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ARTICLE

Epidemiology

Twenty-four-year trends and determinants of change in compliance with Swiss dietary guidelines

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Abstract

Background and aims A healthy diet is the cornerstone of disease prevention, and dietary guidelines have been issued in most countries. We aimed to assess trends in compliance with dietary guidelines in the population of Geneva, Switzerland.

Methods Multiple cross-sectional, population-based surveys conducted between 1993 and 2016 in the canton of Geneva, Switzerland [20,310 participants (52.3% women, mean age 51.9 ± 10.7 years)]. Trends in compliance with the Swiss dietary guidelines regarding food intake were assessed using logistic regression (a) for each guideline and (b) for at least three guidelines. Compliance before and after the first and second issuing of the guidelines was assessed.

Results After multivariable adjustment, compliance with fruits increased overall [odds ratio and (95% confidence interval) for 1-year increase: 1.007 (1.003–1.012), $p < 0.001$], in men, participants aged over 45 and with low educational level. Compliance with vegetables increased overall [1.015 (1.008–1.022), $p < 0.001$], in both genders, age groups [45–54 and 55–64] and participants with low educational level. Compliance with meat increased in women [1.007 (1.001–1.013), $p = 0.021$] and participants with a university degree. Compliance with fresh fish increased in age group [55–64] [1.009 (1.000–1.018), $p = 0.041$]. Compliance with dairy products decreased overall [0.979 (0.972–0.986), $p < 0.001$] and in all groups studied, except for age group [65–74]. Compliance with at least three guidelines increased in age group [55–64] only [1.013 (1.002–1.024), $p = 0.019$]. No effect of the issuing of the guidelines was found.

Conclusion In the Geneva adult population, compliance with the Swiss dietary guidelines improved little. Issuing of dietary guidelines did not impact trends.

Introduction

Dietary intake is the cornerstone for prevention of non-communicable diseases [1] and food guidelines are instruments to guiding healthy food choices by the population [2]. Many countries have issued national dietary guidelines [3–5]. Compliance with dietary recommendations is an important factor for health maintenance and disease prevention [6], but several studies have shown that compliance with national dietary guidelines is low [7, 8]. Still, of the few studies that assessed trends in compliance with dietary guidelines [9–12], some focused on a single guideline [11] or on a specific group of the population [12]. In Switzerland, the dietary guidelines were first issued by the Swiss society of nutrition in 1998, and again in 2011 [5, 13]. Whether the publication of the guidelines led to changes in compliance has never been assessed.

In a previous study [14], we assessed trends in compliance with Swiss guidelines regarding nutrient intake in the Geneva adult population. Still, compliance with nutrient

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intake is harder to convey than to food intake, and many recent studies have pointed out that the protective role of diet against noncommunicable diseases is not due to nutrients alone, but to food and dietary patterns [15–18].

Thus, we now aimed to assess the 24-year trends (1993–2016) in compliance with the Swiss Society of Nutrition (SSN) guidelines for food intake [5]. We also assessed whether the issuing of the Swiss dietary guidelines led to significant changes in compliance. Our hypothesis was that overall compliance increased in the adult population of Geneva, but that the issuing of the guidelines had little if no effect.

Participants and methods

Participants

The "Bus Santé" study is a cross-sectional, on-going population-based study designed to collect information on chronic disease risk factors in the canton of Geneva, Switzerland. Geneva is the westernmost canton of Switzerland, surrounded on almost all sides by France [19]. The sampling methodology of the "Bus Santé" Geneva study has been reported previously [20]. Every year since 1993, a representative sample of non-institutionalized men and women aged 35–74 years is recruited. Participation rates ranged from 50 to 66% throughout the study period.

Dietary intake

Dietary intake was assessed using a validated, self-administered, semi-quantitative FFQ, which also included portion size [21, 22]. Information derived from this FFQ has contributed to several reports from large consortium such as the Global Burden of Disease [23, 24]. 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 participants indicated the average serving size (smaller, equal or bigger) compared to a reference size.

Reported frequencies were transformed into daily consumption frequencies as follows: "never these last 4 weeks" = 0; "once/month" = 1/28; "2–3/month" = 2.5/28; "1–2/week" = 1.5/7; "3–4 times/week" = 3.5/7; "once/day" = 1 and "2 + /day" = 2.5. The consumption frequency of one food category was obtained by summing up all individual consumption frequencies of foods related to that category. For example, daily fruit consumption was obtained by summing up the daily consumptions of fresh fruits (5 items) and fruit juices (fresh and processed without added sugar).

Participants were dichotomized according to whether they followed the dietary guidelines for fruits, vegetables, meat, fish and dairy products from the Swiss Society of Nutrition [13]. The guidelines were as follows: (a) ≥2 fruit portions per day; (b) ≥3 vegetable portions per day; (c) ≤5 meat portions per week; (d) ≥1 fish portion/week and (e) ≥3 dairy products portions/day. As the FFQ queried about fresh and fried fish, two categories were considered: one including and one excluding fried fish, as several studies have shown that fried fish or fried foods are associated with an increased risk of cardiovascular events [25, 26], and also because fried fish represented between 34% (in 2007) and 41% (in 1993) of all fish consumed. Participants were further dichotomized if they complied with at least three guidelines or not; two categories of compliance were created, depending on the type of fish consumed (including or excluding fried fish).

Covariates

Health examinations were conducted throughout the year, from January to December, in two clinics and one mobile medical unit. Body weight and height were measured using standard procedures, and body mass index (BMI, kg/m^2) was calculated. Data for socio-demographic characteristics, smoking and educational history were collected using self-administered, standardized questionnaires. Trained collaborators performed the examinations, interviewed the participants and checked the self-administered questionnaires for completion. Procedures were regularly reviewed and standardized across collaborators.

Smoking status (never smokers, ex-smokers, current smokers) was self-reported. Marital status was categorized as living alone (i.e. being single, divorced and widowed) or in couple (i.e., married or cohabiting). Nationality was defined as Swiss and non-Swiss. Due to changes in coding during the study period, educational level attained was grouped into "university" and "other".

Exclusion criteria

We applied the following exclusion criteria: (a) participants reporting less than 30 items consumed, as this was considered as a marker of either incomplete reporting or of dietary monotony; (b) age <35 or ≥75 years; and (c) missing data for any covariate (age, BMI, education, marital status, smoking habits or nationality).

Ethics statement

The "Bus Santé" Geneva study was approved by the University of Geneva ethics committee and all study participants provided informed written consent to participate in the study. The study has been performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki and its later amendments.

Statistical analysis

Statistical analysis was performed using Stata software version 15.1 (Stata Corp, College Station, TX, USA). Descriptive results were expressed as number of participants (percentage) for categorical variables or as mean ± standard deviation (SD) for continuous variables. Bivariate analysis was performed using chi-square test for categorical variables and analysis of variance for continuous variables. Yearly trends were assessed using unadjusted and multivariable-adjusted logistic regression using compliance to each guideline (dichotomous, yes/no) as dependent variable and year, gender [except when stratifying on gender]; age group [except when stratifying on age group]; education [except when stratifying on education]; body mass index (normal, overweight, obese); marital status (living in couple, living alone); nationality (Swiss, non-Swiss) and smoking status (current, former, never) as independent variables. Results were expressed as multivariable-adjusted odds ratios (OR) and [95% confidence interval (CI)] for a one-year increment. In both unadjusted and adjusted analyses, survey year was used as a continuous variable. Differences in trends between age groups were assessed by including an interaction term (i.e., age groups × year) in the multivariable models.

Generational analysis was conducted using [35–44] and [45–54] age groups in 1993. The [35–44] age group in 1993 corresponded to the [40–49] age group five years later (1998) and to the [45–54] age group in 2003. To assess 20-year trends, only age groups [35–44] and [45–54] in 1993, corresponding to age groups [55–64] and [65–74] in 2013 and further on, were considered. Differences in age groups regarding trends were assessed by including an interaction term (i.e. age groups × year) in the multivariable models.

The impact of the guidelines on compliance was assessed by comparing compliance levels in the 5-year period before and after the issuing of the guidelines. Firstly, we compared period 1993–1997 with period 1998–2002, and period 2006–2010 with period 2011–2015. Secondly, a pooled analysis grouping the two 5-year periods before and the two 5-year period after the issuing of the guidelines was performed.

Statistical significance was considered for a two-tailed test with $p < 0.05$.

Results

Characteristics of participants

Of the initial 22,730 participants, 2,420 (10.6%) were excluded. The reasons for exclusion are indicated in Supplemental Figure 1 and the comparison between included and excluded participants is provided in Supplemental Table S1. Excluded participants were younger (secondary to the age exclusion criteria), more frequently women, less frequently current smokers, had a slightly lower BMI, lived more frequently alone and were more frequently non-Swiss than included ones.

The characteristics of the participants according to survey year are summarized in Table 1 and in Supplemental Table S2. Between 1993 and 2016, mean age and BMI of participants increased; the frequency of current smokers and participants with an educational level below university decreased, and the frequency of participants who were overweight or obese, non-Swiss or lived in couple increased.

Trends in compliance with dietary guidelines

The trends in compliance with at least three dietary guidelines overall and stratified by gender and age group is summarized in Table 2 (including fried fish) and Table 3 (excluding fried fish). The overall results are presented in Supplemental Table S3 (including fried fish) and Supplemental Table S4 (excluding fried fish). In non-adjusted analysis, compliance (including fried fish) increased in women and decreased in participants with educational level below university; after multivariate adjustment, compliance increased in the [55–64] age group and decreased in [35–44] and [45–54] age groups (Table 2 and Supplemental Table S3). When fried fish was excluded, compliance increased in the whole sample and in men, the [55–64] age group and in participants with educational level below university; after multivariate adjustment, compliance increased only in the [55–64] age group (Table 3 and Supplemental Table S4).

Trends regarding individual guidelines are indicated in Supplemental Table S5 (for fruits), Supplemental Table S6 (for vegetables), Supplemental Table S7 (for meat), Supplemental Table S8 (for fish, including fried fish), Supplemental Table S9 (for fish, excluding fried fish) and Supplemental Table S10 (for dairy products) (Table 4). For compliance with fruits, after multivariate adjustment, an improvement was found in the whole sample, in men, in participants aged over 45 and with educational level below university; the increase in men was significantly different from women (p for interaction: 0.003), while no difference was found between educational levels (p for interaction: 0.298) (Supplemental Table S5). For compliance with vegetables, improvements were found in the whole sample, for both genders, in the [45–54] and [55–64] age groups and in participants with educational level below university; the increase in participants with educational level below university was significantly different from participants with a university degree (p for interaction: 0.024) (Supplemental

Table 1 Characteristics of the participants of Bus-Santé study (Geneva, Switzerland) for the period 1993–2016

	1993	2016	Yearly trend	*P* value
Age (years)	51.9 ± 10.3	51.9 ± 11.0	0.030 (0.008–0.052)	0.007
Woman, *n* (%)	335 (50.0)	360 (50.9)	0.997 (0.993–1.001)	0.106
Smoking status, *n* (%) §				
Never	296 (44.2)	336 (47.5)		
Former	168 (25.1)	232 (32.8)	1.003 (0.998–1.008)	0.236
Current	206 (30.8)	139 (19.7)	0.979 (0.975–0.984)	< 0.001
BMI (kg/m^2)	24.4 ± 3.8	25.1 ± 4.3	0.038 (0.030–0.046)	< 0.001
BMI categories, *n* (%) §				
Normal	414 (61.8)	386 (54.6)		
Overweight	202 (30.2)	235 (33.2)	1.012 (1.008–1.017)	< 0.001
Obese	54 (8.1)	86 (12.2)	1.030 (1.023–1.038)	< 0.001
Living in couple, *n* (%)	488 (72.8)	526 (74.4)	0.995 (0.990–0.999)	0.022
Nationality, non-Swiss, *n* (%)	173 (25.8)	260 (36.8)	1.015 (1.011–1.020)	< 0.001
Education, non-university, *n* (%)	447 (66.7)	331 (46.8)	0.958 (0.954–0.962)	< 0.001

Results are expressed as mean ± SD or as number of participants (percentage) except for column trend, where the results are expressed as slope (95% confidence interval) for continuous variables and as odds ratio (95% confidence interval) for categorical variables. The data from all years were used in the analysis, but for the sake of space and formatting only data from the first and last years are reported. Statistical analysis by linear regression for continuous data and by logistic regression (simple or § multinomial) for categorical data. For multinomial regression, never smokers and normal BMI were considered as the reference group. For complete data, please consult Supplemental Table S2.

BMI body mass index

Table 2 Twenty-three year trends (1993–2016) in compliance with at least three dietary guidelines (including fried fish) for the participants of the Bus-Santé study, Geneva, Switzerland

	1993	2016	OR (95% CI)[a]	*P* value[a]	OR (95% CI)[b]	*P* value[b]	*P* value for interaction[b]
Overall	175 (26.1)	176 (24.9)	1.003 (0.998–1.008)	0.223	1.002 (0.997–1.006)	0.511	
Gender							0.748
Female	59 (17.6)	68 (19.6)	1.008 (1.001–1.016)	0.029	1.005 (0.998–1.013)	0.183	
Male	116 (34.6)	108 (30.0)	1.000 (0.994–1.006)	0.912	0.999 (0.993–1.005)	0.765	
Age group (years)							0.244
35–44	40 (20.7)	38 (16.9)	0.993 (0.984–1.002)	0.152	0.990 (0.980–0.999)	0.029	
45–54	54 (24.3)	48 (23.2)	1.004 (0.995–1.012)	0.413	1.005 (0.997–1.014)	0.235	
55–64	54 (31.0)	51 (34.5)	1.008 (0.998–1.017)	0.118	1.010 (1.000–1.020)	0.058	
65–74	27 (33.3)	39 (30.7)	1.005 (0.994–1.016)	0.401	1.005 (0.993–1.016)	0.426	
Education							0.190
University	64 (28.7)	97 (25.8)	0.995 (0.988–1.002)	0.175	0.994 (0.987–1.002)	0.141	
Other	111 (24.8)	79 (23.9)	1.007 (1.000–1.013)	0.034	1.006 (1.000–1.012)	0.067	

Results are expressed as number of participants and (percentage) and as odds ratio (OR) and 95% confidence interval (CI). Percentages are computed based on the number of participants for each category (i.e., 35–44 years) within each year. Data from all years were used in the analysis, but for the sake of space and formatting only data from the first and last years are reported. Statistical analysis by logistic regression within each stratum. For complete data, please consult Supplemental Table S3.

[a]*p* value for trend, unadjusted

[b]*p* value for trend, adjusting for gender [except when stratifying on gender]; age group [except when stratifying on age group]; education [except when stratifying on education]; body mass index (normal, overweight, obese); marital status (living in couple, living alone); nationality (Swiss, non-Swiss) and smoking status (current, former, never).

Table S6). For compliance with meat, improvements were found in women and in participants with a university degree (Supplemental Table S7). For compliance with fish (including fried fish), a decrease was found in the whole sample, in the [45–54] age group and in participants with university degree (Supplemental Table S8); when fried fish

Table 3 Twenty-three year trends (1993–2016) in compliance with at least three dietary guidelines (excluding fried fish) for the participants of the Bus-Santé study, Geneva, Switzerland

	1993	2016	OR (95% CI)[a]	*P* value[a]	OR (95% CI)[b]	*P* value[b]	*P* value for interaction[b]
Overall	122 (18.2)	135 (19.1)	1.005 (1.000–1.010)	0.038	1.003 (0.998–1.008)	0.202	
Gender							0.502
Female	85 (25.4)	85 (23.6)	1.004 (0.910–1.010)	0.239	1.002 (0.995–1.009)	0.561	
Male	37 (11.0)	50 (14.4)	1.010 (0.004–1.019)	0.022	1.006 (0.997–1.014)	0.203	
Age group (years)							0.141
35–44	26 (13.5)	28 (12.4)	0.995 (0.985–1.005)	0.334	0.990 (0.980–1.000)	0.074	
45–54	36 (16.2)	34 (16.4)	1.003 (0.993–1.012)	0.554	1.004 (0.994–1.013)	0.464	
55–64	45 (25.9)	44 (29.7)	1.011 (1.000–1.021)	0.032	1.013 (1.002–1.024)	0.019	
65–74	15 (18.5)	29 (22.8)	1.011 (0.999–1.023)	0.061	1.012 (0.999–1.024)	0.059	
Education							0.146
University	48 (21.5)	78 (20.7)	0.994 (0.987–1.002)	0.502	0.997 (0.989–1.005)	0.429	
Other	74 (16.6)	57 (17.2)	1.006 (1.000–1.012)	0.019	1.008 (1.001–1.014)	0.036	

Results are expressed as number of participants and (percentage) and as odds ratio (OR) and 95% confidence interval (CI). Percentages are computed based on the number of participants for each category (i.e., 35–44 years) within each year. The data from all years were used in the analysis, but for the sake of space and formatting only data from the first and last years are reported. Statistical analysis by logistic regression within each stratum. For complete data, please consult Supplemental Table S4.

[a]*p* value for trend, unadjusted

[b]*p* value for trend, adjusting for gender [except when stratifying on gender]; age group [except when stratifying on age group]; education [except when stratifying on education]; body mass index (normal, overweight, obese); marital status (living in couple, living alone); nationality (Swiss, non-Swiss) and smoking status (current, former, never).

was excluded, an increase in compliance was found in the [55–64] age group (Supplemental Table S9). Finally, compliance with dairy products decreased in the whole sample and in almost all groups studied, except for the [65–74] age group (Supplemental Table S10).

Generational trends in compliance with dietary guidelines

The results for the generational trends in compliance with dietary guidelines are indicated in Table 4 and in Supplemental Table S11. After multivariable adjustment, compliance with at least three guidelines (with or without fried fish) improved in both groups; compliance with fruits, vegetables, meat and fish (excluding fried) improved, while no changes were found regarding compliance with fish (including fried) and dairy products (Table 4 and Supplemental Table S11).

Impact of the issuing of the guidelines on compliance

The results for the impact of the issuing of the Swiss dietary guidelines in 1998 and 2011 on compliance with at least three dietary guidelines are indicated in Table 5. Overall, no significant changes were found regarding compliance before and after the issuing of the guidelines for both periods concerned, and similar findings were obtained when the analysis was split by gender, age group or educational level. Similar findings were obtained for the individual guidelines or when pooling the periods before and after each issuing of the guidelines (1998 and 2011; Supplemental Tables S12 to S19).

Discussion

This study aimed to assess the changes in compliance with the SSN guidelines over the last 24 years in a Swiss adult population. The results indicate that compliance with at least three guidelines was rather low and remained so over the 24-year study period. Conversely, an increase in compliance was found for generations aged [35–44] and [45–54] in 1993.

Trends in compliance with dietary guidelines

Compliance with the SSN guidelines was low and remained so during the 24-year study period: the percentage of subjects complying with at least 3 guidelines was 26.2% in 1993 and 24.9% in 2016. Those findings agree with a prospective study conducted in the neighbour city of Lausanne, where only 25.2% of the population complied with at least three guidelines [27]. There are few studies worldwide assessing trends in global compliance with dietary guidelines. A likely explanation for the low improvement in

Table 4 Twenty-three year generational trends (1993–2016) in compliance with at least three dietary guidelines (excluding fried fish) for the participants of the Bus-Santé study, Geneva, Switzerland

	1993	2016	OR (95% CI) [a]	*P* value[a]	OR (95% CI)[b]	*P* value[b]	*P* value for interaction[b]
At least 3							0.934
35–44	40 (20.7)	43 (37.1)	1.030 (1.021–1.040)	<0.001	1.033 (1.023–1.043)	<0.001	
45–54	54 (24.3)	29 (30.2)	1.028 (1.018–1.038)	<0.001	1.035 (1.024–1.045)	<0.001	
At least 3, no fried fish							0.499
35–44	26 (13.5)	38 (32.8)	1.040 (1.029–1.051)	<0.001	1.043 (1.032–1.055)	<0.001	
45–54	36 (16.2)	20 (20.8)	1.030 (1.019–1.041)	<0.001	1.036 (1.025–1.047)	<0.001	
Fruits							0.627
35–44	78 (40.4)	66 (56.9)	1.026 (1.018–1.035)	<0.001	1.029 (1.020–1.039)	<0.001	
45–54	95 (42.8)	52 (54.2)	1.033 (1.024–1.042)	<0.001	1.040 (1.031–1.050)	<0.001	
Vegetables							0.744
35–44	10 (5.2)	19 (16.4)	1.032 (1.019–1.046)	<0.001	1.034 (1.020–1.049)	<0.001	
45–54	21 (9.5)	8 (8.3)	1.021 (1.006–1.035)	0.003	1.027 (1.012–1.042)	<0.001	
Meat							0.578
35–44	102 (52.9)	68 (58.6)	1.014 (1.006–1.023)	0.001	1.016 (1.007–1.024)	<0.001	
45–54	117 (52.7)	53 (55.2)	1.013 (1.004–1.022)	0.002	1.016 (1.007–1.055)	<0.001	
Fish (all)							0.436
35–44	136 (70.5)	82 (70.7)	1.005 (0.996–1.015)	0.222	1.006 (0.997–1.010)	0.166	
45–54	158 (71.2)	67 (69.8)	1.003 (0.994–1.013)	0.435	1.005 (0.994–1.015)	0.336	
Fish (excl. fried)							0.187
35–44	70 (36.3)	63 (54.3)	1.026 (1.018–1.035)	<0.001	1.026 (1.017–1.035)	<0.001	
45–54	85 (38.3)	44 (45.8)	1.014 (1.005–1.022)	0.002	1.015 (1.006–1.025)	0.001	
Dairy products							0.270
35–44	13 (6.7)	10 (8.6)	0.998 (0.984–1.011)	0.789	0.997 (0.983–1.011)	0.705	
45–54	14 (6.3)	14 (14.6)	1.005 (0.991–1.019)	0.421	1.003 (0.989–1.018)	0.616	

Twenty-three-year generational trends (1993–2016) in compliance with dietary guidelines for the participants of the Bus-Santé study, Geneva, Switzerland

Results are expressed as number of participants and (percentage) and as odds ratio (OR) and 95% confidence interval (CI). Percentages are computed based on the number of participants for each generational cohort within each year. Statistical analysis by logistic regression within each stratum. For complete data, please consult Supplemental Table S11.

[a]*p* value for trend, unadjusted

[b]*p* value for trend, adjusting for gender; education; body mass index (normal, overweight, obese); marital status (living in couple, living alone); nationality (Swiss, non-Swiss) and smoking status (current, former, never).

global compliance is that the increase in compliance with some guidelines (i.e., fruits and vegetables) was compensated by the decrease in compliance with other guidelines (i.e., dairy) [27].

Compliance with fruits and vegetables guidelines increased in all studied groups, a finding also found in France [28] and in the United States [11], but not in New Zealand [10]. The increase in compliance with the vegetable guideline is likely due to the increased availability of vegetables in Switzerland between 1961 and 2007 [29]. Conversely, the increase in compliance with the fruits guideline could not be explained by increased availability, as it actually decreased during the same period [29], from 138 in 1961 to 79 kg/capita/year in 2007 [30]. Indeed, Switzerland produces less than 50% of all foodstuffs of plant origin consumed [31], and the price of fruits has increased almost 70% between 1982 and 2017 [31]. An alternative explanation would be that Geneva inhabitants increased buying fruits and other foods from food retails in neighboring France, as food prices are considerably lower in France than in Switzerland [32].

Compliance with the dairy products guideline decreased in almost all studied groups, a finding also reported in France [28]. Conversely, dairy consumption remained stable in New Zealand [10] and Germany [9], and increased in the United States [11]. This decrease in compliance with dairy product guideline explains the decrease in calcium intake reported in a previous study conducted in the same population [14]. Dairy products are a good source of high quality proteins, vitamins and minerals [33], have been

Table 5 Compliance with at least three dietary guidelines five years before and after publication of the Swiss dietary guidelines, overall and stratified by gender, age group and educational categories, Bus Santé study, Geneva, Switzerland

	1998–2002 vs. 1993–1997	*P* value	2011–2015 vs. 2006–2010	*P* value
Overall	1.017 (0.929–1.113)	0.718	0.992 (0.870–1.131)	0.906
Gender				
Female	1.007 (0.869–1.166)	0.929	0.998 (0.813–1.226)	0.985
Male	1.021 (0.910–1.146)	0.718	0.984 (0.830–1.167)	0.855
Age group (years)				
35–44	0.983 (0.829–1.164)	0.839	0.832 (0.654–1.059)	0.135
45–54	1.005 (0.853–1.184)	0.954	1.079 (0.836–1.392)	0.560
55–64	1.026 (0.856–1.230)	0.780	0.950 (0.733–1.233)	0.701
65–74	1.106 (0.880–1.390)	0.387	1.230 (0.893–1.694)	0.205
Education				
University	1.061 (0.905–1.243)	0.465	0.970 (0.794–1.186)	0.769
Other	0.997 (0.892–1.113)	0.954	0.999 (0.840–1.187)	0.988

Results are expressed as odds ratio and (95% confidence interval) for periods of five years before relative to after issuing the guidelines (1998 and 2011). Statistical analysis by logistic regression adjusting for gender [except when stratifying on gender]; age group [except when stratifying on age group]; education [except when stratifying on education]; body mass index (normal, overweight, obese); marital status (living in couple, living alone); nationality (Swiss, non-Swiss) and smoking status (current, former, never). Results are expressed as odds ratio and (95% confidence interval) for periods of five years before relative to after issuing the guidelines (1998 and 2011)

associated with better nutrient and improved bone health status [34] and might protect against metabolic syndrome [15], cardiovascular disease and type 2 diabetes [34]. Overall, our results indicate that dairy product intake is being neglected by the Geneva population, with possible health consequences on the long term.

Compliance with the meat guideline improved in women and in participants with a university degree. A decrease in meat consumption had also been reported for women in New Zealand [10]. This finding indicates that the more healthy-conscious groups tend to better adhere with dietary guidelines. Indeed, in previous study conducted in Switzerland, persons adhering to the Swiss food pyramid consumed meat significantly less often than persons not adhering to it [35]. Overall, our results indicate that compliance with the meat guideline improved only slightly over the 24-year study period.

Compliance with the fish guideline decreased. The prevalence of compliance decreased even further (from 73.3 to 40.2% in 1993) when fried fish was excluded; this is likely due to the large proportion of fried fish consumed (between 34 and 41% of all fish). Still, when fried fish was excluded, no change regarding trends in compliance was found, except for an increase in age group [55–64]. Our results are consistent with previous longitudinal studies conducted in New Zealand [10], Germany [9] and France [28], where no changes in reported fish consumption were found. Fish consumption is associated with a lower risk of heart failure [36] and all-cause mortality [37], while fried fish does not protect against heart failure [38] and is associated with an increased risk cardiovascular disease [25, 39]. This deleterious association might be related to the type of frying oil used, as a Spanish study found no association between foods fried in olive or sunflower oil and coronary heart disease [40]. Hence, it would be important that fish consumption be improved in the Geneva population, and that cooking methods other than frying be used.

Generational trends in compliance with dietary guidelines

Compliance with most guidelines improved with time, the sole exceptions being compliance with fish (including fried) and dairy products. Several factors might explain this improvement. First, income tends to increase with age, allowing subjects to buy healthier (and usually more expensive) foods; indeed, a previous study has shown that price was one of the main barriers for healthy eating, and that its prevalence decreased with age [41, 42]. Second, because of the high cost of food in Switzerland, people living in Geneva are increasingly buying their foods in nearby France, which might also increase the accessibility to healthier foods [32]. Finally, elderly subjects present more frequently with chronic, non-communicable diseases, the management of which includes dietary therapy; for instance, we have previously shown that subjects with dyslipidemia tend to consume a healthier diet than the general population [43], although no such improvement was found among subjects with type 2 diabetes [44] or hypertension [45]. Overall, our results suggest that compliance with dietary guidelines tends to improve with aging. Still, as our results were based on multiple cross-sectional surveys,

it would be of interest to replicate these findings in a prospective study.

Impact of the issuing of the guidelines on compliance

No significant effect of the issuing of the guidelines by the Swiss society of nutrition in 1998 and 2011 was found. A possible explanation is that simple educational measures have little impact on food purchases compared to other measures such as changes in food prices [46, 47]. Indeed, a previous study identified cost as one of the major barriers towards healthy eating [41, 42]. Overall, our results suggest that the issuing of the Swiss dietary guidelines had little if no impact at all regarding healthy eating.

Importance for public health nutrition

Compliance with food-based dietary recommendations positively impacts population health status [48]. Our results suggest that compliance with dietary guidelines has not improved in a large sample of adults representative of the Geneva population. It would be important to promote healthy eating either by publicizing the guidelines in the lay media or by intervening on food prices, as this approach has been shown to be more efficient than nutritional education [46, 47].

Strengths and limitations

This study has several strengths: data were collected using a validated FFQ and the same standardized methodology was used throughout a 24-year period.

This study also has several limitations. Firstly, the FFQ was not updated and could not take into account possible changes in food availability that occurred during the study period [29]. Still, it would have been complicated to change the FFQ during the study period and to harmonize the findings. Secondly, the guidelines were first issued in 1998, so it is possible that the trends might have been biased by a period (1993–1997) where no guidelines existed. Still, restricting the analysis to the period 1998–2016 led to similar findings (Supplemental Tables S20 to S28), suggesting that the issuing of the guidelines had little if no effect on compliance. Thirdly, this study only assessed the population of the Geneva canton; as dietary intake differs between linguistic regions in Switzerland [49], the generalizability of the findings might be suboptimal. Still, in the absence of similar studies conducted in other cantons, it is currently unknown if trends differ. Finally, food-based dietary guidelines differ slightly between countries (Supplemental Table S29) [50], so our results might not be generalizable to other countries. Nevertheless, this study can be considered as a reference for long-term trends in compliance with healthy diet guidelines.

Conclusion

In the Geneva population, compliance with the Swiss dietary guidelines regarding food intake was rather low and remained so over a 24-year period. Generational trends improved. The issuing of guidelines by the Swiss society of nutrition had no effect on trends.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

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