Age, Period, or Birth Cohort: What Determines Demographic Differences in Seafood Consumption?

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Abstract. Effects of age, period and birth cohort on consumption of fat fish, lean fish and processed fish were estimated based on panel data from the Norwegian Women and Seafood Consumption Study (NOWAC). Cohorts selected for the present analysis were women born between 1951 and 1966. Survey questionnaires were mailed to a stratified random sample from the Norwegian population registry in 1996 and 2001. Complete data sets for both periods were obtained from N = 4590 respondents**.** Data were analyzed by means of multivariate linear models. Results indicate that overall consumption of fat fish and processed fish increased between 1996 and 2001, while consumption of lean fish decreased. All three period effects were stable across birth cohorts. Estimation of polynomial contrasts indicated that birth cohort itself had linear effects on consumption, with older generations consuming significantly more fat and lean fish, but less processed fish than younger generations. Finally, the effects of cohort and period on consumption of lean and processed fish remained stable when biological age was controlled for, whilst the effect of period on fat fish consumption vanished. Regarding total consumption of fat fish, the relative size of the effects suggests that either (a) a positive effect of period is neutralized by a negative effect of birth cohort, resulting in a zero net effect for the period under investigation, or (b) that both effects are peripheral, caused by an underlying biological-ageing effect. Total consumption of lean fish, on the other hand, is clearly falling in Norway, whereas total consumption of processed fish is rising, suggesting clear areas for marketing action.

Keywords: seafood consumption, panel study, cohort analysis, Norway, marketing

1. INTRODUCTION

Previous studies have consistently found that seafood consumption increases with consumers' age. This has been demonstrated for countries such as the US (Nayga & Capps, 1995), Taiwan (Li, Huston, Wang & Lee, 2000), Norway (Myrland, Trondsen, Johnston & Lund, 2000; Olsen, in press), and Denmark (Grunert, Bisp, Bredahl, Sørensen & Nielsen, 1996). Due to the cross-sectional design of these studies, however, it is still unknown if "age" is to be understood as a cohort effect, a period effect, or an effect of biological ageing.

Cross-sectional designs confound the possible meanings of the variable "age" (Baltes, 1968; Blalock, 1967): is age to be understood in terms of birth cohort, meaning that – due to shared historical experiences – people born earlier in the twentieth century have developed a stronger habit of consuming seafood than people born later in the twentieth century? Or is age to be understood in terms of biological age, meaning that older people always consume more seafood, independent of the year in which they were born, for example due to age-related differences in the regulation of endocrine systems that may in turn affect the frequency or intensity of food cravings? From a longitudinal perspective, age-related differences may even have a third interpretation: supply of seafood may vary as a function of time period, inducing a spurious correlation between age and consumption (Mason, Mason, Winsborough & Poole, 1973).

The aim of the present study was to separate these effects. Given that the demographic balance of Western societies is changing towards a higher proportion of elderly consumers, the relative contribution of age, period and cohort effects has serious implications for the development of total seafood consumption:

- If cohort were the underlying cause, a general ageing of society would imply decreasing consumption levels over time as older, high-consumption cohorts are dying away.
- If period were the underlying cause, increase or decrease over time would depend on the existence and shape of a general trend.
- If biological age were the underlying cause, the ageing of society would imply increasing consumption levels over time.

Table 1. Observed means (number of seafood dinners per month; corresponding standard deviations in parentheses) as a function of birth cohort, seafood type and consumption period.

	Fat fish		Lean fish		Processed fish		
Birth cohort	Period 1996	Period 2001	Period 1996	Period 2001	Period 1996	Period 2001	*N*
1951	2.22 (2.13)	2.70 (2.55)	4.53 (3.24)	3.78 (3.02)	2.91 (2.07)	4.34 (2.90)	428
1952	2.28 (2.39)	2.41 (2.58)	4.58 (3.49)	3.65 (2.75)	3.08 (2.16)	4.55 (3.22)	360
1953	2.57 (2.80)	2.50 (2.29)	4.29 (2.95)	3.80 (2.74)	3.04 (2.42)	4.57 (3.32)	424
1954	2.37 (2.42)	2.45 (2.45)	4.10 (2.82)	3.39 (2.84)	2.98 (1.92)	4.35 (3.23)	392
1955	2.24 (2.18)	2.35 (2.16)	4.28 (3.07)	3.44 (2.74)	3.14 (2.34)	4.41 (3.11)	410
1956	1.90 (2.08)	2.12 (2.51)	3.96 (3.25)	3.43 (2.89)	3.01 (2.17)	4.49 (3.29)	235
1957	1.88 (2.03)	2.27 (2.02)	3.98 (3.07)	3.33 (2.39)	3.18 (1.77)	4.84 (3.14)	217
1958	2.06 (2.10)	2.32 (2.31)	4.27 (3.22)	3.61 (3.18)	3.13 (2.33)	4.73 (3.43)	259
1959	2.16 (2.63)	2.24 (2.14)	3.85 (3.01)	3.24 (2.26)	3.31 (2.38)	4.48 (2.86)	249
1960	1.87 (2.20)	2.29 (2.62)	4.08 (3.08)	3.39 (2.95)	3.46 (2.52)	4.66 (3.27)	243
1961	2.06 (2.46)	2.11 (2.30)	3.94 (2.97)	3.13 (2.66)	3.48 (2.47)	4.97 (3.34)	290
1962	1.88 (2.10)	2.05 (2.38)	3.82 (3.10)	3.13 (2.85)	2.99 (2.27)	4.64 (3.21)	249
1963	1.86 (2.37)	2.06 (2.32)	4.15 (3.23)	3.16 (2.36)	3.36 (2.43)	4.84 (3.13)	292
1964	1.88 (1.96)	1.97 (2.04)	3.30 (2.66)	3.13 (2.35)	3.10 (2.44)	4.75 (3.19)	290
1965	1.70 (2.13)	1.93 (1.80)	3.57 (3.20)	3.18 (2.66)	3.26 (2.37)	4.65 (3.15)	252
Total	2.11 (2.31)	2.29 (2.33)	4.09 (3.11)	3.42 (2.74)	3.14 (2.28)	4.59 (3.18)	4590

2. METHOD

The Norwegian Women and Seafood Consumption Study (NOWAC) is a joint epidemiological and seafood consumption panel of Norwegian women. It could be argued that the nature of the data set means that conclusions are only valid for women. However, earlier studies show that there is no difference between the sexes regarding seafood consumption levels in Norwegian households (Myrland, 1998; Fagerli & Wandel, 1999). Nayga and Capps (1995) observed the same relation in the U.S. at home market for fish and shellfish. Furthermore, the female adult member is still the most likely person to make food purchase decisions for the household.

2.1 Data Collection

A random sample of women born between 1951 and 1966 was drawn from the Central Person Register kept by Statistics Norway. The Register contains information on all persons living in Norway, including temporary residents. All persons have a unique identification number consisting of six digits for the birth date (day, month, and year) and a five-digit number used for a control algorithm that includes information on gender. In addition, the register contains information on name, address, citizenship, and marital status.

Survey questionnaires for the first wave of the panel study were mailed in January 1996. Each woman was asked to return the completed questionnaire, together with an informed consent statement for later linkage to national health registers. Those unwilling to participate were asked to return the uncompleted questionnaire. After six weeks, a reminder was mailed to those who had not returned the original invitation. *N* = 6941 women returned the questionnaire. The sample was representative for the female population of Norway belonging to the birth cohorts 1951-1966. Survey questionnaires for the second wave were mailed in January 2001 to those who had returned the questionnaire in 1996 and had agreed to be contacted again for participation in the second wave. *N* = 5223 women returned the questionnaire.

2.2 Measures

Seafood consumption was measured separately in relation to three categories: fat fish (salmon, herring etc.), lean fish (cod etc.), and processed fish (fish cakes, sticks, puddings etc.). Consumption was determined by asking "For each of the listed food items please indicate how many meals you on average consumed during the last year." Participants indicated their consumption frequencies on eight-point scales with response categories (1) "almost never or never", (2) "once a month", (3) "two to three times a month", (4) "once a week", (5) " twice a week", (6) "three times a week", (7) "four to five times a week", and (8) "six to seven times a week". Taking category midpoints, the categorical responses were transformed into metric responses (number of meals per month) prior to the analysis. Missing data were deleted listwise. Complete data sets for both periods were obtained from *N* = 4590 participants. Means and standard deviations are presented in Table 1.

2.3 Analysis

A well-known problem in cohort analysis is the confounding of the variables age, period and birth cohort. It always holds that *age* = *period* – *cohort*, *period* = *cohort* + *age*, and *cohort* = *period* – *age*, that is, when any two of the variables are known, the third one is completely determined.

Attempts to solve the age-period-cohort problem have been numerous (e.g., Glenn, 1977; Mason et al., 1973; Palmore, 1978; Rogers, 1982). However, as convincingly demonstrated by Glenn (1976), any such attempt can only yield estimable parameters if it imposes constraints on the model that all too often are as theoretically questionable as they are empirically falsified (e.g. absence of interaction effects, equality of parameters over adjacent cohorts and/or periods, etc.).

Therefore, the present analysis will follow the method traditionally favored by applied cohort analysts (see Baltes, 1968; Schaie, 1965), estimating two of the three effects simultaneously (period and cohort), including their interaction, and conduct additional post-hoc analyses to explore whether interpretation in terms of the effect that was omitted from the actual model (biological age) will change the conclusions from the analysis. Visual methods will be utilized to simplify interpretation (Glenn, 1977).

Table 2. Differences in seafood consumption as a function of birth cohort, seafood type and consumption period: Omnibus tests.

Source	Type III sum of squares	*df*	Mean square	*F*	*p*	eta^2
Between-subjects effects						
Intercept	92285.90	1	92285.90	19085.13	.000	.807
Birth cohort	159.18	14	11.37	2.35	.003	.007

Error	22122.35	4575	4.84			
Within-subjects effects						
Seafood type	15895.14	2	7947.57	1057.13	.000	.188
Seafood type x birth cohort	870.30	28	31.08	4.13	.000	.012
Error (seafood type)	68790.22	9150	7.52			
Period	707.91	1	707.91	140.62	.000	.030
Period x birth cohort	65.94	14	4.71	.94	.519	.003
Error (period)	23032.02	4575	5.03			
Seafood type x period	4945.68	1.94	2546.62	583.78	.000	.113
Seafood type x period x birth cohort	124.77	27.19	4.59	1.05	.391	.003
Error (seafood type x period)	38758.63	8884.91	4.36			

Note. Within-subjects effects are Huynh-Feldt corrected. Total $N = 4590$.

3. RESULTS

Data were analyzed by means of multivariate linear models, including birth cohort (1951, 1952, … 1966) as a between-subjects factor, and period (1996, 2001) and seafood type (fat fish, lean fish, processed fish) as within-subjects factors. Model parameters were estimated by means of ordinary least squares (SPSS procedure GLM) using Type III partitioning of the total sum of squares. Omnibus test results are presented in Table 2.

A highly significant main effect was found for seafood type. Averaged over both periods, the highest level of consumption was found for processed fish (estimated marginal mean = 3.889 meals per month, *SE* = .033), followed by lean fish (estimated marginal mean = 3.716, *SE* = .038), and finally fat fish (estimated marginal mean = 2.156, *SE* = .029). Differences between seafood types explained 18.8% of the total variance in seafood consumption (as indicated by the effect size measure, eta^2).

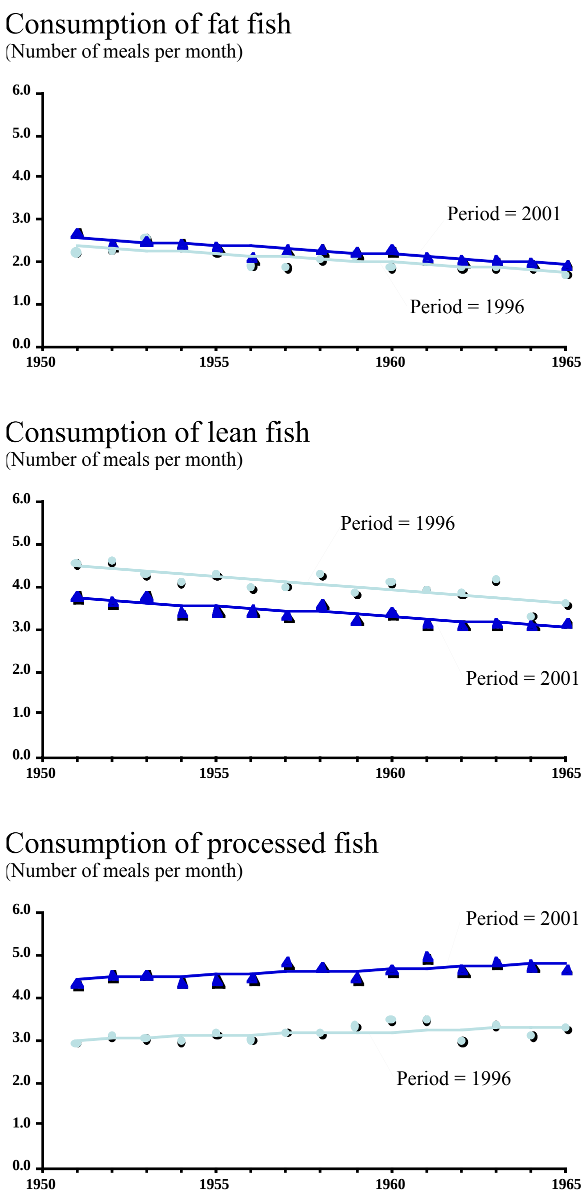

Figure 1. Linear effects of birth cohort on consumption of fat, lean and processed fish within consumption periods 1996 and 2001.

3.1 Cohort Effects

Birth cohorts differed significantly in their overall consumption of seafood. To estimate the functional form of the relationship, a series of polynomial contrasts was imposed on the matrix of between-subjects effects. The linear contrast was highly significant ($p < .001$). All higher-order polynomial contrasts remained insignificant, indicating that the relationship was indeed linear.

However, the size of the overall differences between birth cohorts was rather small. The main effect explained a mere 0.7% of the total variance of seafood consumption. In part, this can be attributed to the fact that seafood type was a highly significant moderator of the cohort effect. Earlier birth cohorts consumed significantly more fat and lean fish than later birth cohorts, but less processed fish. The interaction explained 1.2% of the total variance of seafood consumption.

Estimation of linear effects of birth cohort on consumption yielded regression coefficients of $b = -.044$ ($SE = .008$, $t = -5.718$, $p < .001$) for fat fish in the 1996 period, $b = -.045$ ($SE = .008$, $t = -5.914$, $p < .001$) for fat fish in the 2001 period, $b = -.062$ ($SE = .010$, $t = -6.012$, $p < .001$) for lean fish in the 1996 period, and $b = -.047$ ($SE = .009$, $t = -5.198$, $p < .001$) for lean fish in the 2001 period. For processed fish, on the other hand, the analysis yielded estimates of $b = .023$ ($SE = .008$, $t = 3.095$, $p < .01$) in the 1996 period, and $b = .029$ ($SE = .011$, $t = 2.731$, $p < .001$) in the 2001 period.

The fitted regression lines are shown in Figure 1. The absence of significant interactions involving both cohort and period (see Table 2) suggests that all cohort effects were stable across consumption periods.

3.2 Period Effects

The regression lines in Figure 1 also indicate that seafood consumption shifted considerably between the 1996 and 2001 periods. Total consumption increased from an estimated marginal mean of 9.276 meals per month in 1996 ($SE = .075$) to an estimated marginal mean of 10.254 in 2001 ($SE = .087$). The main effect of period was highly significant (see Table 2), explaining 3% of the total variance in seafood consumption.

Again, the main effect was qualified by a highly significant interaction (see Table 2) with seafood type. Consumption of fat fish increased (estimated marginal mean in 1996 = 2.060 meals per month, $SE = .035$; estimated marginal mean in 2001 = 2.251, $SE = .035$), whereas consumption of lean fish decreased (estimated marginal mean in 1996 = 4.047, $SE = .047$; estimated marginal mean in 2001 = 3.386, $SE = .041$).

The strongest simple effect, however, was an upward surge in the consumption of processed fish (estimated marginal mean in 1996 = 3.161, $SE = .034$; estimated marginal mean in 2001 = 4.617, $SE = .048$). The interaction between period and seafood type explained 11.3% of the total variance in seafood consumption. As already indicated, the absence of any interactions involving period *and* cohort suggests that all period effects were stable across birth cohorts.

3.3 The Role of Biological Age

Strictly speaking, the interpretation of the above results as “true” cohort and period effects can only be maintained if biological age can be ruled out as an influence. Since this is analytically impossible (see Section 2.3), we will choose a pragmatic approach, centering on the notion whether the *conclusions* drawn from the results remain invariant when biological age is offered as an alternative explanation.

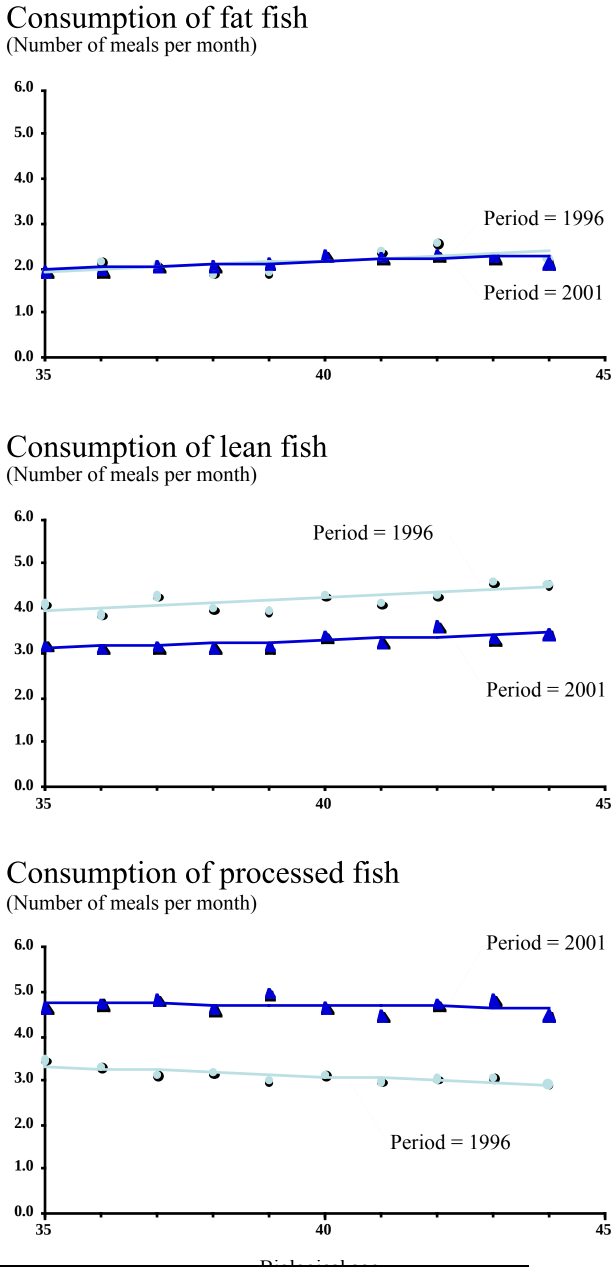

Figure 2. Linear effects of biological age on consumption of fat, lean and processed fish within consumption periods 1996 and 2001.

For this, we will utilize graphical methods (see Glenn, 1977). Figure 2 shows linear regression lines for the relationship between seafood consumption levels and biological age within periods 1996 and 2001. Regarding lean fish and processed fish consumption, the interpretation is straightforward: even when biological age is controlled for (instead of birth cohort), the shift between consumption periods 1996 and 2001 is essentially the same. Lean fish consumption has clearly decreased over time, whereas processed fish consumption has clearly increased.

Responsible for this clarity is the fact that, in both cases, all possible explanations for the overall trend point into the same direction: lean fish consumption is lower in later birth cohorts, lower among younger people, and lower in later consumption periods. Independent of the "true" underlying reasons, the conclusions will therefore be the same. Exactly the opposite pattern is found for processed fish consumption, which is higher in later birth cohorts, higher among younger people, and higher in later consumption periods.

Fat fish consumption, however, cannot be interpreted in such a straightforward manner. Figure 2 indicates that, when biological age is controlled for (instead of birth cohort), the period effect vanishes.

Two explanations are possible for this phenomenon: either (a) a positive effect of period is neutralized by a negative effect of birth cohort of the same absolute value, resulting in a zero net effect for the periods under investigation, or (b) both effects are peripheral, caused by an underlying biological age effect. Based on the present data alone, neither of the alternative explanations can be ruled out.

4. DISCUSSION AND CONCLUSIONS

The aim of the present study was to clarify what the often observed correlation between age and seafood consumption actually means: is age to be understood as an effect of birth cohort, consumption period, or biological age in a narrow sense?

Unlike earlier, cross-sectional studies (e.g., Grunert et al., 1996; Li et al., 2000; Myrland et al., 2000; Nayga & Capps, 1995; Olsen, in press), which necessarily confounded the potential influences of age, period, and birth cohort, we employed a panel design. Longitudinal approaches cannot resolve the confounding problem in age-period-cohort analyses completely (Glenn, 1976), but help reduce ambiguity to a degree that is pragmatically often acceptable.

One of the key results of the present analysis is the need to distinguish between different types of seafood. We found that the size as well as the direction of trends diverged between fat fish (e.g., salmon, herring), lean fish (e.g., cod), and processed fish (e.g., fish cakes, sticks, puddings). Two patterns are clearly identifiable:

- Processed fish consumption is rising in Norway. Consumption levels were found to be higher in later birth cohorts, among younger people in general, and in later consumption periods. Hence, the conclusion remains invariant under all different interpretations of the age-period-cohort problem.
- Lean fish consumption is falling in Norway. Consumption levels were found to be lower in later birth cohorts, among younger people in general, and in later consumption periods. Again, the conclusion remains invariant under all different interpretations of the age-period-cohort problem.

Fat fish consumption, on the other hand, remains ambiguous. Based on the present analysis, we cannot decide whether (a) an increase over time periods is partially cancelled out by a decrease over birth cohorts, leaving a biological age effect as a mere residual, or (b) whether a positive relationship with biological age is the true and only underlying effect. Future research may clarify this question, especially when longer time periods with narrower intervals are investigated.

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