Menopausal Transition Is Not Associated with Dietary Change in Swiss Women

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ABSTRACT

Background: Adherence to a healthy diet could contribute to maintaining adequate health throughout the menopausal transition, but data are scarce.

Objective: We evaluated the association between menopausal status and changes in dietary intake in Swiss adult women.

Methods: Cross-sectional ($n = 2439$) and prospective analyses ($n = 1656$) were conducted between 2009 and 2012 (first follow-up) among women (mean age ± SD, 58.2 ± 10.5 y) living in Lausanne, Switzerland. In both visits, dietary intake was assessed using a validated FFQ, and menopausal status was classified based on the presence or absence of menstruations. Multivariable linear and logistic regression models were used to investigate the cross-sectional association of menopausal status (postmenopausal compared with premenopausal) at the first follow-up with food intake and dietary recommendations. To examine whether menopausal status (premenopausal as reference group, menopausal transition, and postmenopausal) during 5 y of follow-up was associated with longitudinal changes in diet, including adherence to dietary Swiss recommendations, we applied multivariable linear and logistic mixed models adjusted for several covariates.

Results: At the first follow-up, postmenopausal women consumed less ($P < 0.002$) meat [median (IQR) 57.2 (35–86.2) compared with 62.5 (41.2–95.2) g/d], pasta [61.8 (37.5–89.2) compared with 85 (57.8–128) g/d], and added sugar [0.1 (0–4) compared with 0.7 (0–8) g/d] and more dairy products [126 (65.4–214) compared with 109 (64.5–182) g/d] and fruit [217 (115–390) compared with 174 (83.2–319) g/d] than premenopausal women. However, linear regression analysis adjusted for potential confounding factors showed no independent (cross-sectional) associations of menopausal status with total energy intake (TEI) and individual macro- or micronutrient intakes. In the prospective analysis, compared with women who remained premenopausal during follow-up ($n = 244$), no differences were found in changes in TEI, dietary intakes, or adherence to the Swiss dietary recommendations in women transitioning from premenopausal to postmenopausal ($n = 229$) and who remained postmenopausal ($n = 1168$).

Conclusion: The menopausal transition is not associated with changes in dietary habits among Swiss women. *J Nutr* 2021;151:1269–1276.

Keywords: menopause transition, dietary recommendation, dietary habits, Switzerland, cross-sectional, population-based study

Introduction

Menopause marks the end of a physiologic process, after which women face a drastic drop in estrogen concentrations, an increase in iron concentrations, appearance of menopausal symptoms, and an increase in the incidence and mortality rates for cardiovascular disease (CVD) (1, 2). Menopausal transition is associated with adverse changes in sleep and mood (3), body composition as weight gain and accumulation of central body fat (4), a shift toward a more atherogenic lipid profile and impairment of glucose homeostasis, and higher depression, all important risk factors for CVD and overall mortality (5–7). Numerous postmenopausal women also live with type 2 diabetes (T2D), which confers a greater risk of CVD in women compared with men (8–10). Furthermore, the menopausal transition has an adverse impact on overall musculoskeletal

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health, including osteoporosis, osteoarthritis, and sarcopenia (11).

As a preventive approach, balanced nutrition and correct dietary changes during the menopausal transition could have substantial positive effects on cardiometabolic risk, musculoskeletal health, and psychological health. To date, there are few studies examining changes in dietary intake during the menopausal transition (12), with inconsistent results and with smaller sample sizes (i.e., <1000 participants). Some studies report no change and some a decrease in total energy intake (TEI) and carbohydrates (13, 14). For health promotion and disease prevention in women transitioning in menopause, it is important to understand whether dietary changes occur. Furthermore, examining possible changes in dietary intake during menopause can also provide more information on whether the observed adverse metabolic changes during menopause can be attributed to dietary changes.

Therefore, we studied the changes in dietary intake in women before and after menopause using data from the CoLaus study. We compared cross-sectionally the dietary intake between pre- and postmenopausal women, and then we examined whether the change in menopausal status was prospectively associated with 5-y changes in dietary intake compared with women who remained premenopausal during the follow-up or were postmenopausal across the study period.

Methods

Study population

The study was carried out within the framework of CoLaus study, a population-based cohort study conducted in Lausanne, Switzerland. The details of the study have been reported elsewhere (15). Briefly, the baseline study was conducted between June 2003 and May 2006 and included 6733 participants, of whom 5064 attended the first follow-up, April 2009 and September 2012. The second follow-up included 4750 participants and was conducted between May 2014 and March 2017. During each visit, information on medical conditions, use of medications, and lifestyle was collected, and each participant was extensively evaluated regarding cardiovascular risk factors, and blood characterization was performed.

Ethical statement

The institutional Ethics Committee of the University of Lausanne, which afterward became the Ethics Commission of Canton Vaud (www.cer-vd.ch), approved the baseline CoLaus study (reference 16/03, decisions of January 13, 2003, and February 10, 2003). The approval was renewed for the first (reference 33/09, decision of February 23, 2009) and the second (reference 26/14, decision of March 11, 2014). The study was performed in agreement with the Declaration of Helsinki and its former amendments, as well as in accordance with the applicable Swiss legislation. All participants gave their signed informed consent before entering the study.

Selection criteria

The present study used data from the first and the second follow-up visits of the CoLaus study. A total of 2707 women were included in the first follow-up of CoLaus. Of these, 46 were excluded because there was no information on their menopause status and 222 women were excluded due to no information on dietary intake, leaving 2439 women for the cross-sectional analysis (**Figure 1**). Among them, 271 did not participate in the second follow-up visit of the study, and a further 527 women were excluded because there was no information on menopause status ($n = 57$), menopause status was unreliable (women reporting being postmenopausal at the first follow-up and premenopausal at the second follow-up; $n = 15$), or dietary intake was not known ($n = 455$), leaving 1641 women for the prospective analysis (Figure 1).

Menopause status

Women participating in the study were asked whether they were still having menses. Women reporting "no" were classified as postmenopausal and as premenopausal if they answered "yes." Based on the self-reported menopausal status at the first and second follow-up visits, women were classified as being *1*) *premenopausal-premenopausal* if they remained premenopausal, *2*) *premenopausal-postmenopausal* if they changed their status, *3*) and otherwise as *postmenopausal-postmenopausal*.

Dietary assessment

Dietary intake of 4 wk prior to the interview was assessed using a self-administered, semiquantitative FFQ that also included portion size (16). This FFQ has been validated among 626 volunteers from the Geneve population (16, 17). The FFQ consisted of 97 different food items accounting for >90% of the intake of calories, proteins, fats, carbohydrates, alcohol, cholesterol, vitamin D, and retinol and 85% of fiber, carotene, and iron. For each item, consumption frequencies ranging from "less than once during the last 4 weeks" to "2 or more times per day" were provided, and the participants indicated the average serving size (smaller, equal, or bigger) compared with a reference size. To calculate nutrient intakes, frequency of intake was multiplied by the nutrient composition of the specified portion size. Nutrient estimates were based on the French CIQUAL food composition table. Two values of TEI were computed: one including alcohol consumption, the other not. Carbohydrates (total and subtypes such as disaccharides), proteins (total, plant and animal derived), and fats (total, SFAs, MUFAs, and PUFAs) were expressed as a percentage of TEI (alcohol excluded). All food items were reported in g/d. Participants were further dichotomized based on whether they adhered to dietary guidelines recommendations of the Swiss Society of Nutrition, including *1*) 2 and 3 portions of fruits and vegetables per day, *2*) <3 portions of meat per week, *3*) >1 portion of fish per week, and *4*) 3 portions of dairy products per day (milk, yogurt, hard and soft cheese) (18). For each food item recommendation (fruits, vegetables, meat, fish, dairy products), a binary variable (1 = yes, 0 = no) was computed, classifying participants on whether they adhered to the recommendation per item. We also further divided participants into adhering to 3 or more recommendations.

Covariates

On the basis of biological plausibility and previous literature, we selected the potential confounding factors, namely, age, marital status, education level, BMI (in kg/m^2), history of CVD and diabetes, serum lipids, and antihypertensive, hypolipidemic, and antidiabetic treatments (19, 20).

Sociodemographic and lifestyle data were collected by self-administered questionnaires. Sociodemographic data included age, marital status (married, divorced, single, or widowed), and education level (university education, high school, apprenticeship, and mandatory

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The study participants of CoLaus have not provided consent to publicly share the individual-level data underlying this study. Information related to data access is available to qualified, interested researchers at https://www.colaus-psycolaus.ch/professionals/how-to-collaborate/. All responses to data-sharing requests must comply with the ethical and legal constraints of Switzerland.

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Supplemental Tables 1–10 are available from "Supplementary data" link in the online posting of the article and from the same link in the online table of contents at https://academic.oup.com.jn/.

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Abbreviations used: CVD, cardiovascular disease; FSH, follicle-stimulating hormone; TEI, total energy intake; T2D, type 2 diabetes.

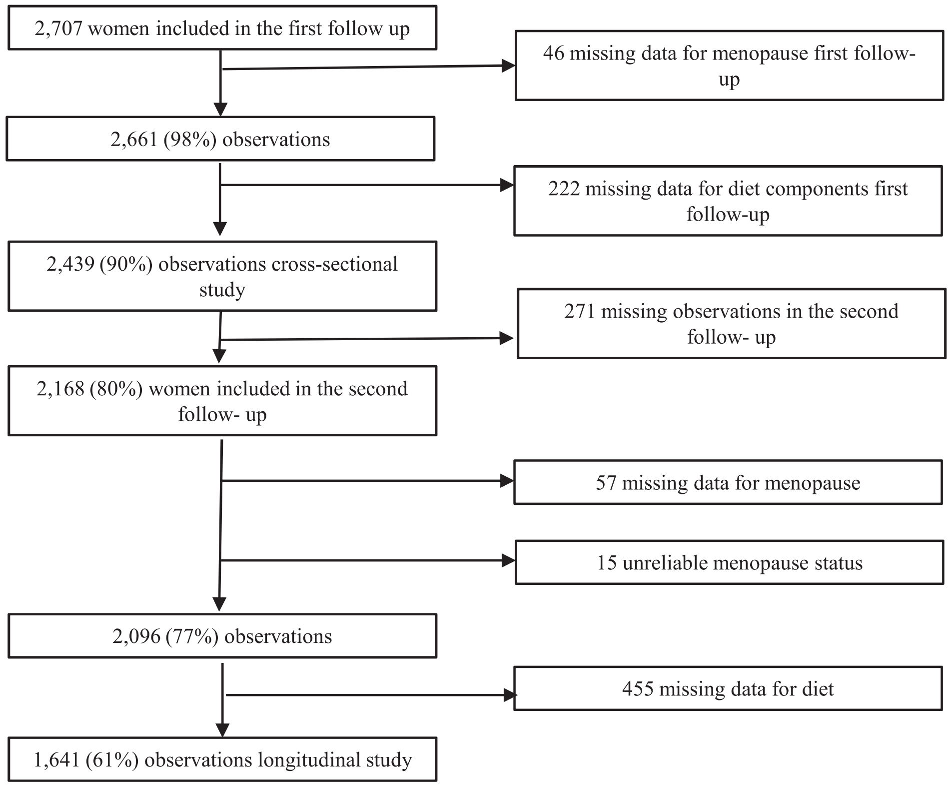

FIGURE 1 Selection of participants for the present study.

education). Health characteristics included BMI calculated and categorized in 3 groups (normal, 18.5 to <25; overweight, 25 to <30; and obese, ≥30) based on the WHO recommendations (21). CVD was defined as a history of myocardial infarction, coronary artery bypass surgery, or percutaneous transluminal coronary angioplasty. T2D mellitus was diagnosed if fasting serum glucose concentration was ≥7 mmol/L or if the participants used glucose-lowering medication. Participants also indicated whether they used antihypertensive medications or lipid-lowering medications.

Statistical analysis

Statistical analyses were performed using Stata version 15.1 for Windows (StataCorp). Continuous variables were reported as mean ± SD if normally distributed and as median and IQR if not normally distributed; categorical variables were presented as numbers and percentages. The normality of continuous variables was checked using a histogram and the Shapiro–Wilk test.

Cross-sectional analysis

We compared the sociodemographic, diet, and other lifestyle variables between pre- and postmenopausal women included in the cross-sectional analysis, using the Student *t* test, Wilcoxon rank-sum test, and χ^2 test, as appropriate. Age and multivariable-adjusted linear and logistic regression models were performed to examine whether menopause status (premenopausal compared with postmenopausal) was cross-sectionally associated with TEI, food intake, and dietary recommendations. Factors for multivariable analyses were selected based on current knowledge and literature, and they were adjusted for age, education level, civil status, BMI, prevalent CVD and diabetes, and use of medications, including lipid-lowering medications and antihypertensive treatment.

Longitudinal analysis

We used repeated-measures analysis to analyze dietary changes during the follow-up among *1*) women who transitioned from premenopausal to menopausal, as well as among women who remained *2*) premenopausal or *3*) postmenopausal. To examine whether changing menopausal status during the follow-up was independently associated with changes in TEI and dietary intake, we performed a linear mixed model with random effects of menopausal categories: *1*) premenopausal during the follow-up (as reference), *2*) women who transitioned to menopause, and *3*) women who were postmenopausal during the all study periods. The models were adjusted for age, education level, civil status, BMI, prevalent CVD and diabetes, and use of medications, including lipid-lowering medications and antihypertensive treatment. Similarly, to investigate whether menopause status would affect changes over time in adherence with the dietary guidelines, we applied mixed-effects logistic regression .

Sensitivity analysis

As a sensitivity analysis, to investigate the possibility of selection bias, we examined whether there were differences in sociodemographic characteristics between included and excluded women from the cross-sectional analysis by using χ^2 or Student *t* test. Because some of the dietary variables were not normally distributed, we also reran the main linear regression and linear mixed analyses using natural log-transformed values, and for longitudinal analysis, we also did a sensitivity analysis applying a generalized linear mixed model, which does not require the response variable to be normally distributed. To explore the impact of BMI, we stratified the main cross-sectional and longitudinal analyses by BMI categories [normal (<25) compared with overweight/obese (≥25)]. To evaluate a possible overadjustment for age or the impact of TEI without alcohol, we ran a sensitivity analysis excluding age as a covariate and using TEI without alcohol as a variable instead of TEI with alcohol. Because physical activity and weight changes during menopausal transition could be related to diet (22), in the longitudinal analysis, we included BMI at both visits as a covariate and also baseline physical activity (expressed as total time min/d). To examine the impact of dietary supplements, we ran the main analyses *1*) adjusting for supplement use (vitamins and minerals, calcium and vitamin D) or *2*) excluding women reporting dietary supplements.

TABLE 1 Demographic and clinical characteristics of women at the first and second follow-ups (after 5 y) of the CoLaus study[1]

Characteristic	First follow-up	Second follow-up
Sample size	*n* = 2439	*n* = 1656
Age, y	58.2 ± 10.5	62.9 ± 9.9
BMI	25.5 ± 4.9	25.7 ± 4.9
BMI category,[2] *n* (%)		
Normal	1284 (53.1)	832 (50.3)
Overweight	753 (31.1)	550 (33.2)
Obese	383 (15.8)	272 (16.4)
Waist circumference, cm	87.4 ± 12.8	86.3 ± 12.6
Smoking status, *n* (%)		
Former	826 (33.9)	593 (36.7)
Never	1126 (46.3)	752 (46.6)
Current	482 (19.8)	269 (16.7)
Educational level, *n* (%)		
University education	443 (18.2)	322 (19.4)
High school	659 (27)	477 (28.8)
Apprenticeship	881 (36.1)	618 (37.3)
Mandatory education	455 (18.7)	239 (14.4)
Marital status, *n* (%)		
Single	413 (16.9)	288 (17.4)
Married/cohabitating	1207 (49.5)	774 (46.7)
Divorced	593 (24.3)	410 (24.8)
Widowed	226 (9.3)	182 (11)
Menopause status, *n* (%)		
Premenopause	677 (27.8)	254 (15.3)
Postmenopause	1762 (72.2)	1397 (84.4)
History of CVD, *n* (%)		
Yes	76 (3.1)	78 (4.7)
No	2363 (96.9)	1578 (95.3)
History of diabetes, *n* (%)		
Yes	137 (5.6)	94 (5.7)
No	2295 (94.4)	1562 (94.3)
Serum lipids, mmol/L		
HDL cholesterol	1.8 ± 0.4	1.8 ± 0.4
LDL cholesterol	3.4 ± 0.9	3.2 ± 0.9
Triglycerides	1.2 ± 0.6	1.2 ± 0.8
Treatments, *n* (%)		
Antihypertensive	584 (23.9)	474 (28.6)
Hypolipidemic	371 (15.2)	272 (16.4)
Antidiabetic	69 (2.8)	73 (4.4)

[1]Values are mean ± SD unless otherwise indicated. CVD, cardiovascular disease.
[2]BMI (in kg/m^2) categories: normal, 18.5 to <25; overweight, 25 to <30; and obese, ≥30.

In addition, we explored whether menopause status in the cross-sectional and longitudinal analyses was associated with supplement intake. An additional sensitivity analysis was performed censoring the nutrition data at the 0.5 and 99.5 percentiles to account for the influence of outliers.

To account for multiple testing, we applied a conservative Bonferroni-corrected $P < 0.002$ [0.05 divided by the number of diet variables ($n = 30$)].

Results

Sample characteristics

The characteristics of the study sample of women included in the cross-sectional and longitudinal analyses are shown in Table 1. After 5 y, women reported higher use of antidiabetic medications and were less frequently current smokers.

Cross-sectional analysis: Menopausal status and dietary intake at first follow-up

Compared with premenopausal women, postmenopausal women were older, had higher BMI, and had more prevalent CVD and T2D (**Supplemental Table 1**). No differences were found in TEI between nonmenopausal and menopausal women (mean ± SD; 1686 ± 638 compared with 1633 ± 649 kcal/d). Compared with premenopausal women, postmenopausal women reported consuming less meat, pasta, added sugar, polysaccharides, MUFAs, and cholesterol but more dairy products, fruits, monosaccharides, and retinol (**Supplemental Table 2**). However, the multivariable linear regression analysis showed no association between menopause status, TEI, and the intake of micro- and macronutrients (**Table 2**). With no adjustments for potential confounding factors, compared with premenopausal women, postmenopausal women showed higher adherence to the dietary guidelines on fruit intake [*n* (%) 809 (33.2) compared with 253 (19.4)] and meat intake [769 (31.5) compared with 248 (10.2)], but no difference was found between the 2 women-groups for other dietary components (Supplemental Table 2). The multivariable logistic regression analysis showed no association between menopause status and adherence to Swiss dietary guidelines related to intake of fruits or for vegetables, meat, or dairy products (Table 2).

Longitudinal analysis: Changes in menopausal status and changes in dietary intake

During the follow-up, there were 244 women who remained premenopausal, and 229 women transitioned from premenopausal to menopause; the rest ($n = 1168$) were postmenopausal women at both first and second follow-up. TEI and dietary intake according to different menopausal status at the first follow-up and after 5 y are summarized in **Supplemental Table 3**.

For the women remaining premenopausal during follow-up, there was an increase in intakes of total fat and MUFAs and a decrease in intakes of pastries, pasta, added sugar, total carbohydrates, and monosaccharides. Premenopausal women transitioning to menopause, during the follow-up, consumed less milk and pasta and more MUFAs, whereas no differences were found for the other dietary components. Menopausal women from the first to second follow-up showed a reduction in intakes of milk, bread and cereals, pasta, vegetable proteins, total carbohydrates, monosaccharides, polysaccharides, and fiber but increases in fish, total fat, SFAs, MUFAs, cholesterol, and vitamins (Supplemental Table 3). The multivariable linear mixed-model analysis showed that, compared with women remaining premenopausal during the follow-up, women transitioning to menopause or being postmenopausal had no significant differences in changes in dietary intake over 5 y ($P < 0.002$). Similarly, women transitioning to menopause or being postmenopausal, compared with women remaining premenopausal during the follow-up, showed no differences in changes in adherence to Swiss dietary guidelines (18) (**Table 3**).

Sensitivity analysis

Supplemental Table 4 summarizes the characteristics of women included in the final cross-sectional analysis ($n = 2439$) and of those excluded ($n = 268$). Compared with women included in the cross-sectional analysis, excluded women were less frequently married and single and more divorced or widowed, had a lower education level, and mostly were current smokers with a higher prevalence of history of diabetes. Stratification analyses by BMI categories did not show a

TABLE 2 Multivariable cross-sectional association between menopausal status (postmenopausal compared with premenopausal women) and dietary intake at the first follow-up of the CoLaus study[1]

Characteristic	β or OR (95% CI)[4]	*P* value
Sample size	$n = 2439$	
Total energy, kcal/d	–36.6 (–116, 43.1)	0.37
Daily intake, animal products, g/d		
Meat	9.4 (0.6, 18.1)	0.04
Fish	–0.06 (–4.8, 4.7)	0.98
Milk	–9.9 (–22.4, 2.5)	0.12
Dairy products	0.2 (–18.9, 19.3)	0.98
Daily intake, other foods, g/d		
Bread and cereals	–3.7 (–11.8, 4.3)	0.36
Pastries	0.09 (–2.2, 2.1)	0.80
Pasta	–9.8 (–16.8, –2.7)	0.01
Added sugar	–0.4 (–1.3, 0.5)	0.41
Vegetable oils	0.3 (–0.6, 1.2)	0.58
Fruits	13.7 (–18.8, 46.2)	0.41
Vegetables	–0.2 (–17.8, 17.4)	0.98
Dietary intake (% of TEI)		
Total proteins	0.4 (–0.02, 0.8)	0.06
Vegetable proteins	–0.1 (–0.2, 0.05)	0.17
Animal proteins	0.5 (0.03, 1)	0.04
Total carbohydrate	–0.8 (–1.9, 0.4)	0.18
Monosaccharides	0.5 (–0.6, 1.6)	0.36
Polysaccharides	–1.2 (–2.2, –0.3)	0.01
Total fat	–0.1 (–0.9, 0.8)	0.88
SFAs	–0.2 (–0.6, 0.2)	0.39
MUFAs	0.04 (–0.4, 0.5)	0.85
PUFAs	0.05 (–0.1, 0.2)	0.63
Daily nutrient intake per day		
Alcohol, g	5.6 (–3.8, 15.1)	0.24
Fiber, g	–0.04 (–1.2, 1.1)	0.95
Cholesterol, mg	0.2 (–17.4, 17.9)	0.98
Calcium, mg	–18.2 (–81.2, 44.8)	0.57
Iron, mg	0.04 (–0.5, 0.5)	0.88
Retinol, μg	13 (–76.3, 102)	0.78
Carotene, μg	–14.7 (–447, 417)	0.95
Vitamin D, μg	0.2 (–0.1, 0.4)	0.30
Adherence to dietary guidelines		
Fruits	1.0 (0.7, 1.2)	0.70
Vegetables	1.2 (0.8, 1.9)	0.35
Meat[2]	0.9 (0.7, 1.2)	0.66
Fish[3]	1.1 (0.8, 1.4)	0.64
Dairy products	0.9 (0.6, 1.2)	0.46
Guidelines adherence score		
At least 3 recommendations	1.0 (0.7, 1.4)	0.84

[1]Values are coefficients β (95% CI) for each food item and OR (95% CI) for dietary guidelines [18], comparing postmenopausal to nonmenopausal women. TEI, total energy intake.
[2]Included poultry.
[3]Included fresh and fried/baked fish.
[4]Obtained from linear or logistic regression models adjusted for age, BMI, education level, civil status, prevalent cardiovascular and diabetes, and use of antihypertensive and hypolipidemic treatments have been applied

role of BMI in the cross-sectional (**Supplemental Table 5**) and longitudinal (**Supplemental Table 6**) associations between menopause status and dietary intake. Restricting the analyses to nutrition data within 0.5 and 99.5 percentiles and using natural log-transformed values of dietary variables yielded similar results to the main analyses (data not shown). Also, applying generalized linear mixed models (**Supplemental Table 7**) did not significantly change the main results. Unlike the results reported in the main analyses, by removing age as a covariate, we found in the cross-sectional analysis that menopause status was associated with pasta, added sugar, and adherence to fruit dietary recommendations ($P < 0.002$) (**Supplemental Table 8**), whereas in the longitudinal analysis, postmenopausal women, compared with postmenopausal women after 5 y, significantly reported higher intakes of dairy products and fruits, lower intake of pasta, and higher adherence to fruit and meat dietary recommendations ($P < 0.002$) (**Supplemental Table 9**). Performing the longitudinal analysis with adjustment for BMI at 2 time points and also for baseline physical activity (**Supplemental Table 10**) or using TEI without alcohol did not

TABLE 3 Multivariable longitudinal association between menopausal categories (premenopausal as reference group, menopausal transition, and postmenopausal) and dietary intake in the first and second follow-up (after 5 y) of the CoLaus study[1]

Characteristic	Pre-postmenopause		Post-postmenopause	
	β or OR (95% CI)[4]	P value	β or OR (95% CI)[4]	P value
Sample size	$n = 229$		$n = 1168$	
Total energy, kcal/d	−36.6 (−136, 62.7)	0.47	−34.8 (−136, 66.3)	0.50
Daily intake, animal products, g/d				
Meat	−1.4 (−10, 7.2)	0.74	5.1 (−3.6, 13.9)	0.25
Fish	−0.7 (−5.5, 4.0)	0.76	0.9 (−3.9, 5.7)	0.72
Milk	−6.8 (−21.9, 8.2)	0.38	−9.6 (−24.9, 5.8)	0.22
Dairy products	−1.8 (−23.7, 20.1)	0.87	4.9 (−17.4, 27.2)	0.67
Daily intake, other foods, g/d				
Bread and cereals	3.2 (−6.9, 13.3)	0.54	−1.4 (−11.6, 8.9)	0.79
Pastries	−1.8 (−5.4, 1.8)	0.34	0.1 (−3.6, 3.8)	0.94
Pasta	−3.8 (−12.8, 5.2)	0.41	−10.6 (−20.8, −2.5)	0.01
Added sugar	−0.9 (−2.0, 0.2)	0.11	−0.7 (−1.8, 0.4)	0.20
Vegetable oils	0.4 (−0.7, 1.6)	0.44	0.6 (−0.6, 1.7)	0.34
Fruits	4.8 (−34, 43.5)	0.81	20.2 (−19.3, 59.6)	0.32
Vegetables	−3 (−22.6, 16.6)	0.76	2.4 (−17.5, 22.3)	0.81
Dietary intake, % of TEI				
Total proteins	−0.1 (−0.6, 0.4)	0.65	0.4 (−0.1, 0.9)	0.16
Vegetable proteins	0.1 (−0.1, 0.3)	0.33	−0.04 (−0.2, 0.1)	0.63
Animal proteins	−0.2 (−0.8, 0.4)	0.47	0.4 (−0.2, 1)	0.15
Total carbohydrates	0.01 (−1.4, 1.4)	0.99	−0.8 (−2.2, 0.6)	0.28
Monosaccharides	−0.5 (−1.8, 0.8)	0.42	0.02 (−1.3, 1.3)	0.97
Polysaccharides	0.5 (−0.6, 1.7)	0.38	−0.8 (−2.0, 0.4)	0.20
Total fat	0.1 (−0.9, 1.2)	0.81	0.1 (−1, 1.1)	0.90
SFAs	−0.2 (−0.7, 0.3)	0.42	−0.3 (−0.8, 0.2)	0.26
MUFAs	0.3 (−0.3, 0.9)	0.33	0.2 (−0.3, 0.8)	0.41
PUFAs	0.1 (−0.1, 0.3)	0.49	0.1 (−0.1, 0.3)	0.21
Daily nutrient intake per day				
Alcohol, g	−1.5 (−13.1, 10)	0.79	2.1 (−9.7, 13.9)	0.73
Fiber, g	0.3 (−1.0, 1.7)	0.63	0.3 (−1.1, 1.7)	0.68
Cholesterol, mg	−7.1 (−28.5, 14.2)	0.51	−7.4 (−29.2, 14.3)	0.50
Calcium, mg	−48 (−122, 26)	0.20	−16.2 (−91.5, 59.1)	0.67
Iron, mg	−0.1 (−0.7, 0.5)	0.68	−0.1 (−0.7, 0.5)	0.78
Retinol, μg	−41 (−129, 46.7)	0.36	−9.2 (−98.5, 80.1)	0.84
Carotene, μg	−254 (−786, 278)	0.35	−195 (−737, 346)	0.48
Vitamin D, μg	−0.2 (−0.4, 0.1)	0.31	0.1 (−0.2, 0.4)	0.62
Adherence to dietary guidelines				
Fruits	−0.1 (−0.6, 0.4)	0.75	−0.1 (−0.6, 0.4)	0.64
Vegetables	0.1 (−0.5, 0.8)	0.70	0.1 (−0.5, 0.8)	0.69
Meat[2]	0.4 (−0.1, 0.9)	0.15	0.2 (−0.3, 0.7)	0.48
Fish[3]	0.1 (−0.5, 0.7)	0.75	0.2 (−0.3, 0.8)	0.43
Dairy products	−0.3 (−2, 1.4)	0.70	−0.3 (−1.9, 1.3)	0.68
Guidelines adherence score				
At least 3 recommendations	0.2 (−0.3, 0.7)	0.41	0.1 (−0.4, 0.6)	0.72

[1]Values are coefficients β (95% CI) for each food item and OR (95% CI) for dietary guidelines [18], between menopausal categories, with women being premenopausal at both first and second follow-ups as reference category. TEI, total energy intake.
[2]Included poultry.
[3]Included fresh and fried/baked fish.
[4]Obtained from linear or logistic mixed-effect models adjusted for age, BMI, civil status, prevalent cardiovascular and diabetes, and use of hypertensive and hypolipidemic treatments have been applied.

materially change the results (data not shown). Also, the cross-sectional and longitudinal analyses adjusted for supplement use (vitamins and minerals, calcium and vitamin D) or excluding women reporting dietary supplements did not materially change the results. Finally, menopause status was not associated with supplement intake at baseline or with changes in supplement intake during the 5 y of follow-up (data not shown).

Discussion

To our knowledge, this is the first large study to comprehensively investigate the associations of menopause status and transition to menopause with dietary changes. We observed that among adult Swiss women, there are changes in diet over time, but these changes are independent of the level and changes in menopause status.

In our study, menopause per se was not a period of marked changes in TEI and dietary intake even after stratification by BMI. This is in line with a study of 898 women that reported that nutrient intakes over a period of 5 to 6 y were similar across menopausal status, with menopause not being independently associated with changes in diet (12). Also, a small study of 94 women showed no role of menopausal status on any of macronutrients investigated during 5 y of follow-up, except for an increase in carbohydrate intake in the menopausal transition group compared with women being postmenopausal for over 12 mo. However, in the later study, the premenopausal women and women transitioning into menopause were grouped together, making the interpretation of the results challenging (13).

Cross-sectional analysis

In the cross-sectional analysis, postmenopausal women consumed more fruits and retinol but less meat, pasta, and added sugar compared with nonmenopausal women. Adherence to dietary guidelines was higher in postmenopausal women. A possible explanation for these differences could be that postmenopausal women, as they age, could have a higher health awareness due to a higher number of diagnosed conditions, as well as a higher purchasing power. This is also supported by our results that, after adjusting for cardiovascular risk factors and chronic conditions, showed no differences between pre- and postmenopausal women on all food items. Also, after removing age as a covariate from the analyses, some of these results remained significant.

Longitudinal analysis

In the prospective analysis, the menopause transition was not associated with changes in TEI and diet, except for a decrease in milk consumption and pasta. The decrease in milk and pasta consumption over a period of 5 y was also observed in premenopausal and postmenopausal women, albeit the decline in milk intake was nonsignificant in premenopausal women. This suggests that the decrease in milk and pasta intake might not be due to the changes in menopause status but could be related to other factors. For instance, the decrease in milk consumption could be due to increased awareness of lactose intolerance and/or due to the large availability in the past years of plant-based types of milk in the market. Many marketing campaigns advertise the use of different types of milk deriving from soya, coconut, almond, rice, and so on rather than cow and other animals, which were constituting the milk component included in our analyses.

Considering age and menopause are correlated, it is difficult to understand the contribution of each of the 2 factors in affecting dietary changes. Removing age from our analyses, postmenopausal women at the first follow-up, compared with postmenopausal women after 5 y, showed higher intakes of dairy products and fruits, lower intake of pasta, and higher adherence to fruit and meat dietary recommendations but not other dietary factors considered in the current study. Future research is needed to understand the independent effects of menopause and age (Supplemental Tables 8 and 9).

Menopause, cardiometabolic changes, and diet

While women undergo menopause, they experience various symptoms, including hot flashes, night sweats, depression, irritability, and anxiety, which might increase the risk of CVD and hamper quality of life. The decline in estrogen concentrations and accumulation of iron during menopause can negatively affect metabolism, potentially leading to weight gain and repercussions on cholesterol levels and carbohydrate digestion (23). In addition, the hormonal changes during menopause can lead to decreased bone density and adverse metabolic changes, which can, in turn, increase the risk of fractures (24) and overall mortality. These adverse metabolic changes in menopause, including weight gain, can also be due to adverse changes in dietary intake in women transitioning into menopause or due to increases in energy intake because of increased appetite (13, 25). Future research is needed to explore dietary factors that could counteract the adverse metabolic changes women experience after menopause and improve women's overall health.

Public health implications

Healthier eating habits (e.g., more vegetables and fruits) and specific educational campaigns throughout women's lives could be important in maintaining optimal health and reducing the development of several medical complications during the menopausal years. Yet, there is little research examining the effect of changes in diet during menopausal transition on metabolic changes and cardiovascular health. Future studies should examine which dietary components or dietary patterns are associated with better health during menopausal transition and whether the identified dietary components/patterns have beneficial and long-term effects in women.

Study limitations

This study has several limitations. First, the food questionnaire is based on self-reported data, with the possibility of inaccurate reporting and recall bias. Although FFQs can be used to estimate TEI, the overall TEI would be a less accurate estimate, and therefore our results on TEI should be interpreted with caution (26). The food questionnaire also is focused on a limited number of food items (97 overall), and some food groups were missing.

We had no information on type of carotene intakes but only on total intake of carotene, and therefore, we cannot exclude the possibility that women may have changed the consumption of different types of carotenoids. Also, FFQs may not be very sensitive in detecting dietary changes, despite studies demonstrating that FFQs, compared with 24-h dietary recalls, have greater reproducibility in detecting differences in self-reported dietary intake over time (27). Furthermore, our study included only the population of Lausanne and Caucasian women, and it might not be generalized for all Swiss people, other populations, and other ethnicities. A misclassification of menopause status might be due to self-reported data and missing information regarding the absence of menstruations in the past 12 mo. Also, because the diet in the longitudinal analysis was assessed prospectively, the subjective measure of menopause would probably lead to nondifferential misclassification with respect to the outcome and would therefore bias estimates toward the null. Yet, when exploring the women reporting the age of menopause, 100% of them had reported no menses, suggesting that the misclassification is unlikely to have happened. Future studies with better definition of menopause status are needed to replicate our findings. For instance, self-reported menopause status should capture the lack of menstruations in the past 12 mo. Also, use of biomarkers as follicle-stimulating hormone (FSH) is helpful if the diagnosis is in doubt in women with suspected premature ovarian failure, but concentrations of FSH do not predict when the last menstrual period will occur. Measurement of thyroid-stimulating hormone and prolactin is also useful in investigating menstrual irregularity (28). Finally, some differences have been reported between included and excluded women regarding smoking status, educational level, marital status, history of diabetes, and antidiabetic treatment, and therefore, the possibility of selection bias cannot be excluded.

Conclusion

In this Swiss population-based study, menopause per se was not associated with changes in TEI and dietary habits or with changes in adherence to dietary guidelines.

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The authors' contributions were as follows—TM: conceived and supervised the study; GG, PM-V, and TM: designed the study; GG, PFR, MG, LB, AB, PM-V, OHF, and TM: participated in data acquisition, collection, analysis, or interpretation; GG and PFR: performed the statistical analyses; GG and TM: drafted the manuscript; PFR, MG, LB, AB, PM-V, and OHF: critically revised the manuscript for intellectual content; and all authors: approved the final version of the manuscript.

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