



# Educational differences in dietary intake and compliance with dietary recommendations in a Swiss adult population

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## Abstract

**Objectives** This study assessed the impact of education on diet and compliance with the national recommendations.

**Methods** The study included 4338 adult participants of the Colaus study, a cross-sectional, population-based study conducted between 2009 and 2012 in Lausanne (Switzerland). Education was categorized as primary, apprenticeship, secondary, and tertiary.

**Results** Men with primary vs. tertiary education had a lower intake of monounsaturated fatty acids (29.4 vs. 30.9 g/day), iron (11.4 vs. 11.8 mg/day), vitamin A (758.2 vs. 904.2 retinol equivalents/day), and vitamin D (2.3 vs. 3.0 µg/day). Women with primary vs. tertiary education had a lower intake of monounsaturated fatty acids (25.5 vs. 27.4 g/day), fiber (15.6 vs. 17.2 g/day) and iron (9.8 vs. 10.3 mg/day). Men with primary vs. tertiary education had a better compliance with protein recommendations [odds

ratio (95 % CI): 2.31 (1.37; 3.90)], while women with primary vs. tertiary education had a better compliance with vitamin A recommendations [odds ratio 1.74 (1.15; 2.65)]. **Conclusions** Overall, our results do not confirm a unidirectional association between education and diet, and question the approach of targeted interventions alone in selected educational groups to prevent chronic diseases.

**Keywords** Education · Compliance · Diet · Switzerland

## Introduction

Dietary intake is a major determinant of non-communicable chronic diseases (NCDs) (Lenoir-Wijnkoop et al. 2013; Malon et al. 2010) and low-educated subjects tend to consume lower quality (Darmon and Drewnowski 2008; Novakovic et al. 2014) and unhealthier diets (Lallukka et al. 2007) 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 (Di Cesare et al. 2013; Hoeymans et al. 1996; Lallukka et al. 2007; Lenoir-Wijnkoop et al. 2013).

Switzerland is a culturally diverse, wealthy European country characterized by a high life expectancy and a low mortality from cardiovascular disease (OECD 2012; Seematter-Bagnoud and Paccaud 2008; World Bank 2011). In 2011, NCDs represented 90 % of all deaths (WHO 2011) and recent studies have suggested that neither dietary intake (Guerra et al. 2012) nor compliance with dietary recommendations have improved in the past years.

Education, as an indicator sharing some health effects with income and occupation (Galobardes et al. 2006), has been assessed as a predictor of dietary patterns in many

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European studies (Hulshof et al. 2003; Irala-Estevez et al. 2000; Maguire and Monsivais 2014). Most of them reported that a low educational level is linked to unhealthier dietary patterns and higher prevalence of NCDs (Cohen et al. 2013; Darmon and Drewnowski 2008). The few Swiss studies assessing the associations between education and dietary intake or compliance to dietary recommendations confirmed that low-educated individuals have worse diets (Galobardes et al. 2001, 2003; Marques-Vidal et al. 2015). Further, most of these studies have been conducted in one city (i.e., Geneva) where the rate of foreigners, and probably dietary pattern diversity, is one of the highest in the country (41 %) (Republique et canton de Geneve 2013; Suisse 2009). Therefore, results may not be easily extrapolated.

The Swiss nutrition policy 2013–2016 has been recently formulated to prevent NCDs and provide equal opportunity to healthy diets to all segments of the population (Swiss Confederation 2012). As low-education populations have been shown to have unhealthier diets in some Swiss populations, information on differences between educational groups is key for the implementation of nutrition interventions, especially those targeting lower educated groups. Therefore, we used data from a Swiss population-based study to assess the educational differences in dietary intake and in compliance with dietary recommendations.

## 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 conducted in accordance with the ethical standards as laid down in the 1964 Declaration of Helsinki and its later amendments or comparable ethical standards. All participants provided written consent before being included. 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 min.

Sampling methods and study details have been described previously (Firmann et al. 2008; Marques-Vidal et al. 2011). Briefly, from 2003 to 2006, a baseline cross-sectional study was conducted to perform genetic assessments in individuals aged 35–75 with Caucasian origin and living in Lausanne (Firmann et al. 2008). A simple, non-stratified random selection of 19,830 subjects was performed, corresponding to 35 % of the Lausanne inhabitants in 2003 and the participation rate was 41 % (Firmann et al. 2008).

For this study, all subjects who participated in the baseline CoLaus study were invited to the follow-up study for the collection of cardiovascular risk factors (e.g., diet assessment) and cardiovascular disease data (Marques-Vidal et al. 2011). Only 75 % of them were followed-up between April 2009 and August 2012 (Guerra et al. 2015).

### 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 into 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) (UNESCO 2011).

### 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 of Geneva, Switzerland (Bernstein et al. 1994; Morabia et al. 1994). The validation study showed that the included food items account for over 90 % of energy, protein, carbohydrate, fat, alcohol, vitamin D and retinol intake, as well as 85 % of fiber, carotene and iron intake, and 62 % of calcium intake (de Abreu et al. 2014). Thus, our FFQ is subject to substantial error (Subar et al. 2003), although this shortcoming is present in all studies using FFQs to assess dietary intake (Ahn et al. 2007; Brinkman et al. 2011; Buscemi et al. 2015; Deschamps et al. 2007).

The FFQ includes a list of 97 items of homogeneous food groups and their portion sizes. The consumption frequencies for each food item range from “less than once during the last 4 weeks” to “2 or more times per day”. For each FFQ item, a reference serving size was provided (e.g., 1 slice of white bread, one 180 g yogurt), and participants could report if their usual serving size was equal, smaller, or bigger than the reference (de Abreu et al. 2014).

The answers to the FFQ were converted into nutrients using the French CIQUAL food composition table. Vitamin A was calculated as retinol + carotene/12 and the results were expressed in  $\mu\text{g}$  of retinol equivalents (RE). Compliance with the dietary recommendations of the Swiss Society of Nutrition was assessed. These recommendations agree with other country’s guidelines and have been endorsed by the Swiss government (Walter et al. 2007). A description of the recommendations can be found in the supplementary Table 1.

**Table 1** Baseline characteristics of the CoLaus participants by educational level, stratified by sex (Lausanne, Switzerland, 2009–2012)

	Age (years)	SE	Marital status		Country of birth					
			Alone	Couple	Switzerland	France	Italy	Portugal	Spain	Other
<b>Men (n = 2037)</b>										
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
<i>p</i> value	<b>&lt;0.001</b>		0.34				<b>&lt;0.001</b>			
<b>Women (n = 2301)</b>										
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
<i>p</i> value	<b>&lt;0.001</b>		0.27				<b>&lt;0.001</b>			

Results are expressed as average (standard error) or as row percentage. Statistical analysis comparing educational categories by Chi-square and ANOVA

Statistically significant ( $p < 0.05$ ) odd ratios are shown in bold

SE standard error

## Exclusion criteria

Participants were excluded if (1) no dietary data were available (2) they had missing covariates or (3) their energy intake was  $<850$  or  $>4500$  kcal/day as performed previously (de Abreu et al. 2014).

## Statistical analysis

Statistical analyses were conducted using Stata version 14 (Stata Corp., College Station, TX, USA). All analyses were performed separately for men and women as an interaction was found between education and sex for calcium and vitamin A. Between-group comparisons were made using student's *t* test or Chi square for continuous and categorical data, respectively. Multivariate analyses of continuous data were performed using analysis of variance adjusting for age, total energy intake, marital status and country of birth. The results were expressed as adjusted mean (standard error). Multivariate-adjusted absolute differences of dietary intake ( $\Delta$ ) and corresponding 95 % confidence intervals (CI) were computed between the lowest and the highest education groups using linear regression models. Normality of the residuals was assessed and confirmed for each model. Multivariate analyses of compliance with dietary recommendations were performed using logistic regression. The results were expressed as odds ratio (OR) and 95 % CI. All analyses were two tailed and statistical significance was assessed for  $p < 0.05$ .

## 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 sex and educational level are summarized in Table 1. Participants with primary education were older and less frequently of Swiss origin than participants with tertiary education ( $p < 0.001$  for both sexes).

### Dietary intake according to educational level

Dietary intake according to sex and educational level is presented in Table 2 for macronutrients and Table 3 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  $<0.02$ ).

**Table 2** Daily energy and macronutrient intake according to education, stratified by sex (Lausanne, Switzerland, 2009–2012)

	Total energy (Kcal/day)	SE	Protein <sup>†</sup> (% TEI)	SE	CHO <sup>†</sup> (% TEI)	SE	Total fat <sup>†</sup> (% TEI)	SE	SFA (g)	SE	MUFA (g)	SE	PUFA (g)	SE	Fiber (g)	SE
<b>Men (n = 2037)</b>																
Tertiary (n = 544)	2048	30	15.6	0.1	44.9	0.4	34.3	0.3	29.4	0.3	30.9	0.3	11.0	0.2	16.7	0.3
Secondary (n = 527)	2029	29	15.6	0.1	45.3	0.4	34.1	0.3	30.1	0.3	30.4	0.3	10.8	0.2	15.9	0.3
Apprenticeship (n = 722)	2031	25	15.3	0.1	45.4	0.3	33.7	0.2	30.0	0.3	29.7	0.3	11.0	0.1	15.4	0.3
Primary (n = 244)	2080	49	15.3	0.2	46.0	0.6	33.5	0.5	29.3	0.6	29.4	0.6	10.9	0.3	15.9	0.5
<i>p</i> for trend <sup>a</sup>	0.6		0.18		0.16		0.12		0.81		<b>&lt;0.01</b>		0.93		0.13	
$\Delta^b$	32.0		-0.3		1.1		-0.8		-0.1		-1.6		0.0		-0.8	
(95 % CI) $\Delta^b$	(-85.8; 149.8)		(-0.9; 0.2)		(-0.4; 2.6)		(-1.9; 0.3)		(-1.5; 1.2)		(-2.8; -0.2)		(-0.7; 0.6)		(-2.0; 0.4)	
<b>Women (n = 2301)</b>																
Tertiary (n = 422)	1667	28	15.3	0.2	46.5	0.4	35.1	0.3	23.2	0.3	27.4	0.4	9.3	0.2	17.2	0.3
Secondary (n = 636)	1723	22	15.3	0.1	47.7	0.4	34.2	0.3	23.1	0.3	26.3	0.3	8.9	0.1	16.8	0.3
Apprenticeship (n = 833)	1679	20	15.4	0.1	47.4	0.3	34.5	0.2	23.6	0.2	25.9	0.3	9.2	0.1	16.5	0.2
Primary (n = 410)	1687	29	15.6	0.2	46.9	0.5	34.6	0.4	23.8	0.4	25.5	0.4	9.4	0.2	15.6	0.3
<i>p</i> for trend <sup>a</sup>	0.90		0.23		0.63		0.47		0.18		<b>&lt;0.001</b>		0.37		<b>0.004</b>	
$\Delta^b$	10.2		0.3		0.4		-0.5		0.5		-1.9		0.1		-1.7	
(95 % CI) $\Delta^b$	(-71.5; 91.9)		(-0.2; 0.8)		(-0.9; 1.7)		(-1.5; 0.5)		(-0.4; 1.5)		(-3.0; -0.9)		(-0.4; 0.5)		(-2.6; -0.7)	

Results are expressed as energy-adjusted means (standard error). Statistical analysis by ANOVA adjusting for total energy (except<sup>†</sup>), age, marital status and country of birth (Switzerland, France, Spain, Portugal, Italy and other)

Statistically significant ( $p < 0.05$ ) odd ratios are shown in bold

SE standard error, CHO carbohydrates, Kcal kilocalories, TEI total energy intake

<sup>a</sup> Linear trend between education and energy or nutrients

<sup>b</sup> Absolute differences in mean intake (95 % CI) between the highest and the lowest educational categories obtained by linear regression models adjusted by total energy (except<sup>†</sup>), age, marital status and country of birth

**Table 3** Daily micronutrient intake according to education, stratified by sex (Lausanne, Switzerland, 2009–2012)

	Calcium (mg)	SE	Iron (mg)	SE	Vitamin A (RE)	SE	Vitamin D ( $\mu$ g)	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 <sup>a</sup>	0.18		<b>0.02</b>		<b>0.01</b>		<b>&lt;0.001</b>	
$\Delta^b$	-40.0		<b>-0.4</b>		<b>-145.9</b>		<b>-0.6</b>	
(95 % CI) $\Delta^b$	(-123.4; 43.4)		<b>(-0.8; -0.1)</b>		<b>(-249.6; -42.3)</b>		<b>(-1.0; -0.3)</b>	
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 <sup>a</sup>	0.93		<b>&lt;0.001</b>		0.15		0.42	
$\Delta^b$	-3.9		<b>-0.5</b>		71.2		-0.1	
(95 % CI) $\Delta^b$	(-60.4; 52.7)		<b>(-0.7; -0.2)</b>		(-24.6; 166.9)		(-0.4; 0.1)	

Results are expressed as energy-adjusted means (standard error). Statistical analysis by ANOVA adjusting for total energy (except<sup>†</sup>), age, marital status and country of birth (Switzerland, France, Spain, Portugal, Italy and other)

Statistically significant ( $p < 0.05$ ) odd ratios are shown in bold

SE standard error, MG milligrams, RE retinol equivalents,  $\mu$ g micrograms

<sup>a</sup> Linear trend between education and energy or nutrients

<sup>b</sup> Absolute differences in mean intake (95 % CI) between the highest and the lowest educational categories obtained by linear regression models adjusted by total energy, age, marital status and country of birth

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  $< 0.01$ ).

#### Compliance with national dietary recommendations

The unadjusted prevalence of compliance with the recommendations of the Swiss Society of Nutrition according to sex and education is presented in supplementary Table 3 for macronutrients and in supplementary Table 4 for micronutrients.

Among men, compliance was highest for MUFA and lowest for PUFA. Men with primary education showed a higher compliance for total fat and SFA, but a lower compliance to MUFA and calcium than men with tertiary education.

Among women, compliance was highest for MUFA and lowest for PUFA. Women with primary education showed a higher compliance for protein, SFA and vitamin A than women with tertiary education.

The results of the multivariate analyses of the associations between educational level and compliance with the dietary recommendations are shown in Table 4 for

macronutrients and Table 5 for micronutrients. Compared to men with tertiary education, men with primary education had a higher likelihood of complying with protein and total fat intake recommendations (131 and 48 % increased likelihood), but men with apprenticeship had a lower likelihood of complying with fiber and vitamin D intake recommendations (42 and 45 % of decreased likelihood). Significant trends were found between education and compliance to protein, total fat, fiber, calcium and vitamin D recommendations.

Women with primary education or apprenticeship had a higher likelihood of compliance with vitamin A intake recommendations compared to women with tertiary education. Significant trends were found between education and compliance to protein and vitamin A recommendations.

#### Discussion

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,

**Table 4** Multivariate analysis of the associations between education and compliance with the Swiss Society of Nutrition recommended macronutrient intake, by sex (Lausanne, Switzerland, 2009–2012)

	Protein	CHO	Total fat	SFA	MUFA	PUFA	Fiber
<b>Men (n = 2037)</b>							
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)	<b>0.58 (0.36; 0.93)</b>
Primary (n = 244)	<b>2.31 (1.37; 3.90)</b>	1.15 (0.79; 1.69)	<b>1.48 (1.00; 2.19)</b>	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	<b>0.005</b>	0.381	<b>0.029</b>	0.182	0.327	0.09	<b>0.014</b>
<b>Women (n = 2301)</b>							
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	<b>0.037</b>	0.642	0.471	0.555	0.250	0.677	0.812

Results are expressed as odds ratio and (95 % confidence interval). Statistical analysis by logistic regression, adjusting for total energy intake, age, marital status and country of birth (Switzerland, France, Spain, Portugal, Italy and other)

Statistically significant ( $p < 0.05$ ) odd ratios are shown in bold

CHO carbohydrates, SFA saturated fatty acids, MUFA monounsaturated fatty acids, PUFA poly-unsaturated fatty acids

**Table 5** Multivariate analysis of the associations between education and compliance with the Swiss Society of nutrition recommended micronutrient intake, by sex (Lausanne, Switzerland, 2009–2012)

	Calcium	Iron	Vitamin A	Vitamin D
<b>Men (n = 2037)</b>				
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)	<b>0.55 (0.36; 0.82)</b>
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	<b>0.048</b>	0.526	0.239	<b>0.004</b>
<b>Women (n = 2301)</b>				
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)	<b>1.74 (1.15; 2.65)</b>	0.96 (0.62; 1.48)
Primary (n = 410)	0.94 (0.66; 1.34)	0.73 (0.47; 1.14)	<b>1.80 (1.12; 2.89)</b>	1.13 (0.69; 1.85)
p for trend	0.991	0.191	<b>0.012</b>	0.909

Results are expressed as odds ratio and (95 % confidence interval). Statistical analysis by logistic regression, adjusting for total energy intake, age, marital status and country of birth (Switzerland, France, Spain, Portugal, Italy and other)

Statistically significant ( $p < 0.05$ ) odd ratios are shown in bold

our results do not confirm the initial hypothesis of a positive gradient between educational level and dietary intake, and call into question the relevance of targeted interventions alone in selected educational groups to prevent 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 (Czernichow et al. 2005; Darmon and Drewnowski 2008; Galobardes et al.

2001; Ovaskainen et al. 2010), and may be explained by the higher cost of healthier diets (Drewnowski and Darmon 2005). Indeed, a higher intake of MUFA gradually increased with increasing educational level, as well as vitamin A and D in men and iron in women. However, differences between educational levels were small and clinically nonmeaningful. A daily intake of at least 16 g of MUFA (22 g of olive oil) is required for a decrease of 0.8 mmHg in systolic and 0.3mmHG in diastolic blood pressure (Alonso et al. 2006), while differences in our study between those with tertiary vs. primary education were 1.6 g in men and 1.9 g in women. Similarly, a daily intake of at least 10 g of fiber is required for a 33 % decreased risk in colorectal cancer mortality (Jansen et al. 1999) while differences in our study between those with tertiary vs. primary education were 1.7 g in women. 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 (National Institutes of Health: Office of Dietary Supplements 2013; Supplements NIOHoD 2014).

#### Compliance with Swiss dietary recommendations

With the exception of MUFA in both sexes and iron in men, less than half of the sample complied with the other Swiss dietary recommendations, a finding in line with previous evidence (de Abreu et al. 2013). 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 health surveys indicate that four out of ten people living in the French-speaking part of Switzerland do not consider their diet as an important issue (Suisse 2012).

In men, the lowest educated group had a higher compliance with protein and total fat recommendations, a finding contradicting the literature (Darmon and Drewnowski 2008; Malon et al. 2010). Interestingly, adjusting for country of birth attenuated the association between educational level and compliance with recommendations. The most likely explanation is that low-educated migrants from Southern Europe have a healthier diet than Swiss-born participants (Confédération Suisse 2008), as in our sample most migrants came from France (19 %), Italy (14 %), Portugal (13 %) and Spain (9 %). Overall, our results suggest that not taking into account the cultural and dietary background of the participants may lead to spurious associations between educational level and dietary intake.

In women, no associations were found between educational groups and compliance with recommendations, except for a higher adherence to vitamin A recommendations in the lower vs. highest educated groups. A possible explanation is that women have healthier dietary habits

than men (Estaquio et al. 2008; Suisse 2012; Touvier et al. 2010) so that educational differences (if any) tend to be smaller. Further, no associations between country of birth and compliance were observed. Overall, our results suggest that, in women, educational level does not influence compliance with dietary recommendations.

#### Relevance for public health

Contrary to other countries (Hulshof et al. 2003; Irala-Estevez et al. 2000; Maguire and Monsivais 2014), no consistent, unidirectional association was found between educational level and dietary intake or compliance to dietary recommendations. Importantly, low compliance rates were found for most dietary recommendations, irrespective of sex or educational level. Thus, interventions aimed at increasing overall compliance rates in the whole population or combining both approaches might be more effective than interventions targeting a specific educational group.

#### Strengths and limitations

The main strength of this study is its relatively large population-based sample to assess educational differences in diet in a Swiss population. In addition, it assessed dietary intake using a validated instrument. This study also presents some limitations. First, the relatively low participation rate (41 % at baseline) might lead to an overestimation of compliance, participants being more health conscious than the rest of the population (Clair et al. 2011; Guerra et al. 2015; Marques-Vidal et al. 2011). This overestimation of compliance further strengthens the need for an adequate improvement of dietary intake in the whole population. Finally, we included participants from a single city, which limits generalization of our results to the whole country.

We conclude that, overall, our results do not confirm an unidirectional association between education and diet, and call into question the relevance of targeted interventions alone in selected educational groups to prevent chronic diseases. Further, interventions addressing the whole population or the combination of targeted plus whole population strategies might be more effective.

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#### Compliance with ethical standards

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**Ethical approval** All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Informed consent was obtained from all individual participants in the study.

**Conflict of interest** Ana-Lucia Mayén declares she has no conflict of interest. Idris Guessous declares he has no conflict of interest. Fred Paccaud declares he has no conflict of interest. Silvia Stringhini declares she has no conflict of interest. Pedro Marques-Vidal declares he has no conflict of interest.

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