrease per consumed meal per year, [95% CI: -0,06; -0,004 g]; ($P < 0.05$) (Table 1). Previous studies have reported that consumption of fatty acids from fish has beneficial effects on gestational length but this association was absent for higher intakes of fish[8].

Table 1: Gestational length, in days, according to daily smoking and seafood category. The unadjusted analysis shows number of subjects (N), mean gestational length in days, and P-value for differences between categories. The adjusted analysis shows estimated coefficients (B) with confidence intervals (CI), based on linear regression.

		Bivariate (unadjusted)			Adjusted coefficients			
Variable		**N**	**Mean (days)**	**P-value**	**B**	**Confidence interval (95%)**		**P-value**
All		633	275					
Maternal smoking (daily)				0,657				
	no	493	276					
	yes	42	277		-0,1	(-4,3	; 4,1)	0,971
Fatty fish				0,058				
	<=52	470	276					
	>52	153	273					
	+1 meal/year				-0,03	(-0,06	; -0,004)	0,028
Half-fat/Lean fish				0,263				
	<=52	289	274					
	>52	338	276					
	+1 meal/year				0,007	(-0,02	; 0,03)	0,605
Shellfish				0,602				
	<=52 x	605	275					
	>52	21	277					
	+1 meal/year				0,04	(-0,02	; 0,11)	0,154
Cod liver oil				0,417				
	<=52 x	329	275					
	>52	286	276					
	+1 dose/year				0,004	(-0,01	; 0,01)	0,390

Notes: Analysis was adjusted for the confounding variables: parity, BMI before pregnancy, maternal age, maternal education, maternal height, gender of the child and cod liver oil.

Birthweight by maternal smoking: The effect of maternal smoking was a 31g decrease in birthweight per meal per year (Table 2), which is a somewhat smaller effect than otherwise reported[9]. The effect was not statistically significant probably due a combination of a small study sample and small number of cigarettes smoked in the smoking group.

Birthweight by fatty fish: Results of the linear regression showed that there was a decrease in birthweight as consequence of fatty fish consumption, however, this association was not significant (P> 0.05) (Table 2). Previously, a decrease in birthweight at higher doses of seafood with high fatty acid content has been reported[10], although the effect has not been related to seafood contaminants.

Table 2: Birthweight, according to gestational length, daily smoking and seafood category. The unadjusted analysis shows number of subjects (N), mean birthweight in grams and P-value for differences between categories and the adjusted analysis shows estimated change in birthweight (B), with confidence intervals (CI), based on linear regression.

		Bivariate (unadjusted)			Adjusted coefficients		
Variable		**N**	**Mean (g)**	**P-value**	**B**	**Confidence interval (95%)**	**P-value**
All		630	3565				
Gestational length				0,000			
	<=280	373	3339				
	>280	253	3897				
	+1 day				29	(26 ; 32)	0,000
Maternal smoking (daily)				0,340			
	no	488	3597				
	yes	43	3498		-31	(-158 ; 97)	0,633
Fatty fish				0,237			
	<=52	469	3587				
	> 52	150	3511				
	+1 meal/year				-0,4	(-1,3 ; 0,5)	0,398
Half-fat/Lean fish				0,053			
	<=52	285	3505				
	> 52	337	3613				
	+1 meal/year				1,0	(0,2 ; 1,9)	0,015
Shellfish				0,538			
	<=52 x	601	3569				
	> 52x	20	3473				
	+1 meal/year				-1,8	(-3,7 ; 0,04)	0,055
Cod liver oil				0,304			
	<=52 x	329	3534				
	> 52x	281	3591				
	+1 dose/year				0,2	(-0,1 ; 0,4)	0,129

Notes: Analysis was adjusted for the confounding variables: parity, BMI before pregnancy, maternal age, maternal education, maternal height, gender of the child and cod liver oil.

Birthweight by half-fat/lean fish: In the linear regression, birthweight significantly increased along with increasing number of fish meals per year: 1,0 g increase in birthweight per consumed meal per year, [95% CI: 0,2; 1,9 g]; (P< 0.05), (Table 2). Consumption of lean fish has not been associated with higher levels of marine contaminants[11,12].

Birthweight by shellfish: Consumption of shellfish was inversely correlated with birthweight and estimated –1,8g reduction per meal per year. This association was borderline significant (P= 0.055). The amount of environmental toxicants present in shellfish, in particular dioxins, is among the highest reported in food items accounted for human consumption[13]. Especially in the crustacea category, with the exception of shrimps[14].

Birthweight by cod liver oil: Results showed no significant effect of consumption of cod liver oil, either on birthweight or gestational length.

We observed a marked difference between fatty fish and half-fat/lean fish consumption and its effect on birthweight. Fat content in fish is determinant of the environmental contaminants present in the fish. In fact, Atuma *et al*. registered low levels of organochlorine compounds in cod (lean fish) from Baltic Sea, in spite of finding high levels of contaminants in other species of fish with high fat content, in the same area[11]. Among the various seafood categories, fatty fish is expected to have higher levels of the omega-3 fatty acids[15]. Therefore, the health effects of each category of seafood may dependen on the balance between the level of contaminants and the content of omega-3 fatty acids.

Our results suggest the need for further investigation concerning the different categories of seafood (fish and shellfish) - and the subcategories within - and its effects on pregnancy outcomes. Further research on seafood and pregnancy outcomes need to take into account the type of seafood with regard to its fat content and consequently its level of environmental contaminants.

Acknowledgements
This work was supported by funds from the Research Council of Norway.

References

1 Allen K.G. and Harris M.A. (2001) Exp. Biol. Med (Maywood.) 226, 498.
2 Petridou E., Stoikidou M., Diamantopoulou M., Mera E., Dessypris N., and Trichopoulos D. (1998) Child Care Health Dev. 24, 229.
3 Olsen S.F. and Secher N.J. (2002) BMJ 324, 447.
4 Patandin S., Koopman-Esseboom C., de Ridder M.A., Weisglas-Kuperus N., and Sauer P.J. (1998) Pediatr. Res. 44, 538.
5 Rylander L., Stromberg U., and Hagmar L. (2000) Chemosphere 40, 1255.
6 Karmaus W. and Zhu X. (2004) Environ. Health 3, 1.
7 Kimbrough R.D. and Krouskas C.A. (2001) Regul. Toxicol. Pharmacol. 34, 42.

8 Olsen S.F., Hansen H.S., Sommer S., Jensen B., Sorensen T.I., Secher N.J., and Zachariassen P. (1991) Am. J. Obstet. Gynecol. 164, 1203.
9 Olsen S.F., Grandjean P., Weihe P., and Videro T. (1993) J. Epidemiol. Community Health 47, 436.
10 Grandjean P., Bjerve K.S., Weihe P., and Steuerwald U. (2001) Int. J. Epidemiol. 30, 1272.
11 Atuma S.S., Linder C.E., Wicklund-Glynn A., Andersson O., and Larsson L. (1996) Chemosphere 33, 791.
12 Furberg A.S., Sandanger T., Thune I., Burkow I.C., and Lun E. (2002) J. Environ. Monit. 4, 175.
13 Takekuma M., Saito K., Ogawa M., Matumoto R., and Kobayashi S. (2004) Chemosphere 54, 127.
14 Jensen E. and Bolger P.M. (2001) Food Addit. Contam 18, 395.
15 Robb-Nicholson C. (2002) Harv. Womens Health Watch. 10, 8.