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EDUCATIONAL DIFFERENCES IN DIETARY INTAKE AND COMPLIANCE WITH DIETARY RECOMMENDATIONS IN A SWISS ADULT POPULATION

Running title: Educational differences in Swiss diet

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28

29 **ABSTRACT**

30 **Background:** Education is a main determinant of diet. This study assessed the impact of

31 education on dietary intake and compliance with dietary recommendations of the Swiss

32 Society of Nutrition, according to gender.

33 **Methods:** 4338 adult participants of the Colaus study, a cross-sectional, population-based

34 study conducted between 2009 and 2012 in Lausanne (Switzerland). Education was

35 categorized as primary, apprenticeship, secondary, and tertiary. Dietary intake was assessed

36 using a validated food frequency questionnaire.

37 **Results:** Men with primary vs. tertiary education had a lower intake of monounsaturated fatty

38 acids (29.4 vs. 30.9g/day), iron (11.4 vs. 11.8mg/day), vitamin A (758.2 vs. 904.2 retinol

39 equivalents/day), and vitamin D (2.3 vs. 3.0 µg/day). Women with primary vs. tertiary

40 education had a lower intake of monounsaturated fatty acids (25.5 vs. 27.4 g/day), fiber (15.6

41 vs. 17.2 g/day) and iron (9.8 vs. 10.3 mg/day). Men with primary education had a better

42 compliance with recommendations for protein [Odds ratio (95% CI): 2.31 (1.37; 3.90)] than

43 men with tertiary education (p for trend 0.005). Men with apprenticeship had a worse

44 compliance with vitamin D recommendations [Odds ratio 0.55 (0.36; 0.82)] than men with

45 tertiary education (p for trend 0.004). Conversely, women with primary education or

46 apprenticeship had a better compliance with recommendations for vitamin A [Odds ratio 1.74

47 (1.15; 2.65) and 1.80 (1.12; 2.89)] than women with tertiary education (p for trend 0.012).

48 **Conclusion:** Overall, our results do not confirm an unidirectional association between

49 education and diet, and call into question the possibility of targeted interventions in selected

50 educational groups to prevent chronic diseases.

51

52 **Keywords**: Education; Country of birth; Compliance; Diet; Switzerland.

INTRODUCTION

Dietary intake is a major determinant of non-communicable chronic diseases (NCDs) [1,2] and low educated subjects tend to consume lower quality [3,4] and unhealthier diets [5] than high educated subjects. This social patterning of diet may contribute to the higher prevalence of NCD risk factors and to the higher NCD-related mortality of low educated subjects compared to high educated subjects [2,5-7].

Switzerland is a culturally diverse, wealthy European country characterized by a high life expectancy and a low mortality from cardiovascular disease [8-10]. In 2011, NCDs represented 90% of all deaths [11] and recent studies have suggested that neither dietary intake [12] nor compliance with dietary recommendations [13] have improved in the past years. Contrary to other studies conducted in Europe [14-16], there is little information of the impact of education on dietary intake or on compliance to dietary recommendations in Switzerland. Such information is necessary if targeted interventions aiming at improving dietary intake and preventing NCDs in lower educated groups are to be conducted.

Therefore, we used data from a Swiss population-based study to assess the educational differences in dietary intake and in compliance with dietary recommendations.

71

METHODS

Sampling

The CoLaus study is a prospective study assessing the social, clinical and genetic determinants of cardiovascular disease in the population of Lausanne, Switzerland. The CoLaus Study was approved by the Institutional Ethics Committee of the University of Lausanne and all participants provided written consent before being included. Sampling methods and study details have been described previously [17, 18].

Dietary intake was collected in the first follow-up survey, which took place between April 2009 and August 2012. Participants were contacted and asked to attend the outpatient clinic at the Lausanne University Hospital (CHUV). Data were collected in a single morning visit lasting about 60 minutes.

Questionnaire data

Prior to the visit, a self-administered questionnaire on demographic, education, marital status and several lifestyle factors was mailed to the participants.

Education was categorized in four levels: "primary" (level 0-1 according to the International Standard Classification of Education [ISCED]), "apprenticeship" (ISCED level 2), "secondary" (ISCED levels 3-5) and "tertiary" (ISCED levels 6-8)[19].

Dietary intake and compliance with dietary recommendations

Dietary intake was evaluated with a self-administered, semi-quantitative food frequency questionnaire (FFQ) assessing food consumption during the 4 weeks prior to the day of data collection. The FFQ was developed and validated in the general adult population

93   of Geneva, Switzerland [20, 21]. The validation study showed that the included food items

94   account for over 90% of energy, protein, carbohydrate, fat, alcohol, vitamin D and retinol

95   intake, as well as 85% of fiber, carotene and iron intake, and 62% of calcium intake [22].

96   Completion for each FFQ was assessed by a trained interviewer on the day of the visit to the

97   clinic, which led to a completion rate of 100%.

98   The FFQ includes a list of 97 items of homogeneous food groups and their portion

99   sizes. The consumption frequencies for each food item range from "less than once during the

100   last 4 weeks" to "2 or more times per day". A reference serving size was used to guide the

101   participants on reporting his/her usual serving size (smaller, equal or bigger) [23].

102   The answers to the FFQ were converted into nutrients using the French CIQUAL food

103   composition table. Vitamin A was calculated as retinol + carotene/12 and the results were

104   expressed in µg of retinol equivalents (RE). Compliance with the dietary recommendations of

105   the Swiss Society of Nutrition was assessed. These recommendations agree with other

106   country's guidelines and have been endorsed by the Swiss government [24]. A description of the

107   recommendations can be found in the **supplementary table 1.**

108   *Exclusion criteria*

109   Participants were excluded if 1) no dietary data was available 2) they had missing

110   covariates or 3) their energy intake was <850 or >4500 kcal/day as performed previously [23].

111   *Statistical analysis*

112   Statistical analyses were conducted using Stata version 14 (Stata Corp., College

113   Station, TX, USA). All analyses were performed separately for men and women as an

114   interaction was found between education and gender for calcium and vitamin A. Between-

115   group comparisons were made using student's t-test or chi-square for continuous and

116   categorical data, respectively. Multivariate analyses of continuous data were performed using

117   analysis of variance adjusting for age, total energy intake, marital status and country of birth.

118   The results were expressed as adjusted mean (standard error). Multivariate-adjusted absolute

119   differences of dietary intake (Δ) and corresponding 95% confidence intervals (CI) were

120   computed between the lowest and the highest education groups using linear regression

121   models. Normality of the residuals was assessed and confirmed for each model. Multivariate

122   analyses of compliance with dietary recommendations were performed using logistic

123   regression. The results were expressed as odds-ratio (OR) and 95% CI. All analyses were

124   two-tailed and statistical significance was assessed for $P<0.05$.

125

RESULTS

Sample selection and characteristics

Among the 5064 participants in the follow up survey, 378 (7.5%) were excluded because of missing dietary data, 133 (2.6%) because of missing covariates, and 215 (4.2%) because of energy intake <850 or >4500 kcal/day, leaving 4338 participants (85.7%) for analysis. Compared to included participants, those excluded were older, less educated, more frequently living alone and less frequently born in Switzerland (**supplementary table 2**).

The characteristics of the included participants according to gender and educational level are summarized in **supplementary table 3**. Participants with primary education were older and less frequently of Swiss origin than participants with tertiary education (p<0.001 for both genders).

Dietary intake according to educational level

Dietary intake according to gender and educational level is presented in **table 1** for macronutrients and **table 2** for micronutrients.

Among men, compared to the tertiary education group, the primary education group had a lower intake of monounsaturated fatty acids (MUFA), iron, vitamin A and vitamin D, and a positive linear association was found between education and consumption of these four nutrients (p for trend <0.02).

In women, compared to the tertiary education group, the primary education group had a lower intake of MUFA, fiber and iron, and a positive linear association was found between education and consumption of these three nutrients (p for trend <0.01).

147 *Compliance with national dietary recommendations*

148   The unadjusted prevalence of compliance with the recommendations of the Swiss

149 Society of Nutrition according to gender and education is presented in **supplementary table**

150 **4** for macronutrients and in **supplementary table 5** for micronutrients.

151   Among men, compliance was highest for MUFA and lowest for PUFA. Men with

152 primary education showed a higher compliance for total fat and SFA, but a lower compliance

153 to MUFA and calcium than men with tertiary education.

154   Among women, compliance was highest for MUFA and lowest for PUFA. Women

155 with primary education showed a higher compliance for protein, SFA and vitamin A than

156 women with tertiary education**.**

157   The results of the multivariate analyses of the associations between educational level

158 and compliance with the dietary recommendations are shown in **table 3** for macronutrients

159 and **table 4** for micronutrients. Compared to men with tertiary education, men with primary

160 education had a higher likelihood of complying with protein and total fat intake

161 recommendations (131% and 48% increased likelihood, respectively), but a lower likelihood

162 of complying with vitamin D intake recommendations (45% of decreased likelihood).

163 Significant trends were found between education and compliance to protein, total fat, fiber,

164 calcium and vitamin D recommendations.

165   Women with primary education or apprenticeship had a higher likelihood of

166 compliance with vitamin A intake recommendations compared to women with tertiary

167 education. Significant trends were found between education and compliance to protein and

168 vitamin A recommendations.

169

170

DISCUSSION

There is little information regarding compliance to dietary recommendations in Switzerland [22]. Our results show that the effect of educational level in dietary intake differs according to the macro or micronutrient considered. Our results also show that a low educational level is not consistently associated with a lower compliance to the Swiss dietary recommendations. Overall, our results do not confirm the initial hypothesis of a positive gradient between educational level and dietary intake, and call into question the possibility of targeted interventions in selected educational groups to prevent dietary-related NCDs.

Dietary intake according to educational level

Our results were in line with those found in other studies for MUFA, fiber, vitamin A, and D [3, 25-27], and may be explained by the higher cost of healthier diets [28]. However, differences between educational levels were small and clinically unmeaningful. At least 16g of MUFA (22g of olive oil) are required for a decrease of 0.8mmHg in systolic and 0.3mmHG in diastolic blood pressure [29]. Similarly, at least 10g of fiber are required for a 33% decreased risk in colorectal-cancer mortality [30]. As for vitamin A and D, the average daily levels of intake are sufficient to meet the recommended amounts of intake for 98% of all individuals [31, 32].

Compliance with Swiss dietary recommendations

With the exception of MUFA in both genders and iron in men, less than half of the sample complied with the other Swiss dietary recommendations, a finding in line with previous evidence [23]. A possible explanation is that residents in Switzerland do not appear to consider a healthy diet as an important factor. For instance, data from the Swiss national

193 health surveys indicates that four out of ten people living in the French speaking part of

194 Switzerland do not consider their diet as an important issue [33].

195   In men, the lowest educated group had a higher compliance with protein and total fat

196 recommendations, a finding contradicting the literature [3, 34]. Interestingly, adjusting for

197 country of birth attenuated the association between educational level and compliance with

198 recommendations. The most likely explanation is that low educated migrants from Southern

199 Europe have a healthier diet than Swiss-born participants [35]. Overall, our results suggest that

200 not taking into account the cultural and dietary background of the participants may lead to

201 spurious associations between educational level and dietary intake.

202   In women, no associations were found between education groups and compliance with

203 recommendations, except for a higher adherence to vitamin A recommendations in the lower

204 vs. highest educated groups. A possible explanation is that women have healthier dietary

205 habits than men [33, 36, 37] so that educational differences (if any) tend to be smaller. Further, no

206 associations between country of birth and compliance were observed. Overall, our results

207 suggest that, in women, educational level does not influence compliance with dietary

208 recommendations.

209 *Impact for public health*

210   Contrary to other countries [14-16], no consistent, unidirectional association was found

211 between educational level and dietary intake or compliance to dietary recommendations.

212 Importantly, low compliance rates were found for most dietary recommendations, irrespective

213 of gender or educational level. Thus, interventions aimed at increasing overall compliance

214 rates in the whole population will be more effective than interventions targeting a specific

215 educational group.

216 *Strengths and limitations*

217   There is little evidence regarding dietary intake and compliance with dietary

218   recommendations according to education in Switzerland. Our results provide important

219   information on the dietary intake and compliance to dietary recommendations according to

220   education in the Swiss population. Further, they highlight the importance of whole population

221   interventions vs. targeted interventions.

222   This study also presents some limitations. First, the relatively low participation rate

223   (41% at baseline) might lead to an overestimation of compliance, participants being more

224   health conscious than the rest of the population. This overestimation of compliance further

225   strengthens the need for an adequate improvement of dietary intake in the whole population.

226   Finally, we included participants from a single city, which limits generalization of our results

227   to the whole country.

228   We conclude that, overall, our results do not confirm an unidirectional association

229   between education and diet, and call into question the possibility of targeted interventions in

230   selected educational groups to prevent chronic diseases.

231

239

240 **CONFLICT OF INTEREST**

241 None declared.

242

KEY POINTS

- There are several educational differences in dietary intake and compliance with dietary recommendations in our Swiss population, especially in men.

- A low adherence to most intake recommendations has been found in the whole sample, disregarding educational differences.

- Our findings should be used for interventions in the whole population to increase adherence to intake recommendations, instead of focusing on a specific segment of the population.

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342 **Table 1**. Daily energy and macronutrient intake according to education, stratified by gender

	Total energy (Kcal/day)	(SE)	Protein† (% TEI)	(SE)	CHO† (%TEI)	(SE)	Total fat† (%TEI)	(SE)
Men (n=2037)								
Tertiary (n=544)	2048	30	15.6	0.1	44.9	0.4	34.3	0.3
Secondary (n=527)	2029	29	15.6	0.1	45.3	0.4	34.1	0.3
Apprenticeship (n=722)	2031	25	15.3	0.1	45.4	0.3	33.7	0.2
Primary (n=244)	2080	49	15.3	0.2	46.0	0.6	33.5	0.5
P for trend [a]	0.6		0.18		0.16		0.12	
Δ [b]	32.0		-0.3		1.1		-0.8	
(95% CI) Δ [b]	(-85.8;149.8)		(-0.9;0.2)		(-0.4;2.6)		(-1.9;0.3)	
Women (n=2301)								
Tertiary (n=422)	1667	28	15.3	0.2	46.5	0.4	35.1	0.3
Secondary (n=636)	1723	22	15.3	0.1	47.7	0.4	34.2	0.3
Apprenticeship (n=833)	1679	20	15.4	0.1	47.4	0.3	34.5	0.2
Primary (n=410)	1687	29	15.6	0.2	46.9	0.5	34.6	0.4
P for trend [a]	0.90		0.23		0.63		0.47	
Δ [b]†	10.2		0.3		0.4		-0.5	
(95% CI) Δ [b]	(-71.5; 91.9)		(-0.2;0.8)		(-0.9;1.7)		(-1.5; 0.5)	

343 SE, standard error; CHO, carbohydrates ; Kcal, kilocalories; TEI, total energy intake. Results

344 are expressed as energy-adjusted means (standard error). Statistical analysis by ANOVA

345 adjusting for total energy (except †), age, marital status and country of birth (Switzerland,

346 France, Spain, Portugal, Italy and other). [a] Linear trend between education and energy or

347 nutrients. [b] Absolute differences in mean intake (95% CI) between the highest and the lowest

348 educational categories obtained by linear regression models adjusted by total energy (except

349 †), age, marital status and country of birth.

351 **Table 1 (continued).** Daily energy and macronutrient intake according to education, stratified

352 by gender.

	SFA (g)	(SE)	MUFA (g)	(SE)	PUFA (g)	(SE)	Fiber (g)	(SE)
Men (n=2037)								
Tertiary (n=544)	29.4	0.3	30.9	0.3	11.0	0.2	16.7	0.3
Secondary (n=527)	30.1	0.3	30.4	0.3	10.8	0.2	15.9	0.3
Apprenticeship (n=722)	30.0	0.3	29.7	0.3	11.0	0.1	15.4	0.3
Primary (n=244)	29.3	0.6	29.4	0.6	10.9	0.3	15.9	0.5
P for trend [a]	0.81		**<0.01**		0.93		0.13	
Δ[b]	-0.1		**-1.6**		0.0		-0.8	
(95% CI) Δ[b]	(-1.5;1.2)		**(-2.8;-0.2)**		(-0.7;0.6)		(-2.0;0.4)	
Women (n=2301)								
Tertiary (n=422)	23.2	0.3	27.4	0.4	9.3	0.2	17.2	0.3
Secondary (n=636)	23.1	0.3	26.3	0.3	8.9	0.1	16.8	0.3
Apprenticeship (n=833)	23.6	0.2	25.9	0.3	9.2	0.1	16.5	0.2
Primary (n=410)	23.8	0.4	25.5	0.4	9.4	0.2	15.6	0.3
P for trend [a]	0.18		**<0.001**		0.37		**0.004**	
Δ[b]†	0.5		**-1.9**		0.1		**-1.7**	
(95% CI) Δ[b]	(-0.4;1.5)		**(-3.0;-0.9)**		(-0.4;0.5)		**(-2.6;-0.7)**	

353 SE, standard error; SFA, saturated fatty acids; MUFA, monounsaturated fatty acids; PUFA,

354 poly-unsaturated fatty acids. Results are expressed as energy-adjusted means (standard error).

355 Statistical analysis by ANOVA adjusting for total energy (except †), age, marital status and

356 country of birth (Switzerland, France, Spain, Portugal, Italy and other). [a] Linear trend between

357 education and energy or nutrients. [b] Absolute differences in mean intake (95% CI) between

358 the highest and the lowest educational categories obtained by linear regression models

359 adjusted by total energy, age, marital status and country of birth. Statistically significant

360 (p<0.05) differences are shown in bold.

Table 2. Daily micronutrient intake according to education, stratified by gender

	Calcium (mg)	(SE)	Iron (mg)	(SE)	Vitamin A (RE)	(SE)	Vitamin D (µg)	(SE)
Men (n=2037)								
Tertiary (n=544)	1138	21	11.8	0.1	904.2	27.8	3.0	0.1
Secondary (n=527)	1178	21	11.4	0.1	862.9	22.3	2.7	0.1
Apprenticeship (n=722)	1124	18	11.3	0.1	850.6	19.9	2.4	0.1
Primary (n=244)	1098	35	11.4	0.2	758.2	29.5	2.3	0.1
P for trend a	0.18		**0.02**		**0.01**		**<0.001**	
Δ^b	-40.0		**-0.4**		**-145.9**		**-0.6**	
(95% CI) Δ^b	(-123.4; 43.4)		**(-0.8;-0.1)**		**(-249.6 ; -42.3)**		**(-1.0;-0.3)**	
Women (n=2301)								
Tertiary (n=422)	987	19.3	10.3	0.1	808.9		2.6	0.1
Secondary (n=636)	989	15.4	10.0	0.1	863.3		2.5	0.1
Apprenticeship (n=833)	1008	13.8	9.8	0.1	867.2		2.6	0.1
Primary (n=410)	983	20.4	9.8	0.1	880.1		2.4	0.1
P for trend a	0.93		**<0.001**		0.15		0.42	
Δ^b†	-3.9		**-0.5**		71.2		-0.1	

| | (-60.4;52.7) | **(-0.7;-0.2)** | (-24.6; 166.9) | (-0.4;0.1) |

(95% CI) Δ^b

362   SE, standard error; MG, milligrams; RE, retinol equivalents; µg, micrograms. Results are expressed as energy-adjusted means (standard error).

363   Statistical analysis by ANOVA adjusting for total energy (except †), age, marital status and country of birth (Switzerland, France, Spain,

364   Portugal, Italy and other). [a] Linear trend between education and energy or nutrients. [b] Absolute differences in mean intake (95% CI) between the

365   highest and the lowest educational categories obtained by linear regression models adjusted by total energy, age, marital status and country of

366   birth. Statistically significant ($p<0.05$) differences are shown in bold.

367

Table 3. Multivariate analysis of the associations between education and compliance with the Swiss Society of Nutrition recommended

macronutrient intake, by gender.

	Protein	CHO	Total fat	SFA	MUFA	PUFA	Fiber
Men (n=2037)							
Tertiary (n=544)	1 (reference)	1 (reference)	1 (reference)	1 (reference)	1 (reference)	1 (reference)	1 (reference)
Secondary (n=527)	1.19 (0.85; 1.67)	0.99 (0.76; 1.30)	1.10 (0.82; 1.47)	0.89 (0.63; 1.25)	1.16 (0.80; 1.67)	1.07 (0.28; 4.07)	0.86 (0.54; 1.38)
Apprenticeship (n=722)	1.31 (0.94; 1.81)	1.08 (0.84; 1.40)	1.26 (0.95; 1.66)	1.19 (0.87; 1.65)	1.01 (0.72; 1.43)	2.23 (0.67; 7.41)	0.58 (0.36; 0.93)
Primary (n=244)	**2.31 (1.37; 3.90)**	1.15 (0.79; 1.69)	**1.48 (1.00; 2.19)**	1.18 (0.76; 1.84)	0.73 (0.46; 1.18)	2.89 (0.68; 12.33)	0.55 (0.27; 1.10)
P for trend	**0.005**	0.381	**0.029**	0.182	0.327	0.09	**0.014**
Women (n=2301)							
Tertiary (n=422)	1 (reference)	1 (reference)	1 (reference)	1 (reference)	1 (reference)	1 (reference)	1 (reference)
Secondary (n=636)	1.01 (0.72; 1.40)	1.10 (0.85; 1.43)	1.08 (0.81; 1.45)	0.84 (0.63; 1.12)	0.94 (0.64; 1.39)	0.45 (0.13; 1.63)	1.03 (0.61; 1.76)
Apprenticeship (n=833)	1.29 (0.93; 1.78)	1.17 (0.90; 1.51)	1.11 (0.83; 1.49)	0.85 (0.64; 1.14)	0.84 (0.57; 1.23)	1.28 (0.42; 3.89)	1.10 (0.65; 1.87)
Primary (n=410)	1.37 (0.93; 2.02)	1.03 (0.76; 1.41)	1.13 (0.80; 1.58)	0.89 (0.64; 1.26)	0.80 (0.52; 1.24)	0.91 (0.24; 3.46)	0.88 (0.46; 1.66)
P for trend	**0.037**	0.642	0.471	0.555	0.250	0.677	0.812

21

370   CHO, carbohydrates; SFA, saturated fatty acids; MUFA, monounsaturated fatty acids; PUFA, poly-unsaturated fatty acids. Results are expressed

371   as odds ratio and (95% confidence interval). Statistical analysis by logistic regression, adjusting for total energy intake, age, marital status and

372   country of birth (Switzerland, France, Spain, Portugal, Italy and other). Statistically significant ($p<0.05$) differences are shown in bold

373 **Table 4**. Multivariate analysis of the associations between education and compliance with the

374 Swiss Society of Nutrition recommended micronutrient intake, by gender.

	Calcium	Iron	Vitamin A	Vitamin D
Men (n=2037)				
Tertiary (n=544)	1 (reference)	1 (reference)	1 (reference)	1 (reference)
Secondary (n=527)	1.17 (0.88; 1.54)	0.80 (0.56; 1.15)	0.85 (0.57; 1.26)	0.81 (0.54; 1.20)
Apprenticeship (n=722)	0.85 (0.65; 1.11)	0.79 (0.55; 1.12)	0.94 (0.65; 1.36)	0.55 (0.36; 0.82)
Primary (n=244)	0.71 (0.46; 1.08)	1.06 (0.60; 1.86)	0.56 (0.30; 1.02)	0.58 (0.30; 1.10)
P for trend	**0.048**	0.526	0.239	**0.004**
Women (n=2301)				
Tertiary (n=422)	1 (reference)	1 (reference)	1 (reference)	1 (reference)
Secondary (n=636)	0.94 (0.70; 1.26)	0.90 (0.62; 1.31)	1.51 (0.99; 2.31)	1.13 (0.74; 1.70)
Apprenticeship (n=833)	1.04 (0.78; 1.38)	0.88 (0.61; 1.28)	**1.74 (1.15; 2.65)**	0.96 (0.62; 1.48)
Primary (n=410)	0.94 (0.66; 1.34)	0.73 (0.47; 1.14)	**1.80 (1.12; 2.89)**	1.13 (0.69; 1.85)
P for trend	0.991	0.191	**0.012**	0.909

375 Results are expressed as odds ratio and (95% confidence interval). Statistical analysis by

376 logistic regression, adjusting for total energy intake, age, marital status and country of birth

377 (Switzerland, France, Spain, Portugal, Italy and other). Statistically significant ($p < 0.05$) odds

378 ratios are shown in bold.

379 **Supplementary table 1.** Dietary recommendations of the Swiss Society for Nutrition

Nutrient	Recommended intake for adults aged
Protein	<20% total energy intake
Carbohydrates	>50% total energy intake
Total fat	<30% total energy intake
Saturated fatty acids	<10% total energy intake
Monounsaturated fatty acids	>10% total energy intake
Poly unsaturated fatty acids	>10% total energy intake
Fiber	>30g/day
Calcium	>1g/day
Iron	10mg/day
Vitamin A	1.0 Retinol Equivalents for men
	0.8 Retinol Equivalents for women
Vitamin D	>5μg/day

380 According to the Swiss Society for Nutrition [38].

381

382 **Supplementary table 2**. Characteristics of excluded and included participants**.**

	Included	(SD)	Excluded	(SD)	P-value
N (%)	85.7		14.3		
Age (years)	57.6	10.5	58.6	10.8	0.02
University (%)	22.3		15.6		<0.001
Living in couple (%)	67.6		55.6		<0.001
Born in Switzerland (%)	65.1		49.5		<0.001

383 Results are expressed as mean (standard deviation) or as percentage. Statistical analysis by

384 chi-square or student's t-test. Excluded participants refer to over and under reporters of energy

385 and participants with missing dietary data or missing covariates.

386 **Supplementary table 3**. Baseline characteristics of the CoLaus participants by educational level, stratified by gender.

			Marital status		Country of birth					
Men (n=2037)	**Age (years)**	**(SE)**	**Alone**	**Couple**	**Switzerland**	**France**	**Italy**	**Portugal**	**Spain**	**Other**
Tertiary (n=544)	55.4	0.4	21.7	78.3	64.2	7.4	2.4	0.2	0.9	25.0
Secondary (n=527)	57.4	0.5	21.6	78.4	66.0	8.4	5.5	2.3	2.1	15.8
Apprenticeship (n=722)	58.7	0.4	24.4	75.6	78.0	4.4	6.2	2.4	3.1	6.0
Primary (n=244)	57.1	0.7	19.3	80.7	29.1	3.3	16.0	31.2	13.5	7.0
P-value	**<0.001**		0.34				**<0.001**			
Women (n=2301)										
Tertiary (n=422)	54.3	0.5	38.6	61.4	55.2	11.1	1.7	1.0	1.2	29.9
Secondary (n=636)	57.1	0.4	40.4	59.6	57.4	10.5	2.8	1.3	2.0	25.9
Apprenticeship (n=833)	59.6	0.4	43.8	56.2	84.4	2.8	2.6	1.2	2.0	7.0
Primary (n=410)	59.5	0.5	40.0	60.0	47.1	4.9	9.5	17.6	7.8	13.2
P-value	**<0.001**		0.27				**<0.001**			

387 SE, standard error. Results are expressed as average (standard error) or as row percentage. Statistical analysis comparing educational categories

388 by chi-square and ANOVA.

Supplementary table 4. Compliance with the recommendations of the Swiss Society of Nutrition regarding macronutrients according to gender

and educational group.

	Protein	CHO	Total fat	SFA	MUFA	PUFA	Fiber
Men (n=2037)							
Tertiary (n=544)	32.4	28.3	21.5	15.8	87.0	0.9	9.0
Secondary (n=527)	36.8	27.9	23.9	14.8	88.2	0.8	9.3
Apprenticeship (n=722)	38.9	29.6	26.5	17.7	86.8	1.1	7.2
Primary (n=244)	37.7	34.0	38.9	29.1	79.1	2.1	10.3
P-value	0.11	0.33	**<0.001**	**<0.001**	**0.01**	0.43	0.38
Women (n=2301)							
Tertiary (n=422)	33.9	34.4	23.0	25.4	88.9	1.4	6.9
Secondary (n=636)	32.7	38.1	25.5	22.8	87.3	0.6	8.7
Apprenticeship (n=833)	40.1	39.0	25.1	21.1	86.1	1.2	7.8
Primary (n=410)	38.5	40.0	30.0	28.5	83.9	1.2	9.8
P-value	**0.01**	0.33	0.12	**0.03**	0.18	0.60	0.45

391   CHO, carbohydrates; SFA, saturated fatty acids; MUFA, monounsaturated fatty acids; PUFA, poly-unsaturated fatty acids; Kcal, kilocalories;

392   TEI, total energy intake. Results are expressed as percentage. Statistical analysis by chi-square.

Supplementary table 5. Compliance with the recommendations of the Swiss Society of Nutrition regarding micronutrients according to gender and educational group.

	Calcium	Iron	Vitamin A	Vitamin D
Men (n=2037)				
Tertiary (n=544)	52.8	62.0	11.6	12.3
Secondary (n=527)	54.8	57.9	11.0	10.3
Apprenticeship (n=722)	51.0	58.2	12.7	7.3
Primary (n=244)	41.4	65.2	9.8	8.6
P-value	**0.01**	0.14	0.61	**0.02**
Women (n=2301)				
Tertiary (n=422)	38.4	28.9	8.3	10.0
Secondary (n=636)	39.5	33.7	13.1	11.6
Apprenticeship (n=833)	40.6	31.2	14.5	8.5
Primary (n=410)	37.1	32.7	15.9	11.7
P-value	0.67	0.41	**0.01**	0.17

393   Results are expressed as percentages. Statistical analysis by chi-square.

394 **Supplementary table 6.** Multivariate analysis of the associations between country of birth and the Swiss Society of Nutrition recommended

395 macronutrient intake, stratified by gender.

	Protein	CHO	Total fat	SFA	MUFA	PUFA	Fiber
Men (n=2037)							
Switzerland (n=1331)	1 (reference)	1 (reference)	1 (reference)	1 (reference)	1 (reference)	1 (reference)	1 (reference)
France (n=124)	0.69 (0.40; 1.17)	0.71 (0.46; 1.11)	0.84 (0.52; 1.35)	**1.65 (1.01; 2.71)**	1.00 (0.55; 1.79)	N/A	1.30 (0.65; 2.61)
Italy (n=126)	**0.55 (0.32; 0.96)**	1.27 (0.85; 1.90)	**2.22 (1.51; 3.29)**	**3.13 (2.05; 4.79)**	0.72 (0.43; 1.19)	1.18 (0.14; 10.1)	0.64 (0.29; 1.42)
Portugal (n=106)	0.54 (0.26; 1.13)	1.23 (0.76; 2.01)	**2.70 (1.67; 4.36)**	**4.77 (2.84; 8.02)**	0.51 (0.28; 0.93)	1.06 (0.10; 10.8)	1.92 (0.83; 4.44)
Spain (n=71)	**0.21 (0.10; 0.47)**	1.41 (0.84; 2.38)	**2.14 (1.27; 3.60)**	**3.58 (2.07; 6.21)**	0.53 (0.28; 1.00)	**5.79 (1.29; 25.9)**	**3.10 (1.32; 7.26)**
Other (n=279)	0.71 (0.49; 1.04)	1.24 (0.93; 1.66)	**1.51 (1.12; 2.05)**	**2.54 (1.82; 3.54)**	0.64 (0.44; 0.93)	**8.59 (3.01; 24.5)**	1.12 (0.65; 1.95)
Women (n=2301)							
Switzerland (n=1494)	1 (reference)	1 (reference)	1 (reference)	1 (reference)	1 (reference)	1 (reference)	1 (reference)
France (n=157)	0.80 (0.51; 1.28)	0.97 (0.68; 1.38)	1.29 (0.88; 1.89)	1.39 (0.94; 2.06)	0.96 (0.58; 1.59)	3.32 (0.87; 12.7)	0.93 (0.48; 1.83)
Italy (n=86)	1.49 (0.81; 2.73)	**1.92 (1.23; 3.01)**	**1.92 (1.21; 3.06)**	**2.08 (1.29; 3.35)**	0.86 (0.46; 1.60)	1.73 (0.21; 14.1)	0.94 (0.37; 2.37)
Portugal (n=94)	0.54 (0.29; 1.02)	1.49 (0.94; 2.38)	**2.12 (1.31; 3.45)**	**3.17 (1.95; 5.13)**	0.63 (0.33; 1.21)	3.48 (0.60; 20.1)	**3.29 (1.51; 7.17)**
Spain (n=67)	0.56 (0.28; 1.11)	**1.78 (1.08; 2.96)**	**2.07 (1.23; 3.49)**	**2.75 (1.64; 4.64)**	0.60 (0.31; 1.17)	N/A	1.11 (0.39; 3.14)
Other (n=403)	1.03 (0.76; 1.40)	1.12 (0.88; 1.42)	1.29 (0.99; 1.67)	**1.79 (1.38; 2.32)**	0.71 (0.51; 0.99)	**3.40 (1.27; 9.14)**	1.05 (0.65; 1.69)

396   CHO, carbohydrates; SFA, saturated fatty acids; MUFA, monounsaturated fatty acids; PUFA, poly-unsaturated fatty acids; NA, not applicable

397   due to small sample size of compliers (n<5). Results are expressed as odds-ratio and (95% confidence interval). Statistical analysis by logistic

398   regression adjusting for total energy intake, age, education and marital status. Statistically significant (p<0.05) odds ratios are shown in bold.

399 **Supplementary table 7.** Multivariate analysis of the associations between country of birth and the Swiss Society of Nutrition recommended

400 micronutrient intake, stratified by gender.

	Calcium	Iron	Vitamin A	Vitamin D
Men (n=2037)				
Switzerland (n=1331)	1 (reference)	1 (reference)	1 (reference)	1 (reference)
France (n=124)	0.69 (0.45; 1.05)	1.22 (0.69; 2.14)	1.13 (0.63; 2.01)	1.30 (0.73; 2.33)
Italy (n=126)	**0.50 (0.32; 0.79)**	1.42 (0.78; 2.58)	0.81 (0.43; 1.50)	0.61 (0.28; 1.33)
Portugal (n=106)	**0.22 (0.12; 0.40)**	1.26 (0.58; 2.76)	1.90 (0.93; 3.86)	0.98 (0.44; 2.18)
Spain (n=71)	**0.50 (0.28; 0.90)**	1.32 (0.59; 2.93)	0.63 (0.22; 1.82)	1.05 (0.42; 2.60)
Other (n=279)	**0.49 (0.36; 0.67)**	0.89 (0.59; 1.35)	0.80 (0.50; 1.29)	1.07 (0.68; 1.67)
Women (n=2301)				
Switzerland (n=1494)	1 (reference)	1 (reference)	1 (reference)	1 (reference)
France (n=157)	0.73 (0.49; 1.09)	0.92 (0.56; 1.51)	0.67 (0.38; 1.19)	1.23 (0.72; 2.12)

Italy (n=86)	0.58 (0.33; 1.01)	1.16 (0.58; 2.31)	0.67 (0.32; 1.40)	0.68 (0.28; 1.65)
Portugal (n=94)	**0.52 (0.29; 0.91)**	1.62 (0.80; 3.31)	1.59 (0.85; 2.96)	1.58 (0.79; 3.15)
Spain (n=67)	0.74 (0.40; 1.35)	**3.03 (1.53; 6.02)**	0.72 (0.31; 1.66)	1.61 (0.76; 3.44)
Other (n=403)	**0.65 (0.49; 0.86)**	**1.51 (1.07; 2.13)**	1.24 (0.89; 1.74)	**1.67 (1.17; 2.38)**

401 Results are expressed as odds-ratio and (95% confidence interval). Statistical analysis by logistic regression adjusting for total energy intake, age,

402 education and marital status. Statistically significant (p<0.05) odds ratios are shown in bold.

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┌─────────────────────┐
│ Follow-up           │
│ N=5064 (75.2%)      │
└─────────────────────┘
           │
           │         ┌─────────────────────┐
           ├ ─ ─ ─ ─>│ No dietary data     │
           │         │ N=378 (7.5%)        │
           │         └─────────────────────┘
           │
           │         ┌─────────────────────┐
           ├ ─ ─ ─ ─>│ Missing covariates  │
           │         │ N=133 (2.6%)        │
           │         └─────────────────────┘
           │
           │         ┌─────────────────────────────┐
           ├ ─ ─ ─ ─>│ TEI<850 or >4500 kcal/day   │
           │         │ N=215 (4.2%)                │
           │         └─────────────────────────────┘
           │
           ▼
┌─────────────────────┐
│ Included            │
│ N=4338 (85.7%)      │
└─────────────────────┘
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