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# Trends and determinants of change in compliance to dietary guidelines in a Swiss community-dwelling sample

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**ABSTRACT**

Adherence to dietary guidelines is associated with significantly better health outcomes. Studies across the world shows that compliance with the guidelines was low, but data in Switzerland are lacking. Hence, we aimed to assess the 5-year trends in dietary compliance regarding food guidelines in Switzerland in a prospective, population-based observational study. Data from 2882 participants (1591 women, 35-75 years), from the first (2009–2012) and second (2014–2017) follow-up. Dietary intake was assessed using a validated food frequency questionnaire. Compliance with the guidelines of the Swiss society of nutrition was assessed at baseline and 5.5 years afterwards. Prevalence rates for compliance were calculated using the exact Poisson method. Factors associated with changes in compliance (never, shifter or maintainer) were assessed by multinomial logistic regression using "Never compliers" as reference. Overall, improvements in compliance to fruits (42.4% to 45.1%) vegetables (6.9% to 8.6%) and fish (66.6% to 60.5%) were found, while compliance to meat decreased (61.1% to 58.5%). The prevalence of participants complying with at least three dietary recommendations did not change (24.1% to 25.2%). During follow-up, only 11.6% of participants maintained compliance to at least three dietary recommendations, and 62.4% never managed to comply. Female gender and older age were associated with maintaining compliance during the two study periods. In conclusion, compliance with dietary guidelines is a dynamic status, and only a small fraction of the population achieves sustained compliance with at least three guidelines. Almost two thirds of the population never achieve compliance with three guidelines.

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**Keywords**: prospective study; dietary guidelines; epidemiology; public health; Switzerland.

ABBREVIATIONS LIST

BMI - Body mass index

FFQ - Food frequency questionnaire

SSN - Swiss society of Nutrition

## INTRODUCTION

Diet is one of the main determinants of health [1]. Adherence to dietary guidelines is associated with significantly better health outcomes, and individuals are encouraged to improve their dietary quality by decreasing the consumption of certain types of foods and to increase the consumption of others such as fruits and vegetables [2]. Accordingly, the Swiss society of Nutrition (SSN) has issued guidelines regarding food and nutrient intake [3]. In a previous study, we have shown that compliance with the guidelines was low [4], a finding in agreement with studies conducted in the USA [5] or in China[6].

Similarly, in a previous study conducted in Geneva (Switzerland), we have shown that compliance regarding nutrient intake did not improve between 1999 and 2009 and that intakes deviate substantially from SSN guidelines [7]. Still, the study relied on multiple cross-sectional surveys in Geneva and no prospective data collected on the same individuals is available. Indeed, we failed to find any study which assessed changes in compliance to dietary guidelines in a prospective setting. Such studies are important as they allow identifying individual factors related to changes in compliance. Further, in another study based on a national sample, we showed a sharp reduction between 2007 and 2012 in the prevalence of several barriers to healthy eating such as price, taste, limited options at markets and restaurants, and lack of will power [8]. This favorable trend could theoretically increase the likelihood of complying with the dietary guidelines.

Hence, our study aimed to assess the 5-year trends and determinants in dietary compliance regarding food guidelines of the SSN in a population-based prospective study. Our hypothesis

was that the prevalence rates of compliers to any food guideline would increase and that this increase would be more pronounced in woman and in more educated people.

## METHODS

### *Study setting and participant selection*

The CoLaus study is a population-based study assessing the clinical, biological and genetic determinants of cardiovascular disease in the city of Lausanne, Switzerland. Its aims and sampling strategy have been reported previously [9]. The source population was defined as all subjects aged between 35 and 75 years registered in the population register of the city, which also includes information on age and sex. A simple, non-stratified random sample of 19,830 subjects (corresponding to 35% of the source population) was drawn and the selected subjects were invited to participate. The following inclusion criteria were applied: (a) written informed consent; (b) willingness to take part in the examination and to provide blood samples.

The baseline study was conducted between 2003 and 2006 and included 6733 participants; the first follow-up visit was conducted between April 2009 and September 2012 and included 5064 participants; the second follow-up was conducted between May 2014 and April 2017. The first and second follow-ups included all participants willing to be re-contacted. At both follow-ups, participants attended a single visit, which included an interview, a dietary assessment, a physical exam, and blood and urine collections in the fasting state. For this study, only data from the first (2009–2012) and second (2014–2017)

follow-up examinations was used as dietary intake assessment was introduced at the first follow-up.

*Compliance to dietary guidelines*

Dietary intake was assessed using a validated, self-administered, semi-quantitative food frequency questionnaire (FFQ) which also included portion size [10,11]. Briefly, this FFQ assesses the dietary intake of the previous 4 weeks and consists of 97 different food items which account for more than 90% of the intake of calories, proteins, fat, carbohydrates, alcohol, cholesterol, vitamin D and retinol, and 85% of fibre, carotene and iron. To our knowledge, there is no FFQ (validated or not) assessing dietary intake for the whole year in Switzerland; the other available and validated FFQ assesses the dietary intake of the previous month [12]. Hence, this FFQ provides the best dietary assessment currently available and has been used in several food intake evaluations. Conversely, the FFQ was not validated regarding compliance to guidelines. 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 also 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 frequency of consumption 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 recommendations for fruits, vegetables, meat, fish and dairy products from the Swiss Society of Nutrition [13]. The recommendations were: ≥2 fruit portions/day; ≥3 vegetable portions/day; ≤5 meat portions/week; ≥1 fish portion/week and ≥3 dairy products portions/day.

Compliance was considered if the participant complied to at least three guidelines. Changes in compliance were assessed using the same methodology as a previous study assessing changes in vitamin use [14]. Participants were categorized into "never" (no compliance at both follow-ups); "new" (no compliance at the first but compliance at the second follow-up); "former" (compliance at the first but no compliance at the second follow-up) and "full" (compliance at both follow-ups) compliers.

*Other covariates*

Age at first follow-up (range: 41-79 years) was categorized into 10-year age groups: 40-49; 50-59; 60-69 and 70-79. Socioeconomic and lifestyle variables were collected using a self-administered questionnaire. Marital status was defined as living alone (single, divorced or widowed) or living in a couple (married or other). Smoking status was categorized into never, former and current smoker. Educational level was collected at baseline and categorized as

obligatory school, apprenticeship, high school/college or university. Country of birth was categorized as Swiss/other.

Body weight and height were measured with participants standing without shoes in light indoor clothing. Weight was measured in kilograms to the nearest 0.1 kg using a Seca™ scale (Seca, Hamburg, Germany). Height was measured to the nearest 5 mm using a Seca™ height gauge (Seca, Hamburg, Germany). Body mass index (BMI) was defined as weight/height$^2$ and categorized as normal (BMI<25 kg/m$^2$); overweight (25≤ BMI <30 kg/m$^2$) and obese (BMI ≥30 kg/m$^2$). Due to small numbers (n=72), underweight participants (BMI<18.5 kg/m$^2$) were included in the "normal" category.

*Inclusion and exclusion criteria*

Participants were excluded from the analyses if they 1) had no follow-up; 2) failed to fill the FFQ and 3) missed any covariate (smoking, BMI, education or country of birth).

*Statistical analysis*

Statistical analyses were conducted using Stata version 14.2 for windows (Stata Corp, College Station, Texas, USA). Participants characteristics were expressed as number (percentage) for categorical variables or as average ± standard deviation for continuous variables. Prevalence rates for compliance for the first (2009-2012) and the second (2014-2017) follow-up were

presented as rates (95% confidence interval) using the exact Poisson method. Paired analyses were conducted using the participant as her/his control using the McNemar test for paired proportions. The factors associated with changes in compliance were assessed by multivariable analysis using multinomial logistic regression and the "Never compliers" as reference. A sensitivity analysis was conducted by assessing the prevalence and determinants of an improvement in the number of dietary guidelines complied to. Statistical significance was assessed for a two-sided test with $p<0.05$.

*Ethical statement*

The institutional Ethics Committee of the University of Lausanne, which afterwards became the Ethics Commission of Canton Vaud (www.cer-vd.ch) approved the first (reference 33/09, decision of 23rd February 2009) and the second (reference 26/14, decision of 11th March 2014) follow-ups. The study was performed in agreement with the Helsinki declaration and its former amendments. All participants gave their signed informed consent before entering the study.

RESULTS

*Selection procedure and characteristics of participants*

The selection procedure is summarized in **figure 1**. Of the initial 5064 participants, 2182 (43.1%) were excluded, leaving 2882 participants (56.9%) for analysis. The comparison

between included and excluded participants is provided in **table 1**. Excluded participants were more frequently male, smokers and lived alone; they were also older and had a higher BMI. Of the 2882 included participants, 1591 (55.2%) were female, mean age was 56.6 ± 10.0 years and 399 (13.8%) were obese.

*Trends in compliance to dietary guidelines*

The number and percentage of participants complying with different guidelines at baseline and follow-up is provided in **supplemental table 1**. Very few participants (less than 0.5%) managed to comply with all guidelines.

Trends in compliance to dietary guidelines overall and according to participants' characteristics are indicated in **Table 2** and **Supplemental table 2**. Overall, there was an increase in compliance to fruits, vegetables and fish consumption, a decrease in compliance to meat consumption, and no significant changes in compliance to dairy consumption over the follow-up.

Compliance to fruits and fish consumption increased in both genders; an increase in compliance to vegetables consumption was found in women and a decrease in compliance to meat consumption was found in men. Among the different age groups, the largest changes occurred in the 70+ group, who increased compliance to fish and dairy consumption and decreased compliance in meat consumption. Among smoking categories, the changes occurred mainly among current smokers, who increased their compliance to fruits, vegetables and fish consumption. Participants living in couple increased their compliance to fruits, vegetables and fish consumption and decreased their compliance to meat consumption.

Compliance to fish consumption also increased in participants living alone. Participants born outside Switzerland increased compliance to fruits, vegetables and fish consumption, while participants born in Switzerland increased compliance to fish and decreased compliance to meat consumption.

Among the different educational groups, the largest changes occurred in the participants with apprenticeship level, who increased the compliance to vegetables and fish and decreased compliance to meat consumption. Participants with normal BMI increased their compliance to fruit and vegetable consumption, while participants with the highest BMI increased their compliance to fish and decreased their compliance to meat consumption. Non-sedentary participants increased compliance to fruits and vegetables consumption, while sedentary participants increased compliance to fish and decreased compliance to meat consumption (**Supplemental table 2**).

Finally, no changes in the compliance levels to at least three dietary recommendations were found for all participants' characteristics (**Table 2**).

*Determinants of change in compliance to dietary guidelines*

The detailed evolution of overall, new, former and full compliers is provided in **Figure 2.** The number of "new compliers" (n=390) almost compensated the number of "former compliers" (n=359), leading to similar prevalence of compliers to at least three dietary recommendations between the two study periods.

The multivariable analysis of the factors associated with changes in compliance to at least three dietary guidelines is summarized in **table 3**. Participants who maintained compliance during the two study periods were women and in the older age groups. Women and non-sedentary participants also maintained their compliance of fruits, vegetables and meat consumption.

The multivariable analysis of the factors associated with changes in compliance to each individual dietary guideline is summarized in **supplemental tables 4 to 7**. Overall, the same associations were found between compliance and female gender, older age, marital status and physical activity. Participants born outside Switzerland also had a higher likelihood of maintaining compliance with fruits, vegetables and fish.

*Sensitivity analysis*

The results for the increase in the number of dietary guidelines complied with is summarized in table 4**.** Overall, over half of the participants increased the number of dietary guidelines complied with. Women showed a lower likelihood of improvement in compliance, while compliance to an increasing number of items at baseline was inversely related to increase in the number of recommendations complied to: OR and 95% CI: 0.77 (0.71-0.84). Conversely, no other factor was significantly associated with improvement in compliance.

DISCUSSION

To our knowledge, this is the first study assessing prospectively the compliance to dietary guidelines in adults. Our results show that over six out of ten participants fail to comply with at least three guidelines during a 5.5 years follow-up. Our results also show that participants who complied with at least three guideline recommendations throughout the study period were mostly women, normal weight, non-smokers, non-sedentary, older, and non-Swiss.

*Trends in compliance to dietary guidelines*

Over 50% of compliers in 2009-2012 were no longer compliers in 2014-2017. Two earlier studies assessed trends in healthy eating in the Swiss population, using data from national cross-sectional surveys [15,16]. They concluded that consumption meat ≥1/day and fish ≤1/week decreased while consumption of fruit ≤1/day increased between 1997 and 2002 [16]. In 2007, the percentage of the population consuming at least five portions of fruits and vegetables per day and three serving of dairy products were 30% and 10%, respectively [15]. Still, no information was available regarding the other dietary guidelines.

Overall, compliance to fruits, vegetables and fish increased between the 2009-2012 and 2014-2017. Possible explanations include a decrease in some barriers to healthy eating, such as the price, lack of willpower, limited options of food and daily habits, independent of education or income status [8]. They are also in agreement with an increase in the "fish and vegetables" dietary pattern observed in the Canton of Geneva [17], which is only 60 miles distant from Lausanne and has a similar population structure. Conversely, the compliance to dairy products did not change, and compliance to meat consumption decreased. The reasons for such a decrease are not easily understood as they do not replicate the decrease in the "meat and

chips" dietary pattern observed in Geneva [17] or the decrease in meat consumption reported in national statistics [18]. Hence, it would be important that such findings be replicated in other settings. Interestingly, this decrease in compliance seemed to be restricted to men and elderly participants. A possible explanation for the decrease in compliance to meat consumption in this study is the lift regarding fat consumption in the US dietary guidelines, which occurred during the second follow-up period of this study and received wide media coverage. This might have prompted subjects who originally restricted their meat consumption for health reasons (i.e. cardiovascular prevention) to further increase their meat consumption.

*Determinants of change in compliance to dietary guidelines*

Current smokers were less likely to improve compliance to at least three dietary guidelines, a finding in agreement with other studies showing that smokers have a poor eating habit [19-21]. A meta-analysis reported that smoke habits are associated with an increased consumption of meat and a low consumption of fruits and vegetables [22]. Overall, our results indicate that current smoking is a deterrent for changes in dietary intake and acquisition of healthy eating patterns.

Men tend to have lower compliance regarding dietary guidelines than women [23], likely due to higher nutrition knowledge [24]. In our study women were more likely to be "new", "former" and "full" compliers to at least three guidelines recommendations than men. A higher likelihood of being "new" or "full" complier is in agreement with several population studies, which reported that women from different age groups have a higher compliance with food and nutrients recommendations [6,25-27]. Conversely, the higher likelihood of being "former"

compliers was not expected, and the reasons for such an association should be further explored.

Elderly people tend to have a better compliance than younger, except for the consumption of dairy products [28-30]. This low consumption of dairy products might be related to the avoidance of full-fat dairy products due to high blood lipid levels or to increased intolerance to lactose [29]. Elderly participants were also more likely to be "new", “former” and “full” compliers to at least three guidelines recommendations than younger participants. Again, the higher likelihood of being “new” and “full” complier might be due to the fact that the elderly have a better diet quality [31,32].

Couples were more likely to be “new” compliers. This finding is in agreement with other studies found positive associations between marriage and food behaviour [33,34], and an inadequate intake in fruits, vegetables and fish in persons who live alone [35]. Our results thus suggest that living with somebody else is associated with an improvement in compliance to dietary guidelines.

Overweight and obese participants had a lower likelihood of being “full” compliers to at least three dietary recommendations, while no association was found with “never” or “former”. Obese individuals consume larger quantities of food than normal individuals [36,37] and are less prone to changes in dietary behaviour [38]. Obesity levels are inversely associated with adherence to guidelines [39,40], suggesting that obese subjects might be less prone to adhere to healthy eating and thus to prevent diet-related diseases.

Educational level had no effect on compliance with the recommendations, a finding in agreement with another Swiss study [41]. Overall, our results suggest that educational achievement does not play a significant part in compliance or changes in compliance to dietary guidelines.

Sensitivity analysis showed a small but significant increase in the number of guidelines complied with. Those findings are partly in agreement with previous studies conducted in Switzerland [16,17] but not with another focusing on nutrients [7] or with the Whitehall II study, where no changes were found regarding adherence to a healthy diet after 5.5 years follow-up [42]. Overall, our results suggest that compliance to guidelines might be improving in the Swiss French-speaking population, but more studies are necessary to confirm this positive trend.

*Study limitations*

This study has several limitations. First, excluded participants were more frequently male, smokers and lived alone, and many did not fully answer to the FFQ. Hence, our results are based on a health-conscious sample and might be overestimated. Still, in the absence of other prospective study available, they provide the first results regarding recent trends in compliance to food guidelines. Further, the fact that the results are globally unfavourable suggests that the actual status is even worse. Second, the FFQ was not validated regarding compliance to guidelines and might not capture all types of fruits and vegetables, thus reducing the prevalence of compliers. Still, as the FFQ was applied to the same participants in

the two study periods, it is expected that reporting bias might have been the same and have little impact on trends. Third, it was not possible to assess if changes in compliance were due to changes in other lifestyle behaviours such as quitting smoking, as it was not possible to know the timeline of the changes.

## *CONCLUSION*

Compliance with dietary guidelines is a dynamic status, and only a small fraction of the Swiss population achieves sustained compliance with at least three guidelines. Almost two thirds of the population never achieve compliance with at least three guidelines.

## AUTHORS CONTRIBUTIONS

DS made part of the statistical analyses and wrote most of the article; PMV collected data, made part of the statistical analysis and wrote part of the article; IG and LP revised the article for important intellectual content. PMV had full access to the data and is the guarantor of the study.

## CONFLICT OF INTEREST

The authors report no conflict of interest.

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## FIGURE LEGENDS

Figure 1: selection procedure. No follow-up" corresponds to a participant who participated in the 2009-2012 survey but did not attend the 2014-2017 survey. "No endpoints" corresponds to a participant who did participate in the 2014-2017 survey but did not fully complete the food frequency questionnaire.

Figure 2: Prevalence of compliers to at least 3 dietary recommendations for the first (2009-2012) and second (2014-2017) follow-ups of the Colaus study (n=2881), Lausanne, Switzerland.

TABLES

**Table 1**: characteristics of included and excluded participants, CoLaus study, Lausanne, Switzerland.

| | **Included** | **Excluded** | **p-value** |
|---|---|---|---|
| Sample size | 2882 | 2183 | |
| Gender (%) | | | |
| Female | 1591 (55.2) | 1116 (51.1) | 0.004 |
| Male | 1291 (44.8) | 1067 (48.9) | |
| Age (years) | 56.6 (10.0) | 59.2 (11.0) | <0.001 |
| Age groups (%) | | | |
| 40-49 | 890 (30.9) | 541 (24.8) | <0.001 |
| 50-59 | 910 (31.6) | 631 (28.9) | |
| 60-69 | 768 (26.7) | 585 (26.8) | |
| 70+ | 314 (10.9) | 426 (19.5) | |
| Smoking (%) | | | |
| Never | 1239 (43.0) | 797 (37.5) | <0.001 |
| Former | 1099 (38.2) | 784 (36.9) | |
| Current | 544 (18.9) | 545 (25.6) | |
| Marital status (%) | | | |
| Alone | 1173 (40.7) | 1029 (47.1) | <0.001 |
| In couple | 1709 (59.3) | 1154 (52.9) | |
| Country of birth (%) | | | |
| Switzerland | 1966 (68.2) | 1219 (55.8) | <0.001 |
| Other | 916 (31.8) | 964 (44.2) | |
| Educational Level (%) | | | |
| University | 698 (24.2) | 381 (17.5) | <0.001 |
| High school/college | 820 (28.5) | 486 (22.3) | |
| Apprenticeship | 1037 (36.0) | 760 (34.9) | |
| Obligatory | 327 (11.4) | 551 (25.3) | |
| BMI ($kg/m^2$) | 25.7 (4.3) | 26.8 (4.9) | <0.001 |
| BMI categories (%) | | | |
| Normal | 1392 (48.3) | 788 (37.2) | <0.001 |
| Overweight | 1091 (37.9) | 870 (41.0) | |
| Obese | 399 (13.8) | 460 (21.7) | |
| Physical activity (%) | | | |
| Sedentary | 1253 (43.5) | 524 (40.3) | 0.052 |

| | | |
|---|---|---|
| Non-sedentary | 1629 (56.5) | 776 (59.7) |

BMI, body mass index. Results are expressed as mean ± standard deviation for continuous variables or as number of participants (percentage) for categorical variables. Statistical analysis by student's t-test for continuous variables or chi-square test for categorical variables.

**Table 2**: five-year trends in compliance to dietary guidelines, CoLaus study, Lausanne, Switzerland.

| | **(2009-2012)** | **(2014-2017)** | **p-value** |
|---|---|---|---|
| Fruits ≥ 2/day | 42.4<br>(40.6 - 44.3) | 45.1<br>(43.3 - 47.0) | 0.009 |
| Vegetables ≥ 3/day | 6.9<br>(6.0 - 7.9) | 8.6<br>(7.6 - 9.7) | 0.005 |
| Meat ≤ 5/week | 61.1<br>(59.3 - 62.9) | 58.5<br>(56.6 - 60.3) | 0.009 |
| Fish ≥ 1/week | 66.6<br>(64.9 - 68.4) | 70.5<br>(68.8 - 72.2) | <0.001 |
| Dairy ≥ 3/day | 8.2<br>(7.2 - 9.2) | 8.3<br>(7.3 - 9.4) | 0.823 |
| Compliance with at least three | 24.1<br>(22.6 - 25.7) | 25.2<br>(23.6 - 26.8) | 0.273 |

Results are expressed as rate (95% confidence interval). Statistical analysis by McNemar test for paired samples

**Table 3**: factors associated with change in compliance with at least ~~3~~ three recommendations, CoLaus study, Lausanne, Switzerland.

| | **New** | **Former** | **Full** |
|---|---|---|---|
| Group size | 390 | 359 | 335 |
| Gender | | | |
| Male | 1 (ref.) | 1 (ref.) | 1 (ref.) |
| Female | 1.87 (1.47 - 2.38) | 1.82 (1.41 - 2.34) | 2.26 (1.72 - 2.96) |
| Age groups | | | |
| 40-49 | 1 (ref.) | 1 (ref.) | 1 (ref.) |
| 50-59 | 1.25 (0.93 - 1.66) | 1.16 (0.86 - 1.57) | 1.45 (1.04 - 2.02) |
| 60-69 | 1.62 (1.20 - 2.19) | 1.66 (1.22 - 2.25) | 2.68 (1.93 - 3.71) |
| 70+ | 1.62 (1.09 - 2.41) | 1.67 (1.11 - 2.51) | 2.64 (1.72 - 4.06) |
| Smoking | | | |
| Never | 1 (ref.) | 1 (ref.) | 1 (ref.) |
| Former | 0.90 (0.70 - 1.15) | 1.00 (0.78 - 1.29) | 0.91 (0.70 - 1.19) |
| Current | 0.73 (0.53 - 1.00) | 0.58 (0.41 - 0.83) | 0.65 (0.45 - 0.93) |
| Marital status | | | |
| Alone | 1 (ref.) | 1 (ref.) | 1 (ref.) |
| In couple | 1.36 (1.08 - 1.72) | 1.19 (0.94 - 1.51) | 1.18 (0.92 - 1.51) |
| Country of birth | | | |
| Switzerland | 1 (ref.) | 1 (ref.) | 1 (ref.) |
| Other | 1.43 (1.12 - 1.82) | 1.25 (0.97 - 1.61) | 1.29 (0.99 - 1.68) |
| Educational level | | | |
| University | 1 (ref.) | 1 (ref.) | 1 (ref.) |
| High school | 1.11 (0.81 - 1.52) | 1.17 (0.85 - 1.61) | 1.09 (0.79 - 1.52) |
| Apprenticeship | 1.07 (0.78 - 1.45) | 0.88 (0.64 - 1.22) | 0.87 (0.63 - 1.21) |
| Obligatory | 1.06 (0.71 - 1.59) | 1.1 (0.73 - 1.67) | 0.88 (0.56 - 1.38) |
| BMI categories | | | |
| Normal | 1 (ref.) | 1 (ref.) | 1 (ref.) |
| Overweight | 0.97 (0.75 - 1.24) | 0.85 (0.66 - 1.1) | 0.72 (0.55 - 0.95) |
| Obese | 1.04 (0.74 - 1.46) | 0.73 (0.50 - 1.06) | 0.51 (0.33 - 0.78) |
| Physical activity | | | |
| Sedentary | 1 (ref.) | 1 (ref.) | 1 (ref.) |
| Non-sedentary | 1.20 (0.96 - 1.52) | 1.11 (0.87 - 1.41) | 1.68 (1.32 - 2.16) |

Statistical analysis by multinomial logistic regression using never compliers as reference and all the variables indicated in the table. Results are expressed as relative risk ratio and (95% confidence interval). Never compliers are defined as no compliance at both follow-ups); “new compliers” (no compliance at the first but compliance at the second follow-up); “former compliers” (compliance at

the first but no compliance at the second follow-up) and “full compliers” (compliance at both follow-ups).

**Table 4**: bivariate and multivariable analysis of the factors associated with an increase in the number of items complied with, CoLaus study, Lausanne, Switzerland.

| | No increase | Increase | P-value | Multivariable |
|---|---|---|---|---|
| **N** | 1251 | 1629 | | |
| **Gender** | | | <0.001 | |
| Male | 500 (40.0) | 790 (48.5) | | 1 (ref.) |
| Female | 751 (60.0) | 839 (51.5) | | 0.79 (0.67 - 0.93) |
| **Age groups** | | | 0.490 | |
| 40-49 | 382 (30.5) | 507 (31.1) | | 1 (ref.) |
| 50-59 | 406 (32.5) | 503 (30.9) | | 0.98 (0.81 - 1.19) |
| 60-69 | 338 (27.0) | 430 (26.4) | | 1.09 (0.89 - 1.33) |
| 70+ | 125 (10.0) | 189 (11.6) | | 1.22 (0.93 - 1.60) |
| **Smoking** | | | 0.156 | |
| Never | 538 (43.0) | 700 (43.0) | | 1 (ref.) |
| Former | 495 (39.6) | 603 (37.0) | | 0.95 (0.81 - 1.13) |
| Current | 218 (17.4) | 326 (20.0) | | 1.14 (0.92 - 1.40) |
| **Marital status** | | | 0.170 | |
| Alone | 527 (42.1) | 645 (39.6) | | 1 (ref.) |
| In couple | 724 (57.9) | 984 (60.4) | | 1.03 (0.89 - 1.21) |
| **Country of birth** | | | 0.687 | |
| Switzerland | 849 (67.9) | 1117 (68.6) | | 1 (ref.) |
| Other | 402 (32.1) | 512 (31.4) | | 1.07 (0.90 - 1.26) |
| **Educational level** | | | 0.237 | |
| University | 322 (25.7) | 374 (23.0) | | 1 (ref.) |
| High school | 348 (27.8) | 472 (29.0) | | 1.17 (0.95 - 1.44) |
| Apprenticeship | 433 (34.6) | 604 (37.0) | | 1.18 (0.96 - 1.45) |
| Obligatory | 148 (11.8) | 179 (11.0) | | 0.97 (0.74 - 1.28) |
| **BMI categories** | | | 0.014 | |
| Normal | 643 (51.3) | 748 (45.9) | | 1 (ref.) |
| Overweight | 446 (35.7) | 645 (39.6) | | 1.16 (0.98 - 1.37) |
| Obese | 162 (13.0) | 236 (14.5) | | 1.17 (0.92 - 1.48) |
| **Physical activity** | | | 0.230 | |
| Sedentary | 723 (57.8) | 905 (55.6) | | 1 (ref.) |
| Non-sedentary | 528 (42.2) | 724 (44.4) | | 1.15 (0.99 - 1.35) |

BMI, body mass index. Analysis including fried fish consumption. Results in the bivariate analysis are expressed as number of participants and (percentage); results of the multivariable analysis are expressed as odds ratio and (95% confidence interval). Statistical analysis by chi-square (bivariate) and by logistic

regression (multivariable). Multivariable analysis included all the variables indicated in the table and the number of items complied with at baseline. Due to very small numbers, participants complying with five items (n=4) were grouped with participants complying with four items.