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Abbreviations: BMI, body mass index; CI, confidence interval; GLOBOCAN, Global Cancer Observatory; HR, hazards ratio; IPAQ, International Physical Activity Questionnaire; SD, standard deviation; SFA, saturated fatty acid; WCRF/AICR, World Cancer Research Fund/American Institute of Cancer Research

Abstract

The impact of dairy product consumption for long-term health remains unclear, in particular regarding their involvement in cancer etiology for frequent locations like breast or prostate. Besides, little is known about potentially different effects of dairy producto subtypes. Our objective was therefore to evaluate the associations between dairy product consumption (total and subtypes) and cancer risk. A total of 101,279 participants from the French NutriNet-Santé cohort study were included (78.7% women; mean (SD) age=42.2 (14.5) years). Dairy product consumption was assessed using validated web-based 24-hour dietary records. Multi-adjusted Cox models were computed. After a median [interquartile range] follow-up time of 5.9 [2.7-8.3] years, we documented 2,503 incident cancer cases (783 breast, 323 prostate, and 182 colorectal cancers). Total dairy product consumption was not significantly associated with cancer. However, the consumption of “fromage blanc” (a French type of quark/cottage cheese) was associated with an increased risk of cancer overall [HR for 1 serving increment (95% CI)=1.11 (1.01-1.21); *P*-trend=0.03] and of colorectal cancer [HR=1.39 (1.09-1.77); *P*-trend<0.01]. Besides, sugary dairy dessert consumption was directly associated with colorectal cancer risk [HR for 1 serving increment=1.58 (1.01-2.46); *P*-trend=0.046]. No association was observed between the consumption of dairy products or sugary dairy desserts and the risk of prostate and breast cancers. In our study, the consumption of dairy products was not associated with the risk of overall, colorectal, breast or prostate cancers. The consumption of “fromage blanc” and sugary dairy desserts were associated to an increased risk of colorectal cancer, but this warrants further investigations.

Introduction

Cancer incidence is rapidly increasing and has become a leading cause of death in many countries. The Global Cancer Observatory (GLOBOCAN) estimated that 18.1 million new cancer cases occurred worldwide in 2018 [1]. There is accumulating evidence that diet and lifestyle factors play an important role on cancer development [2]. In particular, dairy product consumption may be involved in cancer prevention through their content in calcium, vitamin D, lactic acid-producing bacteria (fermented dairy products), conjugated linoleic acid but also lactoferrin or butyrate [2]. In 2018, the Third Expert Report from the World Cancer Research Fund/American Institute of Cancer Research (WCRF/AICR) concluded that consuming dairy products probably decreases the risk of colorectal cancer [2]. Associations with a decreased breast cancer risk (pre-menopause) and an increased prostate cancer risk (potentially through elevated levels of insulin-like growth factor 1) were less clear, with only limited-suggestive evidence [2], thus requiring additional studies. Evidence for other cancer locations is more limited [2]. Besides, more evidence is needed regarding potential specific associations between dairy product subtypes and cancer risk.

We therefore analyzed the associations between the consumption of total dairy products and specific dairy product subtypes and the risk of developing overall, breast, prostate and colon cancers in the NutriNet-Santé Cohort Study.

Material and methods

Study population

The NutriNet-Santé study is a French, ongoing, web-based prospective cohort launched in 2009 aiming to evaluate the relationship between nutrition, mortality and health outcomes, and examine determinants of dietary behaviors and nutritional status. Detailed information on this cohort can be found elsewhere [3]. Participants (aged >18 years old) with access to the

Internet have been continuously recruited since May 2009 from the general population by vast multimedia campaigns, and followed through questionnaires using a dedicated and secured online platform (http://www.etude-nutrinet-sante.fr). Electronic informed consent was obtained from each participant. The NutriNet-Santé Study (registered at ClinicalTrials.gov as NCT03335644) is conducted according to the Declaration of Helsinki guidelines. It was approved by the Institutional Review Board of the French Institute for Health and Medical Research and the 'Commission Nationale de l'Informatique et des Libertés' (CNIL n°908450/n°909216).

Data collection

At baseline, participants completed a set of five validated questionnaires related to sociodemographic and lifestyle characteristics [4], anthropometry [5,6], dietary intakes [7–9], physical activity (validated short version of the International Physical Activity Questionnaire [IPAQ]) [10] and health status. Dietary data were collected at baseline and every six months through series of three non-consecutive validated web-based 24-hour dietary records (2 weekdays and 1 weekend day), randomly assigned over a two-week period. Portion sizes were estimated using validated photographs [11], standard containers or directly in g or mL. Mean daily energy, alcohol and macro- and micro-nutrient intakes were estimated using a French food composition database [12]. Amounts consumed from composite dishes were estimated considering French recipes validated by food and nutrition professionals. Dietary under-reporters were detected on the basis of the method proposed by Black [13]. The present study focused on the consumption of dairy products, which include milk and cheese, as well as yogurt, "fromage blanc" and "petit-Suisse" (French specialties, similar to cottage cheese or quark) with a sugar content < 12%). Fermented dairy products included yogurt, cheese, "fromage blanc" and "petit-Suisse". Sugary dairy desserts, milk-based products not classified as dairy products according to French recommendations due to their high sugar content (e.g.,

cream dessert, pudding, custard, “crème brûlée”, milkshake, as well as sweetened or fruit yogurt, “fromage blanc” and “petit-Suisse” with a sugar content ≥12%) were also considered. The consumption of dairy products and sugary dairy desserts was assessed as the mean intake over all dietary records that were completed during the first two years of each participant’s follow-up.

Case ascertainment

Participants were asked to report their health status at baseline and every six months through a health check-up questionnaire. A dedicated and secured web-interface is also available at any time for the participants to report health events, new treatments, or medical exams. Reported cancer cases were validated by an expert medical committee, based on medical and anatomopathological reports collected from the participants, their physicians and/or hospitals. The NutriNet-Santé study is also linked to the national medical databases of the health insurance (SNIIRAM) and to the French cause-specific mortality registry (CépiDC) enabling to complete death and health data thereby limiting potential bias due to unreported cancer cases. Cancer cases were classified using the International Chronic Diseases Classification, 10th Revision, Clinical Modification (ICD-10) [14]. All primary cancers diagnosed between the inclusion and January 7th, 2019 were considered as cases, except for basal cell skin carcinoma.

Statistical analysis

A total of 129,787 individuals provided at least 2 24h dietary records during their first two years of follow-up, of which were excluded n=21,804 energy under-reporters and n=6,704 participants with prevalent cancer at baseline. Dairy product consumption was considered using standard servings: 150 g of milk; 125 g of yogurt; 30 g of cheese; 100 g of “fromage blanc”; 120 g of “petit-Suisse” and 125 g of sugary dairy dessert. Servings for total dairy products were calculated as the sum of the servings of milk, cheese, yogurt, “fromage blanc”,

and “petit-Suisse”. Dairy desserts were considered separately. Hazards ratios and 95% confidence intervals were computed from Cox proportional hazard models. Main outcomes were overall, breast, prostate and colorectal cancers (the most common cancer locations in the cohort). Participants contributed person-time from their inclusion until their date of diagnosis, last completed questionnaire, death, or January 7th, 2019, whichever occurred first. Stratifications by menopausal status for breast cancer were also carried out. In these analyses, women contributed person-time to the premenopausal model until their age at menopause, and to the postmenopausal model from their age at menopause.

The main model included the following potential confounders: sociodemographic characteristics – age (timescale), sex, educational level (less than high-school degree, high-school degree, undergraduate and graduate degree); anthropometric characteristics – height (cm), BMI (kg/m^2); lifestyle – smoking status (never, former, current smokers), physical activity (high, moderate, low, missing); personal and family history of diseases (yes/no) – personal history of type 2 diabetes, hypertriglyceridemia, hypercholesterolemia and family history of cancer; study design (number of 24-hour dietary records); dietary intakes of nutrients or food groups associated with cancer risk or reflecting overall diet quality: non-alcohol energy (kcal/d), sugar (g/d), sodium (g/d), alcohol (g/d), fruit and vegetables (g/d), whole grain products (g/d), red and processed meat (g/d) as well as saturated fatty acids (SFAs) (g/d, continuous) and calcium (mg/d) brought by other sources than dairy products. For analyses on dairy product subtypes, models were also adjusted for the consumption of each other dairy products than the one studied. Breast cancer models were additionally adjusted for covariates linked to reproductive history: menopausal status at baseline (yes/no), use of hormonal treatment for menopause (yes/no), oral contraception use (yes/no), number of children (continuous), age at menarche (never, <12y, ≥12y), and age at first birth (never, <30y, ≥30y).

For all covariates except physical activity, ≤5% of values were missing and imputed to the modal (categorical variables) or median (continuous variables) values. A missing class was created for physical activity (14% missing). We conducted secondary analyses to examine the associations between sex-specific quartiles of intake of SFAs and calcium from dairy products and the risk of cancer. Sensitivity analyses were performed excluding participants with less than two years of follow-up and repeating the main analyses with a model not adjusted for dietary variables or personal health history.

All tests were two-sided, with $P<0.05$ considered to be statistically significant. We used SAS version 9.4 for the analyses.

Results

A total of 101,279 participants (78.7% women) with a median [interquartile range] follow-up time of 5.9 [2.7-8.3] years were included in the analyses. During follow-up, we documented the incidence of 2,503 overall cancers, 783 breast cancers (324 premenopausal and 459 postmenopausal), 323 prostate cancers and 182 colorectal cancers. Participants consumed on average 198.4 g/day of dairy products, with 83.3g/day of milk, 58.1g/day of yogurt, 36.9g/day of cheese and 17.7g/day of "fromage blanc".

Table 1 contains the baseline characteristics of all participants according to sex-specific quartiles of total dairy product consumption. At baseline, mean (SD) age was 42.2 (14.5) years and mean (SD) BMI was 23.7 (4.5) kg/m^2. Individuals with a higher consumption of total dairy products were more likely to have higher BMI and family history of cancer, to be current smokers and physically active. They also showed significantly higher intakes of energy (without alcohol), total lipids, carbohydrates and sodium and lower intakes of alcohol and sugary dairy desserts.

No association was observed between the consumption of total dairy products and the risk of overall cancer, and neither with the risk of breast cancer (with similar results pre and post-menopause), colorectal cancer and prostate cancer (Table 2).

Likewise, no association was observed for the consumption of milk, yogurt or cheese.

However, an increase of 1 serving in the consumption of "fromage blanc" was associated with an increased risk of overall cancer [HR (95% CI)=1.11 (1.01-1.21); *P* for trend=0.03] and colorectal cancer [HR=1.39 (1.09-1.77); *P* for trend<0.01] but not with breast or prostate cancer risk (Table 2). Similarly, 1-serving increment in sugary dairy dessert consumption was positively associated with the risk of colorectal cancer [HR=1.58 (1.01-2.46); *P* for trend=0.046] (Table 2).

In line, no association was observed between intakes of SFAs and calcium from dairy product sources and cancer risk (Table 3).

The results of the sensitivity analyses (Supplementary Table S1) for overall, colorectal and prostate cancer were similar to the main results.

Discussion

In the present study, no association was observed between the consumption of dairy products and the risk of overall, colorectal, breast or prostate cancers. The consumption of "fromage blanc" and sugary dairy desserts were however associated with higher risk of colorectal cancer.

Our results were in line with a recent meta-analysis showing that there were no strong associations between the intake of milk or yogurt and breast cancer risk [15]. Additionally, although some studies indicated that the consumption of milk and dairy products may increase the risk of prostate cancer, the evidence remains inconsistent [16]. However, unlike our findings, previous studies have shown a significant decreased colorectal cancer risk associated with the

consumption of total dairy products [17], supporting the conclusions of the WCRF/AICR (although the association with cheese consumption was less clear) [2], as well as an overall decrease in cancer risk related to fermented dairy food intake [18]. Differences between these studies and ours could pertained to differences in the amount and types of dairy products consumed but also differences in overall lifestyle between the population studied.

No clear mechanisms seem to explain the observed increased risk of colorectal cancer associated with the consumption of "fromage blanc", a dairy specialty resulting from lactic coagulation and draining, without further processing or additives. Thus, we suggest interpreting this result with caution, as it could result from an artefact of the study sample. The consumption of "fromage blanc" in France is often encouraged as part of dieting. Hence, individuals consuming higher amounts of "fromage blanc" (more likely to have a higher BMI, family history of cancer and higher prevalence of type 2 diabetes in our sample) may be those already at higher risk of cancer, thus introducing a bias in the observed association, even though we adjusted for personal history of diseases and family history of cancer in our main model and excluded cases occurring during the first years of follow-up in sensitivity analyses. In turn, sugary dairy desserts often contain elevated amounts of sugar as well as additives (for instance emulsifiers or texturizers) [19,20], which could contribute to explain the observed association with an increased colorectal cancer risk, notably through body weight gain and subsequent increase in insulin resistance [2].

This study has some limitations that should be acknowledged. First, since this is a volunteer-based cohort, participants in the NutriNet-Santé cohort were more often women, with health-conscious behaviors and with higher educational and socioeconomical status in comparison to the general French population [21]. This could limit the generalization of our results as it may have resulted in a lower number of incident cancer cases and a lower consumption of sugary dairy desserts, which could have led to underestimate the strength of the associations

observed. Secondly, the number of incident colorectal cancer cases was relatively limited, which may have prevented us from observing an association for total dairy consumption [2]. Statistical power was also limited by the fact that there was a substantial proportion of non-consumers for several dairy subtypes. Next, despite the multiple adjustments in our analyses, residual confounding or bias cannot be ruled out. Finally, dietary assessment tools are subject to some measurement error. Yet, to limit this bias, dietary intakes in this study were assessed using repeated 24h dietary records (mean number of dietary records per participant of 5.7 (SD: 3.1)) that have been validated against biomarkers and interviews by a trained dietitian [7–9].

Overall, our analyses did not show evidence of a statistically significant association between dairy product intake and cancer risk. The results suggest a positive modest association between the consumption of "fromage blanc" and sugary dairy desserts and colorectal cancer risk. However, this requires additional investigation in further prospective studies and more mechanistic insights.

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Authors' contribution: The authors' contributions were as follows – MDT, LBP, NEBS, LSS, MT conceptualized the study and defined the analytical strategy; LBP: performed statistical analyses and drafted the manuscript; MDT, MT: supervised statistical analyses;

MDT, NEBS, LSS, MT: supervised writing; LS, CD, BS, EC, GWF, SH, PG, EKG, CJ: critically helped in the interpretation of results, read and revised the manuscript and provided relevant intellectual input. They all read and approved the final manuscript. MDT and MT had primary responsibility for the final content.

Data availability statement: If you are a researcher of a public institution, you can submit a collaboration request including your institution and a brief description of your project to collaboration@etude-nutrinet-sante. All requests will be reviewed by the steering committee of the NutriNet-Santé study. A financial contribution may be requested. If the collaboration is accepted, a data access agreement will be necessary and appropriate authorizations from the competent administrative authorities may be needed. In accordance with existing regulations, no personal data will be accessible.

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Conflict of interest: Dr Nancy Babio declares that her institution received grants from Danone S.A. for the purposes of scientific and technical consulting but not for preparing this study. In addition, she was one of the members of the Scientific Advisory Board of the EU program for the promotion of milk and milk products within the framework of appropriate dietary practices (2017-2019). Jordi Salas was a member of the executive committee of the Instituto Danone España. He is currently an unpaid member of the Danone Institute España and the Danone International Institute and declares he has received funds to cover the

expenses derived from the Institute but not for this study. All other authors declare no conflict of interest.

Ethics Statement: Electronic informed consent was obtained from each participant. The NutriNet-Santé Study (registered at ClinicalTrials.gov as NCT03335644) is conducted according to the Declaration of Helsinki guidelines. It was approved by the Institutional Review Board of the French Institute for Health and Medical Research and the 'Commission Nationale de l'Informatique et des Libertés' (CNIL n°908450/n°909216).

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Table 1. Baseline characteristics of study population according to quartiles of dairy products consumption (*n*=101,279). NutriNet-Santé cohort, France, 2009-19[a]

Characteristics	All participants (*n*=101,279)	Quartiles of total dairy product consumption				*P*-value[a]
		1 (*n*=25,319)	2 (*n*=25,320)	3 (*n*=25,319)	4 (*n*=25,321)	
Age (years)	42.2 (14.5)	41.2 (14.2)	43.0 (14.4)	43.1 (14.6)	41.6 (14.5)	<0.001
Female sex, *n* (%)	79,742 (78.7)	19,935 (19.7)	19,936 (19.7)	19,935 (19.7)	19,936 (19.7)	-
Height (cm)	166.7 (8.0)	166.6 (8.0)	166.6 (8.1)	166.7 (8.0)	167.0 (8.1)	<0.001
BMI (Kg/m^2)	23.7 (4.5)	23.1 (4.2)	23.6 (4.4)	24.0 (4.5)	24.1 (4.7)	<0.001
Family history of cancer[b], *n* (%)	37,550 (37.1)	9,054 (8.9)	9,617 (9.5)	9,679 (9.6)	9,200 (9.1)	<0.001
Higher education						
No	17,279 (17.1)	4,138 (4.1)	4,344 (4.3)	4,354 (4.3)	4,443 (4.4)	<0.001
Yes, <2 years	17,311 (17.1)	4,379 (4.3)	4,224 (4.2)	4,268 (4.2)	4,440 (4.4)	
Yes, ≥2 years	66,689 (65.9)	16,802 (16.6)	16,752 (16.5)	16,697 (16.5)	16,438 (16.2)	
Smoking status, *n* (%)						
Never	17,516 (17.3)	5,709 (5.6)	4,634 (4.6)	3,889 (3.8)	3,284 (3.2)	<0.001
Former	32,816 (32.4)	7,978 (7.9)	8,438 (8.3)	8,604 (8.5)	7,796 (7.7)	
Current	50,947 (50.3)	11,632 (11.5)	12,248 (12.1)	12,826 (12.7)	14,241 (14.1)	
IPAQ physical activity level, *n* (%)						
High	28,154 (27.8)	6,809 (6.7)	6,936 (6.9)	7,180 (7.1)	7,229 (7.1)	
Moderate	37,587 (37.1)	9,466 (9.4)	9,631 (9.5)	9,421 (9.3)	9,069 (9.0)	<0.001
Low	21,422 (21.2)	5,629 (5.6)	5,310 (5.2)	5,188 (5.1)	5,295 (5.2)	
Missing	14,116 (13.9)	3,415 (3.4)	3,443 (3.4)	3,530 (3.5)	3,728 (3.7)	
Energy intake without alcohol (kcal/d)	1850,3 (452.1)	1748,1 (429.5)	1832,2 (426.3)	1870 (441.1)	1950,8 (485.3)	<0.001
Alcohol intake (g/d)	7.7 (11.8)	8.9 (13.4)	8.8 (12.4)	7.6 (11.1)	5.8 (9.7)	<0.001
Total lipid intake (g/d)	81.6 (25.3)	79.2 (24.3)	82.6 (24.3)	82.3 (25.1)	82.5 (27.2)	<0.001
Carbohydrate intake (g/d)	198.7 (57.6)	188.8 (57.7)	194.6 (53.7)	200 (55.0)	211,2 (61.1)	<0.001
Protein intake (g/d)	78.8 (21.5)	68.9 (19.5)	76.3 (19.0)	80.8 (19.4)	89.2 (22.6)	<0.001
Sodium intake, (mg/d)	2718,9 (885,3)	2,557 (875.7)	2734,3 (865.4)	2772,5 (878,6)	2811,8 (900)	<0.001
Number of children[c]	1.3 (1.2)	1.2 (1.2)	1.3 (1.2)	1.3 (1.2)	1.3 (1.3)	<0.001
Menopausal status at baseline[c]						
Premenopausal, *n* (%)	57,187 (71.7)	14,847 (18.6)	13,925 (17.5)	13,763 (17.3)	14,652 (18.4)	<0.001
Perimenopausal or postmenopausal, *n* (%)	22,555 (28.3)	5,088 (6.4)	6,011 (7.5)	6,172 (7.7)	5,284 (6.6)	
Use of hormonal treatment for menopause[c], *n* (%)	4,011 (17.9)	822 (3.7)	988 (4.4)	1,153 (5.1)	1,048 (4.7)	<0.001
Oral contraception[c], *n* (%)	22,475 (28.2)	5,472 (6.9)	5,366 (6.7)	5,524 (6.9)	6,113 (7.7)	<0.001
Total dairy product consumption[d] (g/d)	198.4 (148.8)	46.5 (26.1)	125.8 (22.1)	215.7 (32.4)	405.4 (121.8)	-
Milk consumption[e] (g/d)	83.3 (122.3)	5.9 (12.1)	25.0 (34.6)	69.7 (69.9)	232.6 (147.4)	-
Yogurt consumption[f] (g/d)	58.1 (68.9)	9.2 (16.7)	45.5 (39.0)	79.8 (61.9)	98.0 (93.6)	-
Cheese consumption[g] (g/d)	36.9 (28.0)	27.4 (20.4)	40.5 (27.4)	41.0 (29.6)	38.6 (31.2)	-
"Fromage blanc"[h] consumption (g/d)	17.7 (40.2)	3.4 (10.1)	12.9 (23.3)	22.3 (36.8)	32.1 (63.4)	-
Fermented dairy products consumption[i] (g/d)	115.8 (87.1)	40.7 (25.3)	101.4 (36.8)	147.0 (67.0)	174 (116.9)	-
Sugary dairy desserts consumption[j] (g/d)	36.3 (48.6)	36.9 (53.0)	37.6 (47.1)	35.3 (46.0)	35.3 (47.8)	-
Dairy SFA intake (g/d)	7.9 (5.1)	4.9 (3.5)	7.9 (4.5)	8.8 (5.0)	9.8 (5.7)	-
Dairy calcium intake (mg/d)	432.2 (248.9)	199.4 (134.5)	361.2 (150.6)	477.5 (166.1)	690.6 (226.6)	-

Abbreviations: BMI, body mass index; IPAQ, International Physical Activity Questionnaire; SFA, saturated fatty acids.

[a] P-values were obtained using Chi-square tests (categorical variables) or Fisher tests from unadjusted analysis of variance models (continuous variables).

[b]Among first-degree relatives.

[c]Among women.

[d]includes milk, cheese, yogurt, "fromage blanc" and "petit-Suisse".

[e]includes all mammalian milks including flavored milks (≤12% of the content in simple sugars).

[f]includes all yogurts made with mammalian milk (≤12% of the content in simple sugars).

[g]also comprises low-fat cheeses.

[h]French dairy specialty, similar to cottage cheese/quark (≤12% of the content in simple sugars).

[i]includes cheese, yogurt, "fromage blanc", "petit-Suisse" and fermented milk.

[j]includes cream dessert, pudding, custard, milk shakes, flavored milks, as well as fruit or sweetened yogurt, "fromage blanc" and "petit-Suisse" with ≥12% of the content in simple sugars.

Table 2. Associations between total dairy product and dairy product subtypes consumption and risk of cancer (*n*=101,279). NutriNet-Santé cohort, France, 2009-19[a]

	All cancers		Breast cancer		Colorectal cancer		Prostate cancer	
	Continuous per 1 serving increment[b]		Continuous per 1 serving increment		Continuous per 1 serving increment		Continuous per 1 serving increment	
	HR (95% CI)	*P* value for trend	HR (95% CI)	*P* value for trend	HR (95% CI)	*P* value for trend	HR (95% CI)	*P* value for trend
Cases/person-years (*n*)	2,503/555,386	-	783/435,186	-	182/555,386	-	323/120,200	
Total dairy[c]:	1.02 (0.98-1.05)	0.30	1.00 (0.93-1.06)	0.87	1.05 (0.93-1.19)	0.45	1.00 (0.91-1.09)	0.95
Milk[d]:	1.01 (0.96-1.07)	0.70	0.97 (0.88-1.07)	0.56	0.92 (0.74-1.15)	0.45	1.07 (0.94-1.23)	0.30
Yogurt[e]	0.99 (0.92-1.07)	0.74	1.02 (0.89-1.16)	0.82	0.90 (0.67-1.19)	0.45	1.03 (0.83-1.29)	0.77
Cheese[f]:	1.02 (0.96-1.07)	0.57	0.99 (0.89-1.10)	0.88	1.10 (0.93-1.30)	0.29	0.92 (0.80-1.05)	0.22
"Fromage blanc"[g]:	1.11 (1.01-1.21)	0.03	1.06 (0.90-1.24)	0.48	1.39 (1.09-1.77)	0.008	1.01 (0.77-1.34)	0.93
Fermented dairy products[h]:	1.02 (0.98-1.06)	0.32	1.01 (0.93-1.09)	0.83	1.10 (0.96-1.27)	0.17	0.95 (0.85-1.06)	0.37
Sugary dairy desserts[i]:	1.00 (0.88-1.14)	0.99	1.03 (0.82-1.29)	0.83	1.58 (1.01-2.46)	0.046	0.73 (0.49-1.07)	0.11

Abbreviations: CI, confidence interval; HR, hazard ratio.

[a]Cox proportional hazard models adjusted for age (timescale), sex (in models for overall and colorectal cancer only), height, BMI, baseline type 2 diabetes, prevalent hypertriglyceridemia, prevalent hypercholesterolemia, energy intake without alcohol, sugar intake, sodium intake, fruits and vegetables intake, whole foods, red and processed meat consumption, non-dairy calcium intake, non-dairy SFA intake, alcohol intake, number of 24 h dietary records, smoking status, educational level, physical activity, and family history of cancer. Breast cancer models were additionally adjusted for menopausal status, use of hormonal treatment for menopause, oral contraception use, number of children, age at menarche, and age at first birth. For analyses on dairy product subtypes, models were also adjusted for the consumption of each other dairy products than the one studied.

[b] Intakes in g/day were converted into servings/day based on the use of standard units: 150 g for milk, 125 g for yogurt, 30 g for cheese, 100 g for "fromage blanc", and 120 g for "petit-Suisse". Servings for total dairy products were calculated as the sum of the servings of milk, cheese, yogurt, "fromage blanc", and "petit-Suisse". Servings for fermented dairy products were calculated as the sum of the servings of cheese, yogurt, "fromage blanc", "petit-Suisse" and fermented milk. For sugary dairy desserts, we considered the same serving size as yogurt (125 g).

[c]includes milk, cheese, yogurt, "fromage blanc" and "petit-Suisse".

[d]includes all mammalian milks including flavored milks (≤12% of the content in simple sugars).

[e]includes all yogurts made with mammalian milk (≤12% of the content in simple sugars).

[f]also comprises low-fat cheeses.

[g]French dairy specialty, similar to cottage cheese/quark (≤12% of the content in simple sugars).

[h]includes cheese, yogurt, "fromage blanc", "petit-Suisse" and fermented milk.

[i]includes cream dessert, pudding, custard, milk shakes, flavored milks, as well as fruit or sweetened yogurt, "fromage blanc" and "petit-Suisse" with ≥12% of the content in simple sugars).

Table 3. Associations between SFAs and calcium from dairy product intakes and risk of cancer (*n*=101,279). NutriNet-Santé cohort, France, 2009-19[a]

Cancer site	All cancers		Breast cancer		Colorectal cancer		Prostate cancer	
	Continuous per 1 SD increment[b]		Continuous per 1 SD increment		Continuous per 1 SD increment		Continuous per 1 SD increment	
	HR (95% CI)	*P* value for trend	HR (95% CI)	*P* value for trend	HR (95% CI)	*P* value for trend	HR (95% CI)	*P* value for trend
Cases/person-years (*n*)	2,503/555,386	-	783/435,186	-	182/555,386	-	323/120,200	
SFAs from dairy products:	1.01 (0.96-1.06)	0.65	1.04 (0.94-1.15)	0.46	1.11 (0.95-1.30)	0.20	0.89 (0.78-1.01)	0.08
Calcium from dairy products:	1.02 (0.97-1.07)	0.51	0.97 (0.88-1.06)	0.44	1.07 (0.90-1.27)	0.47	0.99 (0.87-1.12)	0.04

Abbreviations: BMI, body mass index; CI, confidence interval; HR, hazard ratio; SD, standard deviation; SFA, saturated fatty acid.

[a]Cox proportional hazard models adjusted for age (timescale), sex (in models for overall and colorectal cancer only), height, BMI, baseline type 2 diabetes, prevalent hypertriglyceridemia, prevalent hypercholesterolemia, energy intake without alcohol, sugar intake, sodium intake, fruits and vegetables intake, whole foods, red and processed meat consumption, non-dairy calcium intake, non-dairy SFA intake, alcohol intake, number of 24 h dietary records, smoking status, educational level, physical activity, and family history of cancer. Breast cancer models were additionally adjusted for menopausal status, use of hormonal treatment for menopause, oral contraception use, number of children, age at menarche, and age at first birth.

[b]HRs are given for an increase of 1 SD in intake (SD:5.09 g/d for SFAs from dairy products, and 248.9 mg/d for calcium from dairy products).