Fifteen-year trends in the prevalence of barriers to healthy eating in a high-income country[1–3]

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ABSTRACT

Background: Despite increasing levels of education and income in the Swiss population over time and greater food diversity due to globalization, adherence to dietary guidelines has remained persistently low. This may be because of barriers to healthy eating hampering adherence, but whether these barriers have evolved in prevalence over time has never been assessed, to our knowledge.

Objective: We assessed 15-y trends in the prevalence of self-reported barriers to healthy eating in Switzerland overall and according to sex, age, education, and income.

Design: We used data from 4 national Swiss Health Surveys conducted between 1997 and 2012 (52,238 participants aged ≥18 y, 55% women), applying multivariable-adjusted logistic regression models to assess trends in prevalence of 6 barriers to healthy eating (taste, price, daily habits, time, lack of willpower, and limited options).

Results: The prevalence of 3 barriers exhibited an increasing trend until 2007, followed by a decrease in 2012 (from 44% in 1997 to 50% in 2007 and then to 44% in 2012 for taste, from 40% to 52% and then to 39% for price, and from 29% to 34% and then to 32% for time; quadratic P-trend < 0.0001). Limited options decreased slightly until 2007 (35–33%) and then sharply by 2012 (18%) (linear P-trend < 0.0001). Daily habits remained relatively stable across time from 42% in 1997 to 38% in 2012 (linear P-trend < 0.0001). Conversely, lack of willpower decreased steadily over time from 26% in 1997 to 21% in 2012 (linear P-trend < 0.0001). Trends were similar for all barriers irrespective of sex, age, education, and income.

Conclusion: Between 1997 and 2012, barriers to healthy eating remained highly prevalent (≥20%) in the Swiss population and evolved similarly irrespective of age, sex, education, and income. *Am J Clin Nutr* 2017;105:660–8.

Keywords: trends, barriers to healthy eating, adult population, Switzerland, socioeconomic and demographic factors

INTRODUCTION

Healthy eating can lower the risk of developing chronic diseases, such as obesity, diabetes, hypertension, myocardial infarction, stroke, and many forms of cancer (1, 2). Although different diet types can facilitate healthy eating, all are generally characterized by high intakes of fruits, vegetables, whole grains, nuts, and seeds and low intakes of sugar, red meat, and processed foods (2, 3). Women, older people, and those with normal BMI and higher socioeconomic status (SES)[6] are more likely to follow healthy diets (4, 5). Among the factors influencing healthy eating, evidence points to food price (e.g., healthy foods are too expensive) (6–8), food taste (e.g., healthy foods lack taste) (6, 9), time constraints (e.g., lack of time to prepare and cook healthy foods) (6, 7, 10), and lack of willpower (6)—all self-perceived barriers that people identify as impediments to achieve and maintain healthy eating. Hence, despite widespread dietary guidelines and improved nutrition knowledge in the population (11), people face many barriers preventing them from healthy eating.

The Swiss population enjoys a high quality of life, low unemployment and poverty, universal health care, and one of the longest life expectancies worldwide (12). In comparison with bordering France or Germany, Switzerland has low cardiovascular disease risk factors and mortality (13). However, compliance to the Swiss dietary guidelines has remained low in the population (14), showing no improvements over time (15). A previous nationwide study showed that barriers to healthy eating were highly prevalent (≥20%) and demographically and socioeconomically patterned in the Swiss population (16). Still, whether the prevalence of barriers to healthy eating remains constant or evolves over time has never been assessed. Such analysis is important given the persistently low compliance to the dietary guidelines, particularly

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against a backdrop of increasing education and income levels in the Swiss population, as well as increasing globalization that has introduced greater food diversity and decreasing food prices (17). Thus, we used data from the national Swiss Health Surveys (SHSs) conducted between 1997 and 2012 to assess the trends in prevalence of barriers to healthy eating in the adult population according to different demographic and socioeconomic indicators.

METHODS

Database and sampling

Data from 4 consecutive SHSs conducted between 1997 and 2012 were used. The SHS is a cross-sectional, nationwide, population-based study conducted every 5 y by the Swiss Federal Statistical Office. The SHSs do not require consent from an Ethics Committee because they are part of the Swiss Federal Government mandate, and the data were anonymized before use.

Selection of participants was based on a stratified random sampling applied to a database of all private Swiss households with a registered landline or portable telephone (>90% of households between 1997 and 2012), which was further expanded by the use of the official population registries available at each Swiss village or city. The first stratum consisted of the 7 administrative regions of Switzerland (Leman, Mittelland, Northwest, Zurich, Northeast, Central, and South), and the second stratum consisted of the 26 Swiss cantons (equivalent to American states). The primary sampling unit was the household, and the secondary sampling unit was the individual aged ≥15 y. For each sampled subject, an invitation letter to participate in the survey was sent, and phone contacts were made if no response to the letter was obtained. Participants were interviewed by phone by using computer-assisted telephone interview software, and those aged ≥75 y could opt for a face-to-face interview at home (to accommodate participants with disabilities that may interfere with a phone interview; <5% of total participants chose this between 1997 and 2012). Subsequently, all participants were invited to fill out an additional written questionnaire sent by mail. The interviews were conducted in German, French, or Italian—individuals unable to speak any were excluded, as were those with asylum-seeker status or with very poor health. The participation rate was 85% in 1997, 64% in 2002, 66% in 2007, and 53% in 2012. SHS details (in French and German) are available at: http://www.bfs.admin.ch/bfs/portal/fr/index/infothek/erhebungen__quellen/blank/blank/ess/04.html.

Barriers to healthy eating

Barriers to healthy eating were assessed by the question "Many people, maybe including yourself, place importance in following a healthy diet. Please identify which of the following obstacles prevent you from having a healthy diet," which had 10 different possible items, and the responder chose "yes" or "no" for each of them. The different versions of the items are provided in **Supplemental Table 1** and can be summarized as follows: *1*) time, *2*) limited options in markets, *3*) limited options in restaurants, *4*) price, *5*) no social support, *6*) social group opposition, *7*) taste, *8*) fondness of abundant food, *9*) daily habits, and *10*) lack of willpower. The questions assessing barriers were set by a multidisciplinary group of experts, but no reference to any previously validated instrument could be found. However, the barriers assessed were similar to those used in other studies (6, 8, 9, 18, 19), none of which had been validated either. Hence, in the absence of a standard, validated instrument, the current questionnaire was the only option for the Swiss population.

Demographic and socioeconomic variables

Data were self-reported. Age was categorized into 4 groups (18–35, 36–50, 51–65, and >65 y) for the descriptive and multivariable analyses; for the age-period-cohort analysis, age was categorized into twelve 5-y groups (from 18–22 to 73–77 y). Weight and height were collected, and the resulting BMI (in kg/m^2) was categorized as normal or underweight (<25), overweight (25 to <30), and obese (≥30). Smoking status was categorized as current smoker (yes or no), nationality as Swiss or non-Swiss, and living area as urban or rural. Civil status was categorized as married, single, divorced or separated, and widowed. Education was categorized as mandatory, secondary, or tertiary. Mandatory education in Switzerland corresponds to 9 y. Income (net household income after taxes) was categorized into tertiles for each SHS sample [values expressed in Swiss francs (CHF); 1 CHF = 1.04 US$ or 0.92 €]: lower: <2778 CHF, middle: 2778–4000 CHF, and higher: >4000 CHF for 1997; lower: <3000 CHF, middle: 3000–4500 CHF, and higher: >4500 CHF for 2002; lower: <3044 CHF, middle: 3044–4667 CHF, and higher: >4667 CHF for 2007; and lower: <3333 CHF, middle: 3333–4900 CHF, and higher: >4900 CHF for 2012. Occupation was categorized into 6 groups: upper or middle management work; office, nonmanual, or small independent work; manual work; retired; unemployed; and other (student, stay-at-home).

Exclusion criteria

Participants were excluded if they were <18 y old or if they lacked data for barriers to healthy eating or for the demographic and socioeconomic variables.

Statistical analysis

Statistical analyses were performed by using Stata 14 (Stata Corp.). To test for differences in demographic and socioeconomic characteristics of the sample across survey years, we conducted bivariate analyses by using the chi-square test for categorical variables and Student's *t* test for continuous variables. To assess trends in prevalence of barriers to healthy eating, we conducted multivariable analyses using logistic regression adjusting for all demographic and socioeconomic indicators previously mentioned. Linear and quadratic trends were assessed by using orthogonal polynomial contrasts. Potential age-period-cohort effects were assessed by using the median polish analysis (20, 21). To reduce the likelihood of type I error due to the high number of tests performed, we considered statistical significance for 2-sided tests at $P < 0.0001$. We present the results only for

barriers with prevalence ≥20%, which we arbitrarily set as the cutoff for high prevalence.

RESULTS

Sample selection and characteristics

Of the initial 73,067 participants, 52,238 (71.5%) were included in the analysis. In total, 17,966 participants were excluded because they lacked information on barriers to healthy eating (**Supplemental Figure 1**). Excluded participants were more likely to be aged >65, non-Swiss, and single and to have lower education and income and were slightly less likely to be overweight (**Supplemental Table 2**). **Table 1** summarizes the demographic and socioeconomic characteristics of the included participants by sex and survey year. Between 1997 and 2012, the proportion of participants who were older, were overweight and obese, and had tertiary education increased; among women, the proportion of participants with higher income also increased (Table 1).

Overall trends

Between 1997 and 2012, participants consistently identified taste, price, daily habits, time, lack of willpower, and limited options as barriers to healthy eating with prevalence ≥20% (**Figure 1**; for the remaining 4 barriers, see **Supplemental Figure 2**). Three barriers (taste, price, and time) increased in prevalence between 1997 and 2007 and decreased afterward; the prevalence of daily habits remained relatively stable until 2007 and decreased slightly afterward. Conversely, the prevalence of limited options decreased slightly until 2007, and sharply so by 2012, whereas that of lack of willpower decreased steadily over time.

Trends by sex and age

Figure 2 shows the trends in prevalence of self-reported barriers to healthy eating by sex and age groups. Although the prevalence differed between men and women, the trends evolved similarly. Between 1997 and 2007, the prevalence of price, daily habits, and time increased but decreased afterward—markedly so for price. Differently, lack of willpower steadily decreased across the 15-y period (Figure 2). In 2012, men and women were less likely to report daily habits, lack of willpower, and limited options as barriers, but they were more likely to report time than they were in 1997 (**Table 2**; see **Supplemental Table 3** for prevalence values).

The prevalence and trends for barriers to healthy eating tended to differ across age groups—only the trends for taste and price

TABLE 1
Characteristics of 52,238 included participants by sex and survey year, Swiss Health Survey, 1997–2012[1]

	1997		2002		2007		2012		
	Women	Men	Women	Men	Women	Men	Women	Men	P
Participants	5798 (55.7)	4595 (44.2)	7656 (55.5)	6139 (44.5)	7098 (56.0)	5573 (44.0)	8109 (52.7)	7270 (47.3)	
Age group, y									<0.001
18–35	1907 (32.9)	1666 (36.3)	1864 (24.4)	1524 (24.8)	1579 (22.3)	1183 (21.2)	2045 (25.2)	1800 (24.8)	
36–50	1540 (26.6)	1313 (28.6)	2238 (29.2)	2018 (32.9)	2114 (29.8)	1802 (32.3)	2458 (30.3)	2189 (30.1)	
51–65	1285 (22.2)	965 (21.0)	2045 (26.7)	1533 (25.0)	1822 (25.7)	1497 (26.9)	2006 (24.7)	1856 (25.5)	
>65	1066 (18.4)	651 (14.2)	1509 (19.7)	1064 (17.3)	1583 (22.3)	1091 (19.6)	1600 (19.7)	1425 (19.6)	
BMI, kg/m^2									<0.001
<25	4178 (72.1)	2664 (58.0)	5322 (69.5)	3157 (51.4)	4897 (69.0)	2801 (50.3)	5471 (67.5)	3396 (46.7)	
25–29.9	1218 (21.0)	1637 (35.6)	1743 (22.8)	2424 (39.5)	1601 (22.6)	2269 (40.7)	1869 (23.1)	3024 (41.6)	
≥30	402 (6.9)	294 (6.4)	591 (7.7)	558 (9.1)	600 (8.5)	503 (9.0)	769 (9.5)	850 (11.7)	
Smokers	1639 (28.3)	1757 (38.2)	2028 (26.5)	2129 (34.7)	1671 (23.5)	1701 (30.5)	1969 (24.3)	2195 (30.2)	<0.001
Civil status									<0.001
Single	1440 (24.8)	1388 (30.2)	1742 (22.8)	1608 (26.2)	1717 (24.1)	1468 (26.3)	2079 (25.6)	2132 (29.3)	
Married	2982 (51.4)	2687 (58.5)	4054 (53.0)	3743 (61.0)	3539 (49.9)	3240 (58.1)	4425 (54.6)	4402 (60.6)	
Divorced or separated	623 (10.8)	350 (7.6)	924 (12.0)	558 (9.1)	922 (13.0)	618 (11.1)	966 (11.9)	559 (7.7)	
Widowed	753 (13.0)	170 (3.7)	936 (12.2)	230 (3.7)	920 (13.0)	247 (4.5)	639 (7.9)	177 (2.4)	
Swiss national	5041 (86.9)	3925 (85.4)	6933 (90.6)	5451 (88.8)	6451 (90.9)	4906 (88.0)	7025 (86.6)	6035 (83.0)	<0.001
Urban area	4028 (69.5)	3076 (66.9)	5593 (73.1)	4390 (71.5)	4944 (69.7)	3764 (67.5)	5817 (71.7)	5185 (71.3)	<0.01
Education									<0.001
Mandatory	1426 (24.6)	599 (13.0)	1591 (20.8)	627 (10.2)	1001 (14.1)	366 (6.6)	1115 (13.8)	761 (10.5)	
Secondary	3804 (65.6)	2670 (58.1)	5233 (68.4)	3821 (62.3)	4171 (58.8)	2936 (52.7)	4013 (49.6)	3163 (43.6)	
Tertiary	568 (9.8)	1326 (28.9)	829 (10.8)	1687 (27.5)	1926 (27.1)	2271 (40.8)	2964 (36.6)	3338 (46.0)	
Income									<0.0001
Lower	2017 (37.6)	1182 (26.8)	2737 (37.9)	1702 (28.6)	2294 (33.6)	1394 (25.6)	2624 (34.0)	1991 (28.1)	
Middle	1854 (34.5)	1396 (31.6)	2427 (33.6)	1911 (32.1)	2487 (36.4)	1768 (32.5)	2677 (34.7)	2298 (32.4)	
Higher	1498 (27.9)	1839 (41.6)	2053 (28.5)	2343 (39.3)	2053 (30.0)	2285 (42.0)	2419 (31.3)	2800 (39.5)	

[1] Values are n (%). Comparisons were made by using chi-square tests. The P value was for overall difference across survey years with statistical significance at P < 0.0001. Mandatory education was 9 y. Income was categorized as the following (values expressed in CHF; 1 CHF = 1.04 US$ or 0.92 €)—lower: <2778 CHF, middle: 2778–4000 CHF, and higher: >4000 CHF for 1997; lower: <3000 CHF, middle: 3000–4500 CHF, and higher: >4500 CHF for 2002; lower: <3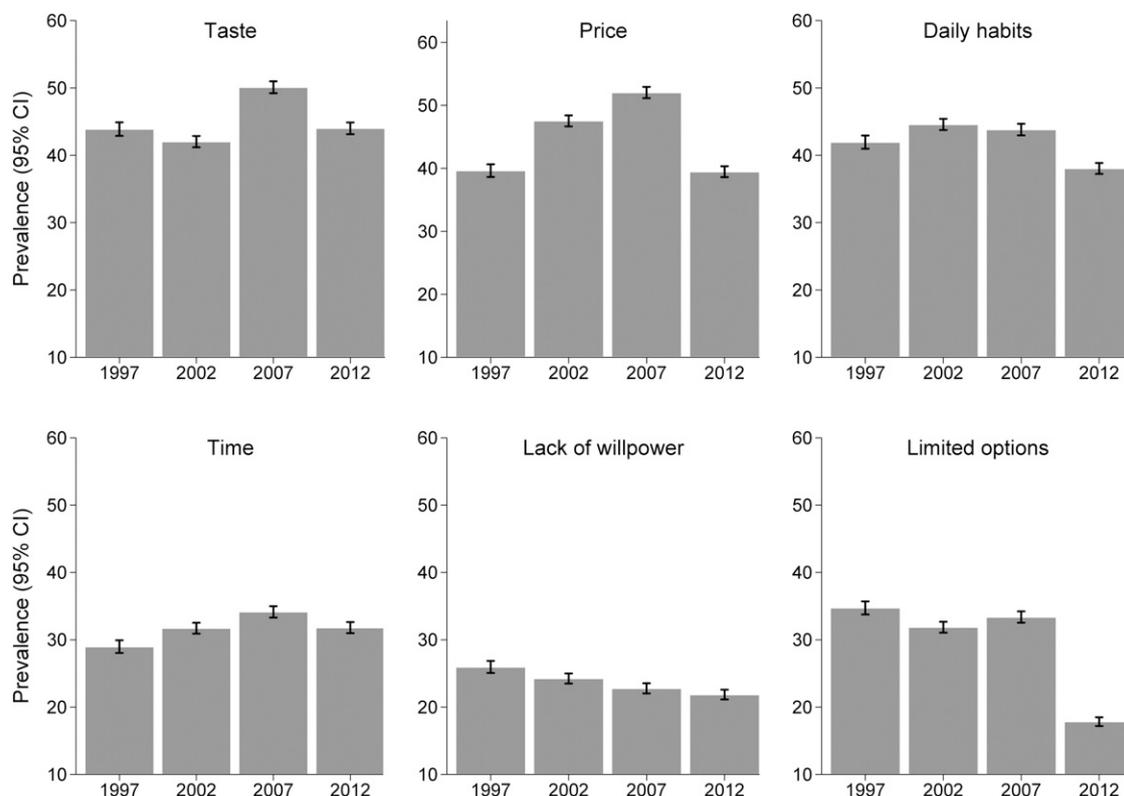044 CHF, middle: 3044–4667 CHF, and higher: >4667 CHF for 2007; and lower: <3333 CHF, middle: 3333–4900 CHF, and higher: >4900 CHF for 2012. CHF, Swiss franc.

FIGURE 1 Overall adjusted prevalence (means and 95% CIs) of self-reported barriers to healthy eating by survey year from the Swiss Health Surveys conducted between 1997 and 2012. Results obtained from logistic regression models were adjusted for age, BMI, smoking, nationality, civil status, living area, education, income, and occupation. Only barriers with a prevalence ≥20% are shown; for the remaining 4 barriers, see Supplemental Figure 2. The number of included participants was 10,393 for 1997, 13,795 for 2002, 12,671 for 2007, and 15,379 for 2012.

were similar, increasing in all groups between 1997 and 2007 and decreasing afterward. Over 15 y, the prevalence of time increased in the 2 younger age groups, remained stable in the 51- to 65-y age group, and decreased in the oldest age group. The prevalence of daily habits increased slightly between 1997 and 2002 but decreased afterward in the 3 younger age groups. The prevalence of lack of willpower decreased in the 3 younger age groups, and that of limited options decreased in all age groups (Figure 2). As shown in Table 2, in 2012 only the youngest age group was more likely to report price as a barrier than in 1997. The 2 younger age groups were more likely to report time and less likely to report daily habits. All age groups were less likely to report lack of willpower (except the oldest group) and limited options in 2012 than in 1997 (Table 2; see Supplemental Table 3 for prevalence values). The median polish analysis indicated no evidence of a birth cohort effect for any of the barriers to healthy eating (**Supplemental Table 4**).

Trends by education and income

As shown in **Figure 3**, the trends in barriers to healthy eating evolved similarly across education and income groups and mirrored the overall trends. In 2012, irrespective of education and income, all participants were less likely to report daily habits, lack of willpower, and limited options as barriers than in 1997 (**Table 3**). Participants in the higher 2 levels of education and income were more likely to report time as barriers than in 1997; conversely,

those with mandatory education were less likely to report time and price (Table 3; see **Supplemental Table 5** for prevalence values).

DISCUSSION

To our knowledge, this is the first study to examine trends in prevalence of self-reported barriers to healthy eating in a population. Our results show that, over a 15-y period, several barriers remained highly prevalent in the Swiss population, and their trends evolved similarly irrespective of sex, age, education, or income.

Overall trends

Between 1997 and 2012, price and taste remained the 2 most prevalent barriers to healthy eating. The prevalence of taste in 1997 (44%) was higher than in the pan-European survey (31%) (6), and it remained high (48%) in 2012. This finding agrees with previous studies showing that taste is one of the most important factors influencing eating behavior, particularly among men (6, 9, 18). This barrier persisted over time, which may be because of the aggressive marketing of fast foods and misleading opinions that healthy eating lacks flavor and enjoyment, exacerbated by the decreasing rate of cooking knowledge and skills in the population (22, 23).

The prevalence of price in 1997 (40%) was much higher than those reported the same year in bordering France (19%), Austria (19%), Germany (9%), and Italy (7%) (6). The increase in prevalence of this barrier between 1997 and 2007 and its
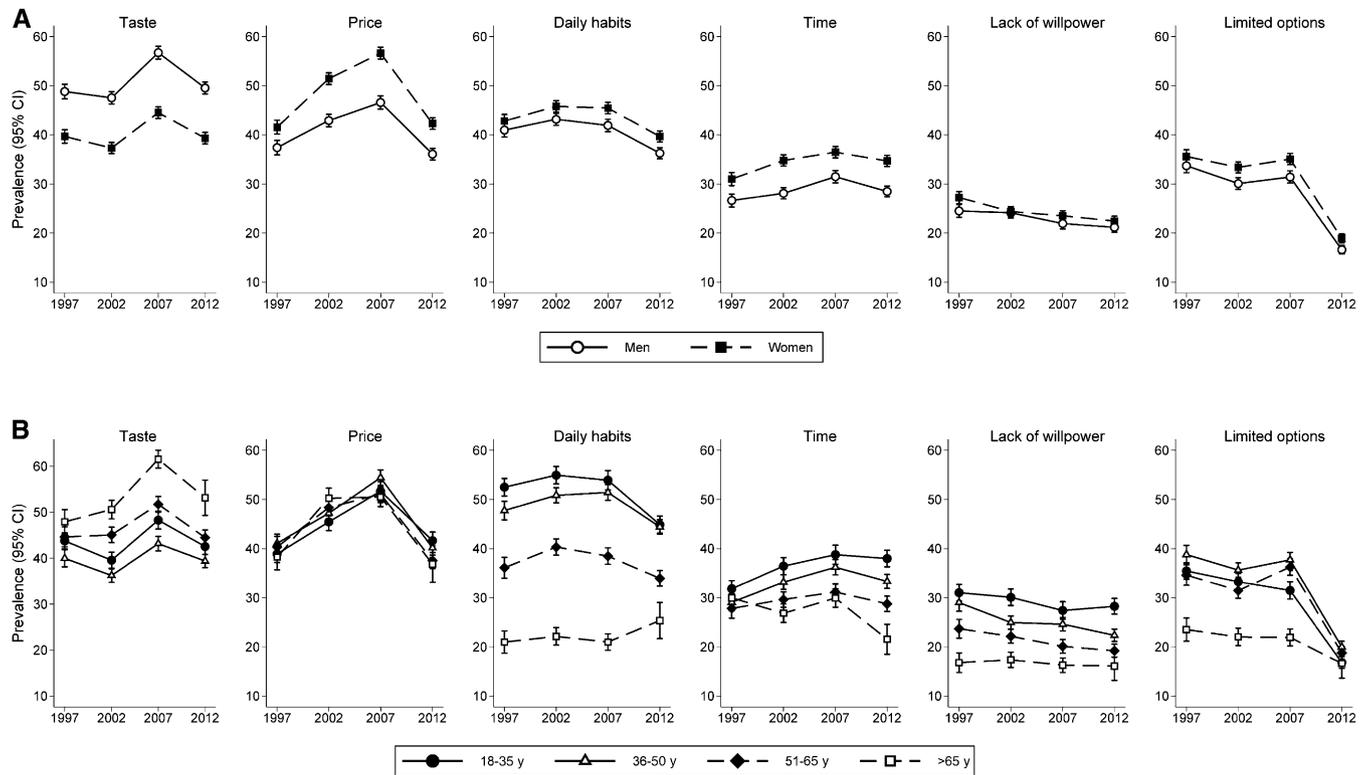
FIGURE 2 Adjusted prevalence (means and 95% CIs) of self-reported barriers to healthy eating in Switzerland by sex (A) and age (B) from the Swiss Health Surveys conducted between 1997 and 2012. Results obtained from logistic regression models adjusted for sex (when stratifying on age), age (when stratifying on sex), BMI, smoking, nationality, civil status, living area, education, income, and occupation. The numbers of participants per survey years 1997, 2002, 2007, and 2012, respectively, were 4595, 6139, 5573, and 7270 for men; 5798, 7656, 7098, and 8109 for women; 3573, 3388, 2762, and 3845 for the age group 18–35 y; 2853, 4256, 3916, and 4647 for the age group 36–50 y; 2250, 3578, 3319, and 3862 for the age group 51–65 y; and 1717, 2573, 2674, and 3025 for the age group >65 y.

subsequent decrease closely resemble the trend in the Swiss consumer price index for the healthier food groups (fresh fruits, vegetables, and fish); meanwhile, the price of less-healthy food groups (bread and flour products, dairy products, ready-made foods) remained relatively stable or decreased over the study period (**Supplemental Figure 3**). This indicates that the perception of price as a barrier in the population indeed reflects the changing prices of healthy foods.

The prevalence of daily habits and lack of willpower tended to decrease over time for all sociodemographic groups. In 1997, the overall prevalence of lack of willpower in Switzerland (26%) resembled that found in bordering countries (6). The overall decrease in these barriers may indicate increasing awareness of the important role of healthy eating as part of a healthy lifestyle, particularly for long-term chronic disease prevention, as has been observed in other European countries (24, 25). Another factor may be the growing view of healthy eating as a socially desirable lifestyle practice (26). These factors may have contributed to increasing willpower to achieve and maintain healthy eating behaviors in an increasingly obesogenic environment.

Conversely, the prevalence of lack of time (for food shopping and preparation) increased slightly over time; in 1997, its prevalence (29%) was higher than in bordering Germany (12%) and France (23%) but lower than in Austria (31%) and Italy (36%) (6). The upward trend observed in Switzerland is in line

with the increasingly widespread feeling of time scarcity reported in the United States (10, 27) and among younger adults in bordering Italy (28) and France (29), because people are devoting more time to work and leisure but less time to preparing foods. Among women, the upward trend is likely due to their increased participation in the labor market in the past decades (30).

The prevalence of limited options (in restaurants and cafeterias) as a barrier nearly halved between 1997 and 2012 across all sociodemographic groups. This is likely due to diversification in menus and an increase in the number of foods and meals offered in restaurants and cafeterias in Switzerland, in turn likely driven by both globalization and increasing consumer demand for healthier options (31). However, as reported trends in the United States have indicated, diversification of menu offerings does not necessarily translate to more healthy options (32, 33). Thus, as the share of the population consuming out-of-home meals continues to increase (34), it is important that diversification and greater offerings in restaurant and cafeteria menus actually introduce more healthy options to customers.

Trends by sociodemographic group

Trends were similar for all barriers irrespective of sex, age, education, and income. Nevertheless, given the persistent inequalities in prevalence of several barriers across demographic

TABLE 2
Multivariable analysis of trends in prevalence of barriers to healthy eating, stratified by sex and age groups, Swiss Health Survey, 1997–2012[1]

	Taste	Price	Daily habits	Time	Lack of willpower	Limited options
Men						
1997	1 (ref)	1 (ref)	1 (ref)	1 (ref)	1 (ref)	1 (ref)
2002	0.95 (0.87, 1.03)	1.27 (1.17, 1.38)	1.11 (1.01, 1.21)	1.09 (1.01, 1.19)	0.97 (0.89, 1.07)	0.82 (0.76, 0.90)
2007	1.37 (1.26, 1.49)	1.50 (1.38, 1.63)	1.04 (0.95, 1.13)	1.30 (1.19, 1.42)	0.85 (0.78, 0.94)	0.88 (0.80, 0.96)
2012	1.02 (0.94, 1.11)	0.96 (0.88, 1.05)	0.80 (0.74, 0.88)	1.12 (1.02, 1.23)	0.81 (0.74, 0.89)	0.38 (0.34, 0.41)
P^2	0.001	0.70	<0.0001	0.0005	<0.0001	<0.0001
P^3	<0.0001	<0.0001	<0.0001	0.0002	0.73	<0.0001
Women						
1997	1 (ref)	1 (ref)	1 (ref)	1 (ref)	1 (ref)	1 (ref)
2002	0.91 (0.84, 0.98)	1.49 (1.38, 1.60)	1.15 (1.07, 1.25)	1.17 (1.08, 1.27)	0.87 (0.80, 0.94)	0.92 (0.85, 0.99)
2007	1.26 (1.16, 1.36)	1.82 (1.69, 1.96)	1.14 (1.05, 1.24)	1.24 (1.15, 1.34)	0.83 (0.76, 0.91)	0.99 (0.92, 1.08)
2012	1.01 (0.93, 1.10)	1.01 (0.93, 1.09)	0.88 (0.80, 0.95)	1.14 (1.05, 1.24)	0.79 (0.72, 0.87)	0.41 (0.38, 0.45)
P^2	0.007	0.09	0.002	0.0008	<0.0001	<0.0001
P^3	0.03	<0.0001	<0.0001	<0.0001	0.14	<0.0001
Age group, y						
18–35						
1997	1 (ref)	1 (ref)	1 (ref)	1 (ref)	1 (ref)	1 (ref)
2002	0.84 (0.76, 0.93)	1.33 (1.20, 1.47)	1.10 (1.01, 1.22)	1.24 (1.12, 1.37)	0.96 (0.86, 1.07)	0.90 (0.80, 0.99)
2007	1.19 (1.07, 1.32)	1.69 (1.52, 1.88)	1.05 (0.95, 1.17)	1.37 (1.23, 1.53)	0.85 (0.76, 0.95)	0.83 (0.74, 0.93)
2012	0.93 (0.84, 1.03)	1.11 (1.01, 1.22)	0.71 (0.64, 0.79)	1.32 (1.19, 1.47)	0.89 (0.79, 0.99)	0.35 (0.31, 0.39)
P^2	0.45	0.003	<0.0001	<0.0001	0.009	<0.0001
P^3	0.37	<0.0001	<0.0001	0.0008	0.27	<0.0001
36–50						
1997	1 (ref)	1 (ref)	1 (ref)	1 (ref)	1 (ref)	1 (ref)
2002	0.86 (0.77, 0.95)	1.28 (1.16, 1.42)	1.14 (1.03, 1.25)	1.22 (1.09, 1.35)	0.81 (0.72, 0.90)	0.87 (0.79, 0.96)
2007	1.17 (1.05, 1.30)	1.75 (1.58, 1.93)	1.17 (1.05, 1.29)	1.38 (1.24, 1.54)	0.80 (0.71, 0.89)	0.96 (0.86, 1.06)
2012	1.00 (0.90, 1.11)	0.97 (0.88, 1.08)	0.88 (0.79, 0.97)	1.21 (1.09, 1.35)	0.71 (0.63, 0.79)	0.38 (0.34, 0.43)
P^2	0.07	0.17	0.03	<0.0001	<0.0001	<0.0001
P^3	0.94	<0.0001	<0.0001	<0.0001	0.23	<0.0001
51–65						
1997	1 (ref)	1 (ref)	1 (ref)	1 (ref)	1 (ref)	1 (ref)
2002	1.02 (0.91, 1.14)	1.40 (1.25, 1.57)	1.20 (1.07, 1.35)	1.09 (0.96, 1.23)	0.91 (0.80, 1.04)	0.87 (0.77, 0.98)
2007	1.35 (1.20, 1.51)	1.56 (1.39, 1.76)	1.10 (0.98, 1.24)	1.16 (1.02, 1.32)	0.79 (0.69, 0.91)	1.07 (0.95, 1.21)
2012	0.98 (0.87, 1.11)	0.90 (0.80, 1.00)	0.92 (0.81, 1.04)	1.02 (0.89, 1.16)	0.73 (0.63, 0.84)	0.45 (0.39, 0.52)
P^2	0.22	0.21	0.08	0.56	<0.0001	<0.0001
P^3	<0.0001	<0.0001	<0.0001	0.01	0.95	<0.0001
>65						
1997	1 (ref)	1 (ref)	1 (ref)	1 (ref)	1 (ref)	1 (ref)
2002	1.11 (0.97, 1.27)	1.65 (1.44, 1.89)	1.07 (0.90, 1.27)	0.86 (0.74, 1.00)	1.01 (0.87, 1.24)	0.91 (0.77, 1.07)
2007	1.75 (1.53, 2.00)	1.68 (1.47, 1.92)	1.01 (0.84, 1.18)	1.01 (0.88, 1.17)	0.96 (0.80, 1.15)	0.91 (0.77, 1.07)
2012	1.22 (0.99, 1.49)	0.95 (0.77, 1.17)	1.21 (0.93, 1.56)	0.67 (0.53, 0.84)	0.91 (0.69, 1.19)	0.62 (0.47, 0.81)
P^2	0.0001	0.64	0.21	0.003	0.38	0.0007
P^3	<0.0001	<0.0001	0.39	0.03	0.53	0.03

[1] Values are ORs (95% CIs). Statistical analysis by using logistic regression was adjusted for age (when stratifying on sex), sex (when stratifying on age), BMI group, smoking, nationality, area of living, civil status, education, income, and occupation. Statistical significance was considered at $P < 0.0001$. The numbers of participants per survey years 1997, 2002, 2007, and 2012, respectively, were 4595, 6139, 5573, and 7270 for men; 5798, 7656, 7098, and 8109 for women; 3573, 3388, 2762, and 3845 for age group 18–35 y; 2853, 4256, 3916, and 4647 for age group 36–50 y; 2250, 3578, 3319, and 3862 for age group 51–65 y; and 1717, 2573, 2674, and 3025 for age group >65 y. ref, reference.

[2] P-linear trend calculated by using orthogonal polynomial contrasts.

[3] P-quadratic trend calculated by using orthogonal polynomial contrasts.

and socioeconomic groups, interventions should not only target the whole population but also selectively target population subgroups that are most vulnerable to face specific barriers to healthy eating (i.e., taste for people with lower education and price for people with lower income). No birth cohort effect was detected. However, the study covered a relatively short period of time (15 y), so future studies should assess the existence of birth cohort effects over longer periods.

Consequences for public health nutrition

Our results showed that barriers to healthy eating evolve dynamically across all sociodemographic groups. This finding indicates that regular monitoring of the prevalence of these barriers is needed and that nutrition interventions should adapt accordingly. Additionally, the prevalence of certain barriers, such as price constraint, closely respond to food and market price fluctuations, which suggests that price changes have a high
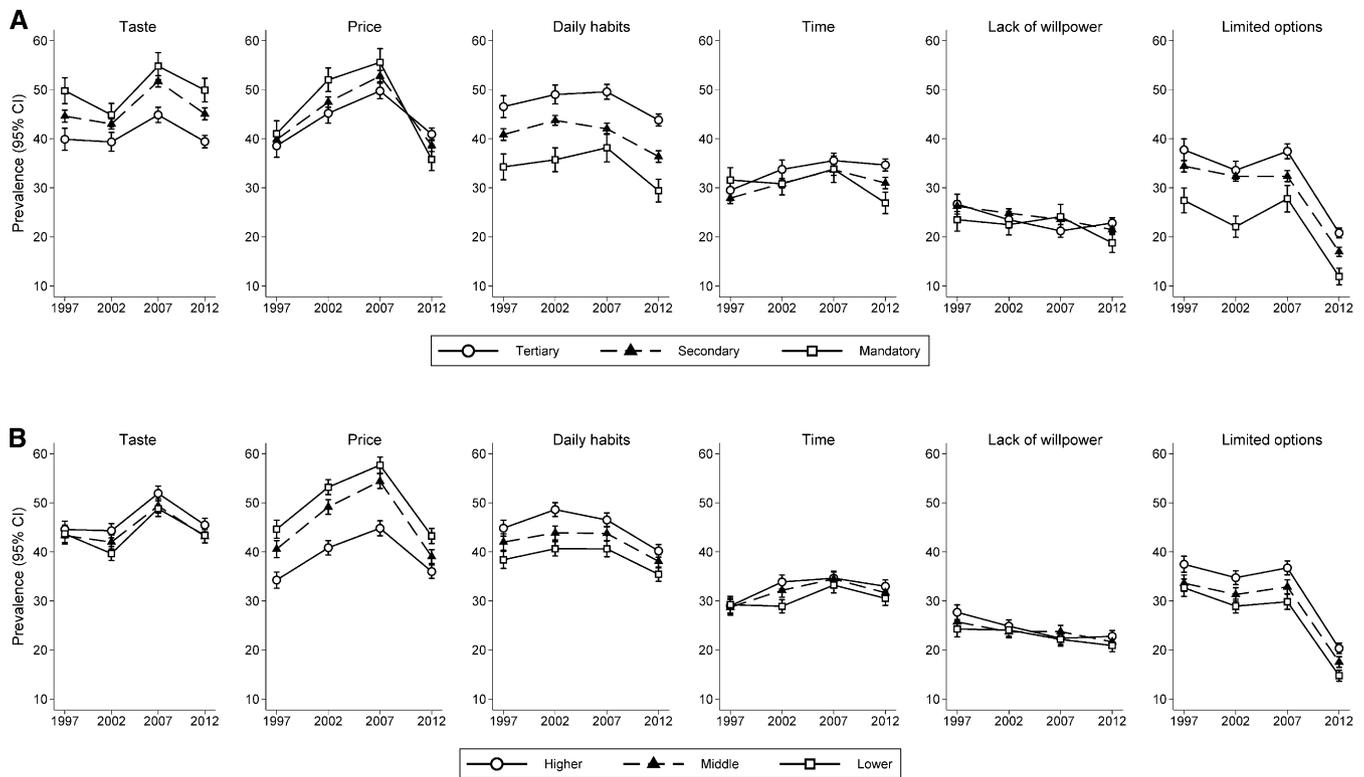
FIGURE 3 Adjusted prevalence (means and 95% CIs) of self-reported barriers to healthy eating in Switzerland by education (A) and income group (B) from the Swiss Health Surveys conducted between 1997 and 2012. Results obtained from logistic regression models adjusted for sex, BMI, smoking, nationality, civil status, living area, occupation, education (when stratifying on income), and income (when stratifying on education). Mandatory education corresponds to 9 y of school. Income was categorized as the following (values expressed in CHF; 1 CHF = 1.04 US\$ or 0.92 €)—lower: <2778 CHF, middle: 2778–4000 CHF, and higher: >4000 CHF for 1997; lower: <3000 CHF, middle: 3000–4500 CHF, and higher: >4500 CHF for 2002; lower: <3044 CHF, middle: 3044–4667 CHF, and higher: >4667 CHF for 2007; and lower: <3333 CHF, middle: 3333–4900 CHF, and higher: >4900 CHF for 2012. The numbers of participants per survey years 1997, 2002, 2007, and 2012, respectively, were 2025, 2218, 1367, and 1876 for mandatory education; 6474, 9054, 7107, and 7176 for secondary education; 1894, 2516, 4197, and 6302 for tertiary education; 3199, 4439, 3688, and 4615 for lower income; 3250, 4338, 4255, and 4795 for middle income; and 3337, 4396, 4338, and 4219 for higher income. CHF, Swiss franc.

impact on self-perceived barriers to healthy eating and thus on eating behavior. This is important, because most population-level interventions to improve healthy eating to date have focused on nutrition knowledge (35–37).

To tackle taste as a barrier to healthy eating, the food industry should advertise and promote ready-to-eat and easy-to-prepare foods that are healthy and flavorful (38, 39). To tackle the barrier of price—particularly as it disproportionally affects people of lower SES in Switzerland (16) and elsewhere (8, 9, 19)—food policy should subsidize healthy foods or tax unhealthy foods to reduce the price differential between healthy and unhealthy foods, empowering people to choose healthy foods instead (36, 37). To tackle time as a barrier, measures should be implemented to introduce flexible work schedules; to expand childcare, maternity, and paternity benefits; and to promote healthy eating behaviors at the workplace.

Strengths and limitations

Our analysis benefits from 4 large representative samples and provides the first trend analysis of prevalence of barriers to healthy eating in a population. The large sample size allowed us to conduct stratified analyses with adequate statistical power.

Several limitations must also be acknowledged. First, participants' understanding of healthy eating was not assessed, but a study in a Swiss city found that participants had a high level of general nutrition and health knowledge (40), which may indicate adequate understanding of healthy eating in the population. Second, participation rates decreased between 1997 (85%) and 2012 (53%), mirroring general decreasing trends in participation to surveys elsewhere (41). Still, they remained in the upper range of participation rates of national surveys conducted in Europe in the same period (41). Third, 29% of participants were excluded, and they were more likely to be of lower SES, which is associated with higher prevalence of barriers to healthy eating (16). Thus, our estimates might be conservative, and the true prevalence of the barriers to healthy eating might be even higher. Fourth, the questionnaire on barriers was not formally validated, which was also the case for the questionnaire used in the pan-European survey (6). Importantly, the barriers assessed in this study were similar to those in the pan-European survey and in other similar studies (6, 8, 9, 18, 19), thus allowing comparisons between surveys. Finally, the lack of a birth cohort effect might be due to the relatively short time period considered (15 y) and to subtle differences that may be undetectable by the median polish analysis.

TABLE 3
Multivariable analysis of trends in the prevalence of barriers to healthy eating, stratified by education and income level, Swiss Health Survey 1997–2012[1]

	Taste	Price	Daily habits	Time	Lack of willpower	Limited options
Education						
Mandatory						
1997	1 (ref)	1 (ref)	1 (ref)	1 (ref)	1 (ref)	1 (ref)
2002	0.83 (0.72, 0.96)	1.57 (1.36, 1.82)	1.07 (0.91, 1.27)	0.95 (0.81, 1.11)	0.93 (0.77, 1.11)	0.75 (0.62, 0.89)
2007	1.26 (1.08, 1.47)	1.85 (1.58, 2.17)	1.20 (1.00, 1.44)	1.09 (0.92, 1.30)	1.03 (0.85, 1.26)	1.06 (0.88, 1.29)
2012	1.02 (0.87, 1.21)	0.76 (0.64, 0.90)	0.76 (0.63, 0.92)	0.73 (0.6, 0.87)	0.66 (0.53, 0.81)	0.33 (0.26, 0.42)
P[2]	0.07	0.01	0.02	0.005	0.0006	<0.0001
P[3]	0.84	<0.0001	<0.0001	0.003	0.008	<0.0001
Secondary						
1997	1 (ref)	1 (ref)	1 (ref)	1 (ref)	1 (ref)	1 (ref)
2002	0.93 (0.87, 1.00)	1.36 (1.27, 1.46)	1.14 (1.07, 1.22)	1.16 (1.08, 1.24)	0.93 (0.87, 1.01)	0.91 (0.85, 0.98)
2007	1.35 (1.25, 1.45)	1.69 (1.57, 1.81)	1.06 (0.99, 1.14)	1.31 (1.22, 1.42)	0.87 (0.81, 0.95)	0.91 (0.85, 0.98)
2012	1.02 (0.95, 1.11)	0.96 (0.89, 1.04)	0.82 (0.76, 0.89)	1.15 (1.06, 1.25)	0.78 (0.71, 0.85)	0.39 (0.35, 0.43)
P[2]	0.0005	0.49	<0.0001	<0.0001	<0.0001	<0.0001
P[3]	<0.0001	<0.0001	<0.0001	<0.0001	0.37	<0.0001
Tertiary						
1997	1 (ref)	1 (ref)	1 (ref)	1 (ref)	1 (ref)	1 (ref)
2002	0.97 (0.86, 1.11)	1.34 (1.18, 1.53)	1.10 (0.97, 1.25)	1.22 (1.07, 1.40)	0.83 (0.72, 0.95)	0.82 (0.73, 0.94)
2007	1.26 (1.12, 1.42)	1.60 (1.42, 1.80)	1.13 (1.01, 1.27)	1.30 (1.15, 1.47)	0.73 (0.64, 0.83)	0.97 (0.87, 1.09)
2012	1.00 (0.89, 1.12)	1.09 (0.97, 1.22)	0.89 (0.79, 0.99)	1.26 (1.12, 1.42)	0.81 (0.72, 0.92)	0.42 (0.37, 0.47)
P[2]	0.17	0.02	0.07	<0.0001	0.0002	<0.0001
P[3]	0.009	<0.0001	<0.0001	0.004	0.0008	<0.0001
Income						
Lower						
1997	1 (ref)	1 (ref)	1 (ref)	1 (ref)	1 (ref)	1 (ref)
2002	0.84 (0.76, 0.92)	1.41 (1.28, 1.55)	1.12 (1.01, 1.24)	0.98 (0.88, 1.09)	0.99 (0.89, 1.11)	0.84 (0.76, 0.94)
2007	1.24 (1.12, 1.37)	1.68 (1.52, 1.86)	1.12 (1.00, 1.24)	1.19 (1.07, 1.32)	0.89 (0.79, 0.99)	0.88 (0.78, 0.98)
2012	1.01 (0.91, 1.13)	0.91 (0.81, 1.01)	0.89 (0.79, 0.99)	1.04 (0.93, 1.17)	0.83 (0.73, 0.94)	0.35 (0.29, 0.39)
P[2]	0.01	0.49	0.07	0.08	0.0007	<0.0001
P[3]	0.79	<0.0001	<0.0001	0.15	0.48	<0.0001
Middle						
1997	1 (ref)	1 (ref)	1 (ref)	1 (ref)	1 (ref)	1 (ref)
2002	0.95 (0.86, 1.05)	1.41 (1.28, 1.55)	1.10 (1.01, 1.21)	1.17 (1.05, 1.29)	0.89 (0.81, 0.98)	0.89 (0.81, 0.99)
2007	1.30 (1.18, 1.43)	1.75 (1.59, 1.93)	1.10 (0.99, 1.21)	1.30 (1.18, 1.44)	0.89 (0.80, 0.99)	0.96 (0.87, 1.06)
2012	1.00 (0.90, 1.11)	0.94 (0.85, 1.04)	0.85 (0.76, 0.94)	1.12 (1.01, 1.24)	0.79 (0.70, 0.88)	0.41 (0.36, 0.46)
P[2]	0.06	0.91	0.003	0.01	<0.0001	<0.0001
P[3]	0.002	<0.0001	<0.0001	<0.0001	0.72	<0.0001
Higher						
1997	1 (ref)	1 (ref)	1 (ref)	1 (ref)	1 (ref)	1 (ref)
2002	1.00 (0.91, 1.10)	1.36 (1.23, 1.49)	1.15 (1.05, 1.27)	1.28 (1.16, 1.41)	0.85 (0.77, 0.94)	0.89 (0.81, 0.97)
2007	1.38 (1.25, 1.52)	1.61 (1.46, 1.77)	1.05 (0.95, 1.15)	1.33 (1.21, 1.47)	0.74 (0.67, 0.83)	0.97 (0.88, 1.07)
2012	1.03 (0.93, 1.13)	1.10 (0.99, 1.21)	0.79 (0.71, 0.86)	1.25 (1.13, 1.38)	0.76 (0.69, 0.85)	0.42 (0.38, 0.46)
P[2]	0.01	0.001	<0.0001	<0.0001	<0.0001	<0.0001
P[3]	<0.0001	<0.0001	<0.0001	<0.0001	0.01	<0.0001

[1] Values are ORs (95% CIs). Statistical analysis by using logistic regression was adjusted for age, BMI, smoking, nationality, area of living, civil status, occupation, education (when stratifying on income), and income (when stratifying on education). Statistical significance was considered at $P < 0.0001$. Income was categorized as the following (values expressed in CHF; 1 CHF = 1.04 US$ or 0.92 €)—lower: <2778 CHF, middle: 2778–4000 CHF, and higher: >4000 CHF for 1997; lower: <3000 CHF, middle: 3000–4500 CHF, and higher: >4500 CHF for 2002; lower: <3044 CHF, middle: 3044–4667 CHF, and higher: >4667 CHF for 2007; and lower: <3333 CHF, middle: 3333–4900 CHF, and higher: >4900 CHF for 2012. The numbers of participants per survey years 1997, 2002, 2007, and 2012, respectively, were 2025, 2218, 1367, and 1876 for mandatory education; 6474, 9054, 7107, and 7176 for secondary education; 1894, 2516, 4197, and 6302 for tertiary education; 3199, 4439, 3688, and 4615 for lower income; 3250, 4338, 4255, and 4795 for middle income; and 3337, 4396, 4338, and 4219 for higher income. CHF, Swiss franc; ref, reference.

[2] P-linear trend calculated by using orthogonal polynomial contrasts.

[3] P-quadratic trend calculated by using orthogonal polynomial contrasts.

Conclusion

Between 1997 and 2012, barriers to healthy eating remained highly prevalent (≥20%) in the Swiss population and evolved similarly irrespective of age, sex, education, and income.

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