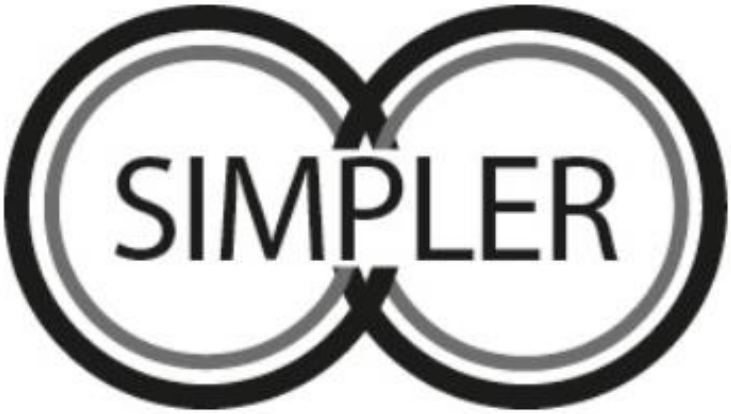


METHODS

QUESTIONNAIRES

Contents

The SIMPLER cohorts

The Swedish Infrastructure for Medical Population-based Life-course and Environmental Research (SIMPLER) is based on two large cohorts, the Swedish Mammography Cohort (SMC) and Cohort of Swedish Men (COSM), and their subcohorts, Swedish Mammography Cohort Clinical subcohort (SMCC) and Cohort of Swedish Men Clinical subcohort (COSMC). The questionnaires used in the SIMPLER cohorts are designed to collect data on diet, lifestyle and health (1). This document describes the development and content of the questionnaires and evaluation of their validity.

Questionnaires in the main cohorts

1987 questionnaire

From 1987 through 1990, women in SMC answered the 1987 Questionnaire that included a Food Frequency Questionnaire (FFQ) section and eight additional health related questions.

Questionnaire:	1987 Questionnaire – women	
Cohort:	SMC	
Years:	1987-1990	
Content:	▪ 67-item FFQ (incl. alcohol) ▪ Marital status ▪ Education	▪ Height & weight ▪ Number of children ▪ Breast cancer in family

1997 questionnaires

In 1997, an extended version of the questionnaire (with twenty-six items in the FFQ section and twenty-one questions on health, physical activity and socioeconomic status added), the 1997 Questionnaire – women, was sent to the same cohort. The extended version was adjusted to male participants (1997 Questionnaire – men) and sent to all COSM participants during 1997 and 1998.

Questionnaire:	1997 Questionnaire – women	1997 Questionnaire – men	
Cohort:	SMC	COSM	
Year:	1997	1997-1998	
Content:	▪ 96-item FFQ (incl. alcohol) ▪ Physical activity & exercise ▪ Smoking & tobacco use ▪ Education & occupation	▪ Dietary supplements ▪ Height & weight ▪ Weight/weight loss history ▪ Hip & waist circumference	▪ Medication use ▪ Diagnoses ▪ Cancer in family ▪ Sleep
Sex-specific content:	SMC ▪ Cohabiting status ▪ Menstruation ▪ Infertility treatment ▪ Contraceptive pills ▪ Estrogen therapy	COSM ▪ Marital status ▪ Urination ▪ Prostate problem medication ▪ Feeling of anger	

Questionnaire development

The questionnaire underwent comprehensive development through the years 2003-2009 (described in the section: Questionnaires in the subcohorts). The previous version of the questionnaire (1997) contained both diet/lifestyle and health sections, which, after a significant increase in the number of questions, were expanded to two separate questionnaires – a Health questionnaire and a Lifestyle questionnaire.

2008/2019 Health questionnaires

The Health questionnaire was adjusted for male and female participants, resulting in the 2008 Health – women questionnaire, and the 2008 Health – men questionnaire. The health questionnaires were sent to all SMC and COSM participants in 2008 and 2019.

Questionnaire:	2008 Health – women 2019 Health – women	2008 Health – men 2019 Health – men
Cohort:	SMC	COSM
Year:	2008 & 2019	2008 & 2019
Content:	▪ Height & weight ▪ Waist & hip circumference ▪ Blood pressure status ▪ Sight, hearing & balance ▪ Toilet habits ▪ Urination ▪ Diagnoses ▪ Medication ▪ General health ▪ Dental health ▪ Aches & pains ▪ Sleep ▪ Stress ▪ Mental health (emotions) ▪ Family's health ▪ Family & social life ▪ Cohabiting status ▪ Occupation	
Sex-specific content:	Endometriosis, menopause, estrogens	Impotence, hemorrhoids

2009/2019 Lifestyle questionnaires

The 2009 Lifestyle questionnaire, assessing diet and lifestyle during the past year, was sent to all participants in SMC & COSM in 2009 and 2019. Except the removal of one FFQ-item (sardines), the 2019 questionnaire was the same as in 2009.

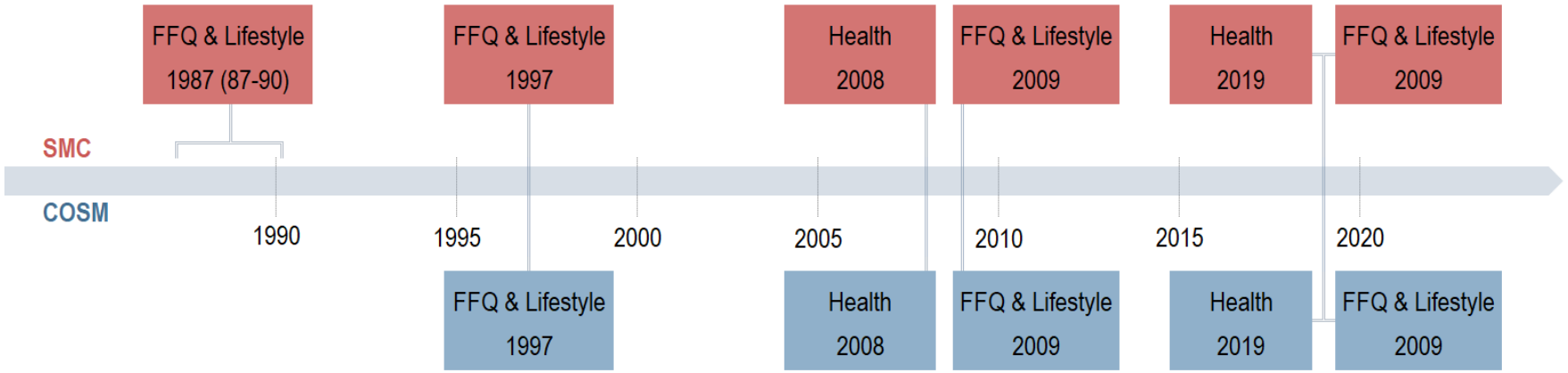
Questionnaire:	2009 Lifestyle – women & men 2019 Lifestyle – women & men
Cohort:	SMC & COSM
Year:	2009 & 2019
Content:	▪ 149 & 148-item FFQ (incl. alcohol)* ▪ Dietary supplements ▪ Physical activity & exercise ▪ Medication use ▪ Smoking & tobacco use ▪ Sun habits ▪ Outdoor activities Eating habits: ▪ Portion size ▪ Meal habits/frequency ▪ Fried food intake ▪ Main type of diet ▪ Diet exclusions ▪ Childhood sweets intake
Alterations 09→19	The FFQ-item '*Sardines'* was removed after 2009.

* The numbers of FFQ-items (149 & 148) include alcohol and sandwich spread. In Harris et al. 2013 (1), the number of FFQ-items (132) only includes the FFQ questions 15 and 17 (not alcohol and sandwich spread). The numbers of FFQ-items for the 1987 and 1997 questionnaires (67 and 96) stated in this document (and in Harris et al.) do include alcohol and sandwich spread.

TABLE 1: Number of respondents in the main cohorts

	Respondents per questionnaire* (response rate)		Respondents completing all questionnaires	
Questionnaire	SMC	COSM	SMC	COSM
1987	61 433 (74%)	-	61 433	
1997	38 984 (70%)	45 906 (49%)	38 984	45 906
2008 Health	30 621 (63%)	29 503 (78%)	25 250	29 503
2009 Lifestyle	25 259 (84%)	26 100 (90%)	21 806	26 006
2019 Health	19 081 (55%)	18 916 (72%)	13 207	15 627
2019 Lifestyle	14 923 (79%)	16 166 (86%)	11 187	13 778
* Number of respondents after exclusion of non-valid questionnaires. Further information on respondents and recruitment is presented on the SIMPLER website.				

FIGURE 1: Main cohort questionnaire overview



Questionnaires in the subcohorts

The subcohorts Swedish Mammography Cohort Clinical subcohort (SMCC) and Cohort of Swedish Men Clinical subcohort (COSMC) started in 2003 and 2010 respectively. Participants were invited to an in-person health examination and were asked to answer a questionnaire assessing diet and lifestyle before their visit (1-3 months).

The launch of SMCC in Uppsala coincided with a comprehensive development of the questionnaires. Consequently, different versions of questionnaires assessing lifestyle and diet (during the past year) together with varying supplemental questionnaires assessing health and sun habits, were used for SMCC-Uppsala, cycle 1 (SMCC-U1).

From 2010 onwards, a modified version of the Lifestyle questionnaire used in SMC and COSM, revised to assess diet and lifestyle during the past month (instead of the past year), and a 1-day food record were used in both subcohorts in Uppsala and Västerås. From 2013 onwards, a toilet habit questionnaire was added for both subcohorts on all sites. In Västerås, the 2008 Health questionnaire was added for both subcohorts from 2015 onwards.

Diet & Lifestyle questionnaires

FFQ 1997

From September 2003 through June 2004, the first 465 SMCC-U1 participants received a 97-item FFQ. It was identical to the FFQ section in the 1997 questionnaire but with one additional food item; *flax seeds*.

Questionnaire:	1997 questionnaire FFQ section
Time period:	Sep 2003 – Jun 2004
Content:	▪ 97-item FFQ (incl. alcohol consumption) ▪ Dietary supplements

FFQ 2004 V1

Subsequently, in 2004, the 1997-questionnaire was improved and extended, resulting in a new version – **FFQ-2004-V1**. Thirty-one food items in the FFQ section were added, while questions on weight history, gynecology, urology, and family composition were excluded. Between September 2004 and March 2009, the majority of SMCC-U1 participants received the FFQ-2004-V1 (n=4 366). Approximately 10% of the respondents received a version with 120 food items instead of 122. It contained one item for *wine* instead of two separate items; *red wine* and *white wine*. Similarly, one item for *nuts/almond* was included instead of two items; *peanuts* and *nuts/almonds*

Questionnaire:	FFQ 2004 V1
Time period:	Sep 2004 – Feb 2009
Content:	▪ 122-item FFQ (incl. alcohol consumption) ▪ Dietary supplements ▪ Physical activity & exercise ▪ Sleep duration ▪ Weight & hip/waist circumference

FFQ 2004 V2

The FFQ-2004-V1 was further improved and a second version was completed in 2009 – the **FFQ 2004 V2**. The FFQ section was extended with thirty-two food items. A battery of questions on eating habits were added, including: main type of diet; diet exclusions; portion sizes; meal habits/frequency; fried food intake; and sweets intake during childhood. Questions on smoking, medication use, and sun habits were added while questions on sleeping duration, physical activity history, hip/waist circumference, and weight were excluded. Between March and September 2009, 119 SMCC-U1 participants answered the FFQ-2004-V2.

Questionnaire:	FFQ 2004 V2
Time period:	March 2009 – Sept 2009
Content:	▪ 140-item FFQ (incl. alcohol consumption) ▪ Dietary supplements ▪ Physical activity & exercise ▪ Medication use ▪ Smoking & tobacco use ▪ Sun habits Eating habits: ▪ Portion size ▪ Meal habits/frequency ▪ Fried food intake ▪ Main type of diet ▪ Diet exclusions ▪ Childhood sweets intake

2009 Lifestyle questionnaire

The final version, 2009 Lifestyle, completed in the spring of 2009, was essentially the same as the FFQ-2004-V2, with minor modifications. Questions on passive smoking were excluded, questions on outdoor activities added, and one food item (*sardines)* was added in the FFQ section. The 2009 Lifestyle questionnaire was designed to be used in SMC and COSM and was sent to all participants in in these two cohorts in 2009. However, it was also used in the subcohorts for a small group of SMCC-U1 participants (n=58) who had answered the 2009 Lifestyle questionnaire shortly before the clinical visit and were therefore not asked to answer any FFQ/Lifestyle questionnaire at the clinical visit.

Questionnaire:	2009 Lifestyle
Time period:	June 2009 – Sept 2009
Content:	▪ 149-item FFQ (incl. alcohol consumption) ▪ Dietary supplements ▪ Physical activity & exercise ▪ Medication use ▪ Smoking & tobacco use ▪ Sun habits & Outdoor activities Eating habits: ▪ Portion size ▪ Meal habits/frequency ▪ Fried food intake ▪ Main type of diet ▪ Diet exclusions ▪ Childhood sweets intake

Lifestyle Month questionnaire

The questionnaire development had so far resulted in questionnaires aimed to be used in SMC and COSM, designed to assess lifestyle and health during the past year. Subsequently, an additional version of the Lifestyle questionnaire, adjusted to assess diet and lifestyle during the past month, was designed for the subcohorts – the **Lifestyle Month** questionnaire.

Slight modifications were made in addition to the time span adjustment; some questions were excluded (main type of diet; exclusions from the diet; childhood sweets intake; sardines; sleep aid medication and cortisone use), some altered (open-ended questions instead of multiple choice, on bread spread and dietary supplements), and two added (type of chocolate). Questions on type of chocolate was added separate from the FFQ section, hence not included in the nutrient calculation.

The Lifestyle Month questionnaire was used in both subcohorts on both sites from 2010 onwards (with the exception of the eldest participants in SMCC-U1, described below).

Questionnaire:	Lifestyle Month
Time period:	April 2010 – Ongoing
Content:	▪ 142-item FFQ (incl. alcohol consumption) ▪ Dietary supplements ▪ Physical activity & exercise ▪ Medication use (analgesics) ▪ Smoking & tobacco use ▪ Sun habits & Outdoor activities Eating habits: ▪ Portion size ▪ Meal habits/frequency ▪ Fried food intake ▪ Type of chocolate

Uppsala Home – Lifestyle Month questionnaire

The Lifestyle Month questionnaire was not used for the eldest participants in SMCC Uppsala, cycle 1 (whom received a home visit during 2012-2013 instead of going to the clinic for the in-person health examination in 2003-2009). For this subgroup (called Uppsala Home) a pared-down version was used (Uppsala Home-Lifestyle Month). In the pared-down version, questions on dietary supplements, sun habits, meal habits/frequency, fried food intake, type of chocolate, pipe smoking, and moist snuff use were excluded. The number of physical activity questions was reduced from seven to two. Two versions of the Uppsala Home-Lifestyle Month questionnaire was used, of which only one included alcohol consumption.

Questionnaire:	Uppsala Home-Lifestyle Month
Time period:	Oct 2012 – Mar 2013
Content:	▪ 134-item FFQ (incl. alcohol: 142 items) ▪ Medication use (analgesics) ▪ Physical activity (walking & exercise) ▪ Outdoor activities ▪ Smoking (cigarettes) ▪ Portion size

Complementary questionnaires and records

Extra-Q

All participants in SMCC-U1 answered a health questionnaire (Extra-Q) with questions on smoking, health conditions, medication and probiotic use at the in-person health examination. In June 2004, two questions were added to the questionnaire, one on consumption of natural remedies and supplements for menopause symptoms and one question aimed at former smokers; at what age did you start smoking? Approximately 10% of the participants in SMCC Uppsala cycle 1 answered the first version and 90% the second version.

Questionnaire:	Extra-Q	
Time period:	Sept 2003 – Sept 2009	
Content:	▪ Menopause & estrogen therapy ▪ Probiotics ▪ Medication use	▪ Diabetes ▪ Smoking ▪ Gut health

Outdoor & sun habits

A sub-sample of SMCC-U1 answered a questionnaire (Outdoor & Sun habits) at the in-person health examination which surveyed various aspects of UVB exposure (2).

Questionnaire:	Sun habits	
Time period:	Aug 2005 – Sept 2009	
Content:	▪ Duration of sunlight exposure ▪ Tanning ▪ Frequency of sun vacations	▪ Skin type ▪ Use of sun protection products ▪ Preference for sun or shade

Toilet habits

From 2013 onwards, a toilet habit questionnaire was added for both subcohorts on all sites.

Questionnaire:	Toilet habits		
Time period:	2013 – Ongoing		
Content:	▪ Bowel emptying frequency	▪ Bristol stool scale	▪ Bowel conditions/diseases

2008 Health questionnaire

From 2015 onwards, the 2008 Health questionnaire (page 4) was added for the Västerås cohorts.

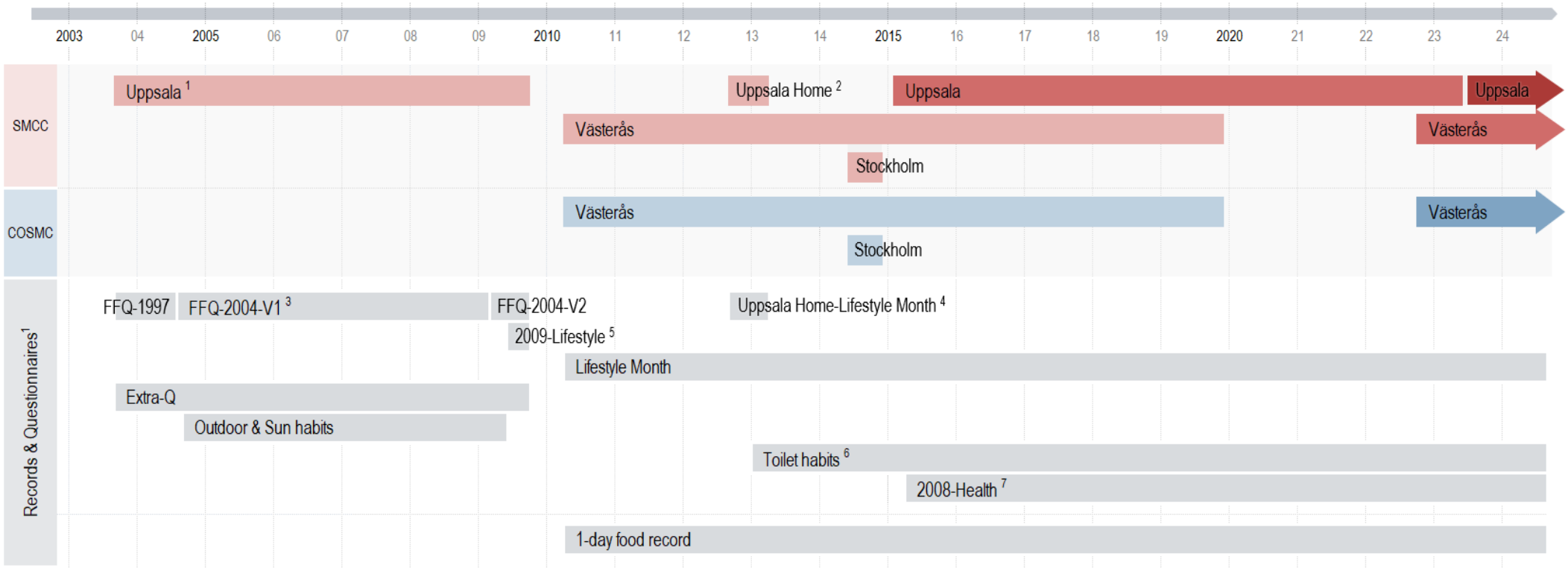
1-day food record

From 2010 onwards, all subcohort participants were asked to complete a 1-day food record before their clinical visit.

TABLE 2: Number of respondents in the subcohorts

	Questionnaire	Subcohort	Site	n=
1st CYCLE	FFQ-1997	SMCC	Uppsala	465
	FFQ-2004-V1			4 366
	FFQ-2004-V2			119
	2009 Lifestyle Questionnaire			58
	Extra-Q			5 021
	Outdoor & Sun habits			1 239
	Uppsala Home–Lifestyle Month			309
	Lifestyle Month Questionnaire		Västerås	1 139
			Stockholm	82
		COSMC	Västerås	6 221
			Stockholm	25
	Toilet habits	SMCC	Västerås	1 139
			Stockholm	82
		COSMC	Västerås	6 221
			Stockholm	25
	2008 Health Questionnaire	SMCC	Västerås	1 139
		COSMC		6 221
2nd CYCLE	Lifestyle Month Questionnaire	SMCC	Uppsala	Ongoing collection and processing – numbers to be presented when completed
			Västerås	
		COSMC		
	Toilet habits	SMCC	Uppsala	
			Västerås	
		COSMC		
	2008 Health Questionnaire	SMCC	Västerås	
		COSMC		

FIGURE 2: Subcohort questionnaire overview



Subcohort cycles

SMCC:	1st cycle	2nd cycle	3rd cycle
COSMC:	1st cycle	2nd cycle	

Notes

1. Due to questionnaire development, different versions of FFQ/Lifestyle questionnnaires were used during the first cycle of SMCC in Uppsala (incl. Uppsala Home)
2. For the eldest participants in the first cycle, the in-person examination (biological sampling, clinical measurements, questioonnaire collection) was conducted at their homes instead of at the clinic. Home visits in Uppsala were conducted between Oct 2012 and Mars 2013. In Västerås, the homevisits were conducted during the same time period as the clinical visits.
3. ~10% of the FFQ-2004-V1 respondents received a version with two minor deviations (one question instead of two on *Wine* and *Nut/almonds*)
4. A number of participants in Uppsala Home received the Lifestyle Month questionnaire, instead of the Uppsala Home-Lifestyle Month.
5. Fifty-eight participants had received the 2009-Lifestyle questionnaire shortly before the subcohort clinical visit, and were therefore not asked to answer FFQ at the visit.
6. Collection in Västerås paused between March 2015 and February 2017.
7. Only for SMCC/COSMC Västerås. Same questionnaire as to the main cohorts in 2008.

Validity and reproducibility

The questionnaires used in SMC and COSM have been evaluated regarding reproducibility and validity in several publications summarized below. The evaluations have been performed throughout the years on different versions and sections of the questionnaires (1).

Health questionnaires

Well-Being

A 10-item well-being assessment is included in the 2008/2019 Health questionnaires (question 38). It consists of the WHO (Ten) Well-being Index – a unidimensional well-being assessment scale based on WHO's 28-item well-being questionnaire (3). The Swedish translation of the WHO-10 has previously been evaluated and found to be psychometrically sound (4).

Diet and lifestyle questionnaires

Physical Activity

The physical activity section in the 2004 FFQ V1 was evaluated among Swedish women (n= 303) regarding its reproducibility in assessment of current and historical physical activity using a test-retest method. The intraclass correlation coefficient between the 1st and 2nd tests (1 y apart) for total current physical activity was 0.69, and for historical total physical activity at age 50 and 30 it was 0.75 and 0.81 respectively (5). Moreover, the validity of the questions was tested in the same sample (n= 116) using 7-day activity records and accelerometers as reference methods. The concordance correlation between FFQ-based estimates of total physical activity and the 7-day activity record-based estimates were 0.64, and 0.38 for the accelerometer-based estimates (6). The data from the accelerometer was further analyzed in a separate paper, presenting profiles of physical activity behaviors (7).

Dietary patterns

Reproducibility of the 1987 FFQ was evaluated among Swedish women (n=265, n=362) regarding identification of dietary patterns through factor analysis using a test-retest method (8). The same test group was used for validity testing using 7-day food records as reference method. For reproducibility the intraclass correlations (Spearman's) between the 1st and 2nd FFQ for three food patterns were 0.63, 0.68, and 0.73, respectively (p= 0.0001). For validity the correlation coefficients between the FFQ and food records, for the patterns were 0.59, 0.50, and 0.85, respectively (p= 0.0001). The result indicated it to be a valid and reproducible method (8).

Dairy fat

The 1987 FFQ was used together with 7-day diet records as reference methods to evaluate adipose tissue content of two fatty acids (15:0 and 17:0) as biomarkers to reflect long-term dairy fat intake among Swedish women (n= 81) (9). In comparison with the diet records, mean intake of milk fat, fat from ruminant meat, and 15:0 and 17:0 were underreported in the FFQ, although the proportions (% of total fat intake) were almost identical. The correlation coefficient (Pearson's) between adipose tissue 15:0 &

17:0 content and FFQ-based estimates of dairy fat intake was 0.39, and for diet record-based estimates 0.62 (P = 0.0001). The use of 15:0 content in adipose tissue as a biomarker for dairy intake was later confirmed in a study among Swedish men (n= 114) (10). In the same study, 14:0 was concluded to be a similarly valid biomarker for the purpose, and 15:0 concentrations in serum a possible alternative if adipose tissue is not available.

Fatty acids

It was examined if additional questions in the 1987 FFQ increased the validity regarding estimation of dietary fat intake among Swedish women, using dietary records (n= 184) and adipose tissue samples (n= 73) as reference methods (11). The correlation (Pearson's) between adipose tissue and FFQ-based estimates of polyunsaturated fat intake was 0.65, which increased to 0.67 with additional questions. The correlation between the FFQ and DR was 0.40 and increased to 0.41 (11).

Long-chain n-3 polyunsaturated fatty acids

The FFQs (1987 and 1997) were evaluated among Swedish women (n=239) regarding the validity for assessment of long-term intake of LCn-3 PUFA (long-chain n-3 polyunsaturated fatty acids) (12). LCn-3 PUFAs were measured in adipose tissue and compared to FFQ-based estimates collected 14.9 years (1987-FFQ), 6.5 years and 1.8 months (1997-FFQ) prior to the adipose tissue sampling. The correlation coefficients were 0.41, 0.29 and 0.31 (Pearson's) respectively for the FFQ-based estimates, indicating reasonable validity (12).

Dietary lignans

The 1987 and 1997 FFQs were evaluated among Swedish women (n= 140), regarding its validity for assessment of dietary lignan intake, using serum enterolactone as a reference biomarker (13). The correlation between plant lignan intake estimated by the 1997-FFQ and serum concentration of enterolactone was low, 0.22 (p= 0.01). No significant correlation was found for the 1987 FFQ (13).

Polychlorinated biphenyls

The 1997 and 2004 FFQs V1 were evaluated among Swedish women (n= 201) regarding the validity for estimation of long-term dietary exposure to polychlorinated biphenyls, using PCB biomarkers as reference method (14). The correlation coefficients ranged from 0.3 to 0.58 ($p < 0.05$) for the six serum PCB biomarkers in relation to FFQ-based PCB estimates, indicating acceptable long-term validity.

Total antioxidant capacity

The 1997 FFQ was evaluated among Swedish women (n= 108) regarding its validity for assessing antioxidant intake from foods, using plasma TAC (total antioxidant capacity) values as reference method (15). Whole plasma ORAC (oxygen radical absorbance capacity), lipophilic plasma ORAC, and plasma TRAP (total radical-trapping absorbance capacity) concentrations correlated moderately positive with FFQ-based TAC total and FFQ-based TAC fruit & vegetables estimates ($P < 0.05$). However, there were no correlation between FFQ-based TAC estimates (FFQ-based TAC total and FFQ-based TAC fruit & vegetables) and the hydrophilic plasma ORAC or plasma FRAP (ferric-reducing antioxidant power) concentrations (15). The 2004 FFQ V1 was evaluated among Swedish women (n= 300) regarding its reproducibility for assessing antioxidant intake from food, using a test-retest method. The intraclass correlations between the 1st and 2nd FFQs (1 y apart) were 0.60, 0.61, and 0.61 (95% CIs) for FFQ-based

ORAC, TRAP, and FRAP estimates, respectively, from fruit and vegetables, indicating good reproducibility (15).

Glycemic index

Reproducibility and validity of the 1997 FFQ were evaluated among Swedish men (n=141) regarding estimation of glycemic index, glycemic load, and total carbohydrate intake, a test-retest method and 7-day food records as reference method (16). The intraclass correlations between the 1st and 2nd FFQs were 0.66 for GI, 0.61 for GL, and 0.61 for carbohydrate intake ($p < 0.001$). The correlations between FFQs and the 7-day food records were 0.62 for GI, 0.77 for GL, and 0.76 for carbohydrate intake. The FFQ was considered to measure GI, GL, and carbohydrates "with reproducibility and validity similar to other commonly studied nutritional factors" (16).

Macronutrients and micronutrients

The 1997 FFQ was evaluated among Swedish men (n=248) regarding its reproducibility and validity for assessment of total nutrient intake from diet and dietary supplements, a test-retest method and 24-h recall interviews as reference method (17). The intraclass correlations between the 1st and 2nd FFQs ranged from 0.54 to 0.85, indicating a high degree of reproducibility. The correlation coefficients (Spearman's) between FFQ-based and 24-h recall interview-based estimations of macronutrient intake from food ranged from 0.44 (protein) to 0.81 (alcohol) with a mean of 0.65. The correlation coefficients for micronutrients (0.49) increased to 0.62 when dietary supplements were included (17). Validity values for macronutrients and micronutrients are presented in table 4. Moreover, the sensitivity and specificity of the 1997 FFQ to identify dietary supplement use were evaluated in the same group of participants (n= 248). The overall sensitivity was 77.7% and the specificity was 93.4% (95% CIs) (18).

TABLE 3: Validity for macronutrient & micronutrient estimates

Table by Messerer et al. (2004), published in The Validity of Questionnaire-Based Micronutrient Intake Estimates Is Increased by Including Dietary Supplement Use in Swedish Men (17).

Validity of nutrient estimates based on the FFQ in comparison to total intake of nutrients by Swedish men from fourteen 24-h recall interviews[1]

Macronutrient	r	Micronutrient	r
Energy, kJ/d	—	β-Carotene, mg/d	0.51 (0.49)
Protein, g/d	0.44	Retinol, mg/d	0.62 (0.37)
Total carbohydrate, g/d	0.73	Vitamin D, µg/d	0.59 (0.48)
Sucrose, g/d	0.70	α-Tocopherol, mg/d	0.57 (0.37)
Dietary fiber, g/d	0.71	Vitamin C, mg/d	0.81 (0.44)
Total Fat, g/d	0.70	Vitamin B-6, mg/d	0.65 (0.43)
SFA, g/d	0.75	Folate, µg/d	0.50 (0.29)
MUFA,[2] g/d	0.66	Iron, mg/d	0.38 (0.25)
PUFA, g/d	0.49	Calcium, mg/d	0.77 (0.77)
Cholesterol, mg/d	0.45	Magnesium, mg/d	0.73 (0.73)
Alcohol (ethanol), g/d	0.81	Selenium, µg/d	0.75 (0.72)
		Zinc, mg/d	0.56 (0.34)
		EPA, g/d	0.64 (0.64)
		DHA, g/d	0.60 (0.57)
Mean	0.65	Mean	0.62 (0.49)

1. Spearman's correlation coefficients based on energy-adjusted nutrients; deattenuated for within-and-between-subject variation in the reference method and for random error in the questionnaire based estimates (n= 248). Numbers in parenthesis show correlation coefficients for micronutrients from foods only.

2. Monounsaturated fatty acids

Food items and nutrients – Unpublished data

In 1992, the 1987 FFQ was evaluated among Swedish women (n= 129) regarding its validity for assessment of total nutrient intake and intake of 60 food items, using the mean of four 7-day dietary records as reference (19, 20). The unpublished validity study results, presented below, has been referred to in several publications (2, 11, 12, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38).

TABLE 4: Unpublished 1987-FFQ validity data – Food items

Table by Wolk (1992) (20).

Reproducibility and Validity of the 1987 FFQ in The Swedish Mammography Cohort						
Food	Reproducibility		Validity (n=129 women)		Validity/ √ Reproducibility	
	Pearson	Spearman	Pearson	Spearman	Pearson	Spearman
Butter	0.368	0.391	0.318	0.217	0.53	0.35
Margarin	0.580	0.554	0.430	0.444	0.56	0.60
Cheese	0.696	0.590	0.353	0.381	0.42	0.50
Milk 0.5 %	0.772	0.765	0.423	0.556	0.48	0.64
Milk 1.5 %	0.614	0.611	0.485	0.428	0.62	0.55
Milk 3 %	0.575	0.509	0.345	0.238	0.45	0.33
Yogurt 0.5%	0.659	0.633	0.597	0.485	0.74	0.61
Yogurt 3 %	0.550	0.537	0.405	0.282	0.55	0.38
Whole grain bread	0.612	0.643	0.376	0.379	0.45	0.47
White bread	0.533	0.538	0.145	0.146	0.20	0.20
Crisp bread	0.584	0.569	0.266	0.340	0.35	0.45
Potatoes, cooked	0.512	0.512	0.355	0.368	0.50	0.26
Potatoes, fried	0.604	0.625	0.156	0.212	0.20	0.27
French fries	0.542	0.687	0.157	0.511	0.21	0.62
Root vegetables	0.584	0.584	0.354	0.412	0.46	0.54
Cabbage	0.516	0.507	0.544	0.306	0.76	0.43
Tomatoes	0.629	0.641	0.283	0.302	0.36	0.38
Lettuce	0.577	0.578	0.350	0.410	0.46	0.54
Spinach, kale	0.380	0.485	0.350	0.410	0.57	0.59
Apples, pears	0.676	0.650	0.417	0.450	0.51	0.56
Citrus fruit	0.487	0.473	0.363	0.459	0.52	0.67
Banana	0.573	0.577	0.294	0.475	0.39	0.63
Juice	0.550	0.538	0.295	0.368	0.40	0.50
Oat meal	0.738	0.737	0.550	0.519	0.64	0.60
Cold cereals, musli	0.671	0.621	0.482	0.581	0.59	0.74

Pancakes	0.635	0.666	0.405	0.379	0.51	0.46
Rice	0.551	0.570	0.311	0.271	0.42	0.36
Spaghetti	0.396	0.476	0.295	0.317	0.47	0.46
Pea soup	0.466	0.539	0.339	0.350	0.50	0.48
Meat, whole pieces	0.604	0.547	0.110	0.290	0.14	0.39
Meat, stews	0.489	0.490	0.088	0.100	0.13	0.14
Bacon	0.426	0.466	0.130	0.179	0.20	0.26
Minced meat	0.499	0.485	0.232	0.179	0.33	0.26
Sausage	0.704	0.686	0.189	0.255	0.23	0.31
Cold cuts	0.714	0.719	0.419	0.478	0.50	0.56
Liver pate	0.620	0.565	0.497	0.520	0.63	0.69
Blood pudding	0.554	0.609	0.315	0.412	0.42	0.53
Liver, kidney	0.467	0.603	0.353	0.264	0.52	0.34
Poultry	0.633	0.685	0.283	0.323	0.36	0.39
Eggs	0.499	0.511	0.283	0.323	0.40	0.45
Fatty fish	0.450	0.476	0.377	0.330	0.56	0.48
Other fish	0.550	0.540	0.364	0.312	0.49	0.42
Shellfish	0.738	0.741	0.470	0.479	0.55	0.56
Chips, popcorn	0.596	0.578	0.445	0.481	0.58	0.63
Rolls, crackers	0.709	0.703	0.286	0.379	0.34	0.45
Ice cream	0.664	0.647	0.447	0.384	0.55	0.48
Sweet soup	0.610	0.611	0.528	0.565	0.68	0.72
Jam, marmelade	0.657	0.616	0.389	0.322	0.48	0.41
Lemonade	0.602	0.614	0.257	0.275	0.33	0.35
Sodas	0.587	0.596	0.286	0.312	0.37	0.40
Candy	0.628	0.575	0.106	0.321	0.14	0.42
Chocolate	0.650	0.633	0.230	0.400	0.29	0.50
Sugar	0.739	0.714	0.684	0.510	0.80	0.71
Coffee	0.734	0.696	0.518	0.527	0.60	0.63
Tea	0.786	0.784	0.717	0.719	0.81	0.81
Beer, 0.5% alco	0.774	0.766	0.763	0.619	0.87	0.71
Beer, 2.8% alco	0.633	0.601	0.452	0.530	0.57	0.68
Beer, 4.5% alco	0.384	0.395	0.676	0.390	1.0	0.62
Wine	0.780	0.802	0.799	0.797	0.90	0.89
Hard liquor, 40 %	0.610	0.611	0.528	0.566	0.68	0.72

TABLE 5: Unpublished 1987-FFQ validity data – Macronutrients & micronutrients

Table by Wolk (1992) (20).

Different measures of linear dependence between nutrient intake calculated from 28-day dietary records and food frequency questionnaire among 129 women.*							
Energy & Nutrients	Not energy adjusted nutrients			Energy adjusted nutrients †			
	Spearman coefficient	S^2_W / S^2_b ‡	Pearson de-attenuated	Pearson de-attenuated	S^2_{WA} / S^2_{bA} ‡	Pearson (95% CI) de-attenuated	
Calories	0.18	0.054/0.043	0.24	--	0.0540/0.043		
Total fat	0.18	0.122/0.070	0.29	0.47	0.037/0.013	0.49	(0.34-0.62)
Saturated fat	0.29	0.134/0.084	0.36	0.40	0.052/0.024	0.42	(0.34-0.62)
Monounsaturated fat	0.18	0.138/0.068	0.27	0.48	0.052/0.016	0.51	(0.36-0.64)
Polyunsaturated fat	0.16	0.133/0.069	0.19	0.35	0.075/0.026	0.36	(0.19-0.51)
Cholesterol	0.35	0.012/0.003	0.36	0.41	0.010/0.002	0.45	(0.28-0.59)
Protein	0.30	0.065/0.044	0.36	0.51	0.035/0.013	0.54	(0.39-0.66)
Carbohydrates	0.24	0.055/0.046	0.22	0.52	0.020/0.008	0.54	(0.39-0.66)
Dietary fiber	0.35	0.080/0.073	0.34	0.53	0.066/0.046	0.54	(0.40-0.66)
Vitamin C	0.27	0.577/0.283	0.30	0.32	0.580/0.244	0.33	(0.16-0.48)
Vitamin B1	0.23	0.033/0.015	0.27	0.36	0.026/0.004	0.40	(0.23-0.56)
Vitamin B2	0.41	0.033/0.023	0.44	0.59	0.025/0.011	0.62	(0.49-0.72)
Vitamin B6	0.31	0.036/0.021	0.32	0.44	0.029/0.011	0.46	(0.30-0.59)
Vitamin B12	0.23	0.312/0.072	0.31	0.36	0.290/0.051	0.39	(0.22-0.54)

Vitamin A	0.27	0.126/0.040	0.33	0.46	0.122/0.030	0.49	(0.33-0.62)
Retinol	0.32	0.099/0.020	0.35	0.40	0.093/0.013	0.45	(0.28-0.60)
Carotene	0.30	0.439/0.160	0.34	0.39	0.442/0.152	0.41	(0.25-0.56)
Folate	0.32	0.103/0.076	0.29	0.46	0.091/0.046	0.48	(0.33-0.61)
Vitamin E	0.16	0.110/0.069	0.21	0.28	0.077/0.036	0.29	(0.12-0.45)
Calcium	0.39	0.115/0.088	0.44	0.46	0.085/0.048	0.48	(0.33-0.60)
Iron	0.15	0.101/0.042	0.21	0.39	0.066/0.011	0.43	(0.26-0.58)
Magnesium	0.30	0.054/0.047	0.31	0.43	0.031/0.020	0.44	(0.29-0.58)
Zinc	0.24	0.069/0.037	0.32	0.37	0.047/0.009	0.40	(0.23-0.55)
Alcohol	0.86	1.117/0.505	0.92	0.82	0.047/0.009	0.85	(0.78-0.90)

* Energy and nutrients are $\log_e$-transformed. Age-dependent portion sizes and standard aggregation of food groups are used.

† The energy adjusted nutrients are obtained as residuals from regressing each nutrient on calories.

‡ The within-person (S^2_W) and between-person (S^2_b) variance of nutrient estimates obtained from dietary records are estimated from 197 women in the compound validation group who completed 28-days of dietary recording.

References

1. Harris HR, Hkansson N, Olofsson C, Julin B, Kesson AM, Wolk A, editors. The Swedish mammography cohort and the cohort of Swedish men: Study design and characteristics of 2 population-based longitudinal cohorts2013.

2. Burgaz A, Akesson A, Oster A, Michaelsson K, Wolk A. Associations of diet, supplement use, and ultraviolet B radiation exposure with vitamin D status in Swedish women during winter. The American journal of clinical nutrition. 2007;86(5):1399-404.

3. Bech P, Gudex C, Staehr Johansen K; The WHO (Ten) Well-Being Index: Validation in Diabetes. Psychother Psychosom.1996;65(4):183–190.

4. Löve J, Andersson L, Moore CD, Hensing G. Psychometric analysis of the Swedish translation of the WHO well-being index. Qual Life Res. 2014;23(1):293-7.

5. Orsini N, Bellocco R, Bottai M, Pagano M, Wolk A. Reproducibility of the past year and historical self-administered total physical activity questionnaire among older women. European journal of epidemiology. 2007;22(6):363-8.

6. Orsini N, Bellocco R, Bottai M, Hagstromer M, Sjostrom M, Pagano M, et al. Validity of self-reported total physical activity questionnaire among older women. European journal of epidemiology. 2008;23(10):661-7.

7. Orsini N, Bellocco R, Bottai M, Hagstromer M, Sjostrom M, Pagano M, et al. Profile of physical activity behaviors among Swedish women aged 56–75 years. Scandinavian journal of medicine & science in sports. 2008;18:95-101.

8. Khani BR, Ye W, Terry P, Wolk A. Reproducibility and validity of major dietary patterns among Swedish women assessed with a food-frequency questionnaire. The Journal of nutrition. 2004;134(6):1541-5.

9. Wolk A, Vessby B, Ljung H, Barrefors P. Evaluation of a biological marker of dairy fat intake. The American journal of clinical nutrition. 1998;68(2):291-5.

10. Wolk A, Furuheim M, Vessby B. Fatty acid composition of adipose tissue and serum lipids are valid biological markers of dairy fat intake in men. The Journal of nutrition. 2001;131(3):828-33.

11. Wolk A, Ljung H, Vessby B, Hunter D, Willett WC. Effect of additional questions about fat on the validity of fat estimates from a food frequency questionnaire. Study Group of MRS SWEA. Eur J Clin Nutr. 1998;52(3):186-92.

12. Wallin A, Di Giuseppe D, Burgaz A, Hakansson N, Cederholm T, Michaelsson K, et al. Validity of food frequency questionnaire-based estimates of long-term long-chain n-3 polyunsaturated fatty acid intake. European journal of nutrition. 2014;53(2):549-55.

13. Lin Y, Wolk A, Hakansson N, Penalvo JL, Lagergren J, Adlercreutz H, et al. Validation of FFQ-based assessment of dietary lignans compared with serum enterolactone in Swedish women. The British journal of nutrition. 2013;109(10):1873-80.

14. Bergkvist C, Akesson A, Glynn A, Michaelsson K, Rantakokko P, Kiviranta H, et al. Validation of questionnaire-based long-term dietary exposure to polychlorinated biphenyls using biomarkers. Molecular nutrition & food research. 2012;56(11):1748-54.

15. Rautiainen S, Serafini M, Morgenstern R, Prior RL, Wolk A. The validity and reproducibility of food-frequency questionnaire-based total antioxidant capacity estimates in Swedish women. The American journal of clinical nutrition. 2008;87(5):1247-53.

16. Levitan EB, Westgren CW, Liu S, Wolk A. Reproducibility and validity of dietary glycemic index, dietary glycemic load, and total carbohydrate intake in 141 Swedish men. The American journal of clinical nutrition. 2007;85(2):548-53.

17. Messerer M, Johansson S-E, Wolk A. The Validity of Questionnaire-Based Micronutrient Intake Estimates Is Increased by Including Dietary Supplement Use in Swedish Men. The Journal of nutrition. 2004;134(7):1800-5.

18. Messerer M, Wolk A. Sensitivity and specificity of self-reported use of dietary supplements. Eur J Clin Nutr. 2004;58(12):1669-71.

19. Wolk-Unpublished, Hans-Olov Adami, Reinhold Bergström, Åke Bruce, Lars Holmberg. Research plan: Validation of a semi-quantitative self-administred questionnaire for epidemiological studies of diet and cancer. [Research plan]. In press 1991.

20. Wolk-Unpublished. Reproducibility and Validity of the 1987 FFQ in The Swedish Mammography Cohort. [Table with results of tests (Spearman and Pearson) of reproducibility and validity.]. In press 1992.

21. Wolk A, Larsson SC, Johansson J-E, Ekman P. Long-term Fatty Fish Consumption and Renal Cell Carcinoma Incidence in Women. JAMA. 2006;296(11):1371.

22. Larsson SC, Bergkvist L, Wolk A. Glycemic load, glycemic index and breast cancer risk in a prospective cohort of Swedish women. International journal of cancer. 2009;125(1):153-7.

23. Larsson SC, Bergkvist L, Wolk A. Dietary carotenoids and risk of hormone receptor-defined breast cancer in a prospective cohort of Swedish women. European journal of cancer (1990). 2010;46(6):1079-85.

24. Larsson SC, Bergkvist L, Wolk A. Folate Intake and Risk of Breast Cancer by Estrogen and Progesterone Receptor Status in a Swedish Cohort. Cancer epidemiology, biomarkers & prevention. 2008;17(12):3444-9.

25. Larsson SC, Bergkvist L, Wolk A. Long-term dietary calcium intake and breast cancer risk in a prospective cohort of women. The American journal of clinical nutrition. 2009;89(1):277-82.

26. Larsson SC, Bergkvist L, Wolk A. Conjugated linoleic acid intake and breast cancer risk in a prospective cohort of Swedish women. The American journal of clinical nutrition. 2009;90(3):556-60.

27. Larsson S, Andersson S-O, Johansson J-E, Wolk A. Cultured milk, yogurt, and dairy intake in relation to bladder cancer risk in a prospective study of Swedish women and men1-3. The American journal of clinical nutrition. 2008;88:1083-7.

28. Larsson SC, Bergkvist L, Wolk A. Milk and lactose intakes and ovarian cancer risk in the Swedish Mammography Cohort. The American journal of clinical nutrition. 2004;80(5):1353-7.

29. Larsson SC, Åkesson A, Wolk A. Long-Term Dietary Acrylamide Intake and Risk of Epithelial Ovarian Cancer in a Prospective Cohort of Swedish Women. Cancer epidemiology, biomarkers & prevention. 2009;18(3):994-7.

30. Larsson SC, Bergkvist L, Giovannucci E, Wolk A. Coffee Consumption and Incidence of Colorectal Cancer in Two Prospective Cohort Studies of Swedish Women and Men. American journal of epidemiology. 2006;163(7):638-44.

31. Julin B, Wolk A, Bergkvist L, Bottai M, Åkesson A, editors. Home Dietary Cadmium Exposure and Risk of Postmenopausal Breast Cancer : A Population-Based Prospective Cohort Study2013.

32. Larsson SC, Holmberg L, Wolk A. Fruit and vegetable consumption in relation to ovarian cancer incidence: the Swedish mammography cohort. British journal of cancer. 2004;90(11):2167-70.

33. Larsson SC, Rafter J, Holmberg L, Bergkvist L, Wolk A. Red meat consumption and risk of cancers of the proximal colon, distal colon and rectum: The Swedish Mammography Cohort. International journal of cancer. 2005;113(5):829-34.

34. Bellavia A, Larsson SC, Wolk A. Fish consumption and all-cause mortality in a cohort of Swedish men and women. Journal of internal medicine. 2017;281(1):86-95.

35. Larsson SC, Virtamo J, Wolk A. Fish consumption and risk of stroke in Swedish women. The American journal of clinical nutrition. 2011;93(3):487-93.

36. Larsson SC, Bergkvist L, Wolk A. Processed meat consumption, dietary nitrosamines and stomach cancer risk in a cohort of Swedish women. International journal of cancer. 2006;119(4):915-9.

37. Larsson SC, Bergkvist L, Wolk A. Long-term meat intake and risk of breast cancer by oestrogen and progesterone receptor status in a cohort of Swedish women. European journal of cancer (1990). 2009;45(17):3042-6.

38. Larsson SC, Wolk A. Potato consumption and risk of cardiovascular disease: 2 prospective cohort studies. The American journal of clinical nutrition. 2016;104(5):1245-52.