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Selling, buying and eating – a synthesis study on dietary patterns across language regions in Switzerland

Matthes, Katarina L ; Zuberbuehler, Christine A ; Rohrmann, Sabine ; Hartmann, Christina ; Siegrist, Michael ; Burnier, Michel ; Bochud, Murielle ; Zwahlen, Marcel ; Bender, Nicole ; Staub, Kaspar

Abstract: Purpose Cross-cultural studies on differences in eating and consumer behavior have several limitations due to differences between countries, for example, in national health policies. Switzerland combines cultural diversity between the language regions, but with a common national health policy. Therefore, Switzerland provides an ideal framework to investigate cross-cultural eating and consumer behavior. The aim of this study was to combine food consumption, purchase data and sales data to obtain a more comprehensive understanding of cultural dietary differences. Design/methodology/approach Six national Swiss studies on food consumption, one study of food sales from the largest supermarket chain in Switzerland and one national study of food purchasing were included. The estimated marginal mean of each food category in each language region was calculated using linear regression and respective linear random effect models. Findings In the French- and Italian-speaking regions more fish was sold, bought and consumed than in the German-speaking region of Switzerland. In contrast, in the German-speaking region, more milk and dairy products were sold, bought and consumed. Language regions explained sales, purchase and consumption of foods, but the findings were only consistent for fish and milk and dairy products. Originality/value If possible limitations of cross-culture studies between countries are eliminated, cultural eating and consumer differences are still visible, even in a small country like Switzerland. For the first time, the complexity of studying food consumption, purchasing and sales is shown in one study. This indicates the importance of further studies which consider these three perspectives to better understand cultural differences in eating and consumption behavior.

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Selling, buying and eating – a synthesis study on dietary patterns across language regions in Switzerland

Understanding
cultural dietary
differences

Katarina L. Matthes

Institute of Evolutionary Medicine, University of Zurich, Zurich, Switzerland

Christine A. Zuberbuehler

Swiss Federal Food Safety and Veterinary Office (FSVO), Bern, Switzerland

Sabine Rohrmann

*Epidemiology, Biostatistics and Prevention Institute, University of Zurich,
Zurich, Switzerland*

Christina Hartmann and Michael Siegrist

Department of Health Sciences and Technology, ETH Zurich, Zurich, Switzerland

Michel Burnier

*Service of Nephrology and Hypertension, University Hospital,
Lausanne, Switzerland*

Murielle Bochud

*Institute of Social and Preventive Medicine, University of Lausanne,
Lausanne, Switzerland*

Marcel Zwahlen

Institute for Social and Preventive Medicine, University of Bern, Bern, Switzerland

Nicole Bender

Institute of Evolutionary Medicine, University of Zurich, Zurich, Switzerland, and

Kaspar Staub

*Institute of Evolutionary Medicine, University of Zurich, Zurich, Switzerland and
Zurich Center for Integrative Human Physiology (ZIHP), University of Zurich,
Zurich, Switzerland*

Abstract

Purpose – Cross-cultural studies on differences in eating and consumer behavior have several limitations due to differences between countries, for example, in national health policies. Switzerland combines cultural diversity between the language regions, but with a common national health policy. Therefore, Switzerland provides an ideal framework to investigate cross-cultural eating and consumer behavior. The aim of this study

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The authors would like to make readers aware that Dr Nicole Bender and Dr Kaspar Staub made equal contributions to this piece of research.

was to combine food consumption, purchase data and sales data to obtain a more comprehensive understanding of cultural dietary differences.

Design/methodology/approach – Six national Swiss studies on food consumption, one study of food sales from the largest supermarket chain in Switzerland and one national study of food purchasing were included. The estimated marginal mean of each food category in each language region was calculated using linear regression and respective linear random effect models.

Findings – In the French- and Italian-speaking regions more fish was sold, bought and consumed than in the German-speaking region of Switzerland. In contrast, in the German-speaking region, more milk and dairy products were sold, bought and consumed. Language regions explained sales, purchase and consumption of foods, but the findings were only consistent for fish and milk and dairy products.

Originality/value – If possible limitations of cross-culture studies between countries are eliminated, cultural eating and consumer differences are still visible, even in a small country like Switzerland. For the first time, the complexity of studying food consumption, purchasing and sales is shown in one study. This indicates the importance of further studies which consider these three perspectives to better understand cultural differences in eating and consumption behavior.

Keywords Consumer behavior, Cross-culture study, Cultural regions, Dietary patterns

Paper type Research paper

1. Introduction

Cross-cultural studies have documented important variability in eating and consumer behavior, not only between countries but also at regional levels within countries ([Guerrero et al., 2009](#); [Ferraris et al., 2019](#)). Askegaard and Madsen have presented that language regions have a major influence on food consumption and that this might not be homogenous within countries ([Askegaard and Madsen, 1998](#)). They have shown that the most heterogenous countries in food consumption in Europe are Belgium, Portugal, Greece and Italy. Furthermore, the French-speaking part of Switzerland was very different from the rest of Switzerland. These differences might be expressed both in food choices and in consumption patterns, but also in beliefs, attitudes or lifestyles ([Olsen et al., 2007](#); [Guerrero et al., 2009](#)).

However, studies on cross-cultural differences in eating and consumer behavior between countries have several limitations. First, national health policies and health care systems may not be the same between countries, and different nutrition campaigns could be applied. Second, types of culture might be different (collectivist vs individualistic), which leads to different consumer behaviors ([Ferraris et al., 2019](#)). Third, the prosperity of a country and the product prices can vary between countries, as well the per capita income. These points might lead to biased results, which cannot always be compensated with statistical methods. Furthermore, while several studies have investigated differences in eating and consumer behavior between countries ([Linseisen et al., 2002](#); [Slimani et al., 2002](#); [Freisling et al., 2010](#)), only few investigated differences within countries. There are only a few countries that allow cross-cultural studies within a country. In Belgium, a multilingual country (French and Dutch), dietary patterns substantially differ between language regions within the country ([De Ridder et al., 2016](#)).

Our study aimed to fill this research gap. Switzerland, a multilingual country with three main languages (German, French and Italian), geographically located in the heart of Europe between Germany, Austria, France and Italy, partly influenced by the culture of these countries, provides an ideal framework to investigate cross-cultural eating behaviors avoiding these limitations. Switzerland combines cultural diversity between the language regions, but with a common national nutrition policy and health care system, similar product price policy and per-capita income.

Several food consumption studies have been conducted to investigate the diet of the Swiss population ([Keller et al., 2012](#); [Hartmann et al., 2013](#); [Ogna et al., 2014](#); [Chatelan et al., 2017](#); [De Mestral et al., 2017](#); [Siegrist and Hartmann, 2019](#)). However, only two studies in Switzerland, namely, menuCH, the first Swiss national nutrition survey and the Swiss Health Survey

(SHS), have analyzed the differences between the three language regions in more depth. The results of these studies clearly demonstrated differences in diet between language regions: For instance, results from these two single studies have shown that the French- and the Italian-speaking part rather follow a Mediterranean diet compared to the German-speaking part. Furthermore, in the German-speaking part more processed meat was consumed, whereas a higher consumption of fruit and vegetables have been observed in the French-speaking part (Keller *et al.*, 2012; Vormund *et al.*, 2015; Boes *et al.*, 2016; Richard *et al.*, 2016; Chatelan *et al.*, 2017; Krieger *et al.*, 2019; Pestoni *et al.*, 2019). These different cultural dietary patterns have often been considered as the reason for regional disparities in health outcomes and mortality (Faeh *et al.*, 2009; Richard *et al.*, 2014; Vormund *et al.*, 2015; Wanner *et al.*, 2018; Pestoni *et al.*, 2019).

In addition to food consumption studies, the supermarket food sales data of one of the largest Swiss supermarket chains have been assessed, and the authors of the study demonstrated that sales differ between language regions (Güsewell *et al.*, 2019). The French-speaking and Italian-speaking regions showed healthier food sales patterns than the German-speaking part of Switzerland. Another perspective has been proposed by the Swiss Household Budget Survey (HBS), which has analyzed household spending on food and the amount of food bought by private households (Bolliger, 2013). However, to date, there exist no evaluations of a comprehensive consumer behavior by language region. So far, food consumption studies have not been combined to obtain a broader view of cultural differences in food consumption. Moreover, as far as we know, data regarding food sales and household spending were not considered in existing analyses.

This study intends to pioneer efforts to combine food consumption, purchase data und sales data. This might lead to a more comprehensive understanding of cultural dietary differences. We included, for the first time, food sales and purchasing data in the analysis to examine whether food-related behaviors are coincided across the three perspectives (sales, purchasing and consumption) and the language regions. The aim of this study was therefore to investigate food consumption, purchasing and sales of the three main language regions in Switzerland by analyzing the impact of different types of cultures (“German”, “French” and “Italian”) and assessing the hypothesis that even a small country like Switzerland shows heterogenous eating behaviors due to these different cultural backgrounds. Besides the language regions, we investigated how food consumption was influenced by other potentially important co-factors like sex, age, education, nationality and urbanity. Our results shall inform similar studies on other multicultural countries and regions of Europe.

2. Materials and methods

For our analysis, we included available national Swiss studies from 2009 to 2017 with sufficient information about food sales, purchasing or consumption and data about the three main language regions as defined by the Swiss Federal Office of Statistics. In Switzerland, 71.2% of the population lives in the German-speaking region, 24.4% in the French-speaking region and 4.4% in the Italian-speaking region (Swiss Federal Statistical Office, 2019a). A map of the language regions can be found in the [supplementary Figure S1](#). For all studies, we restricted the minimum age of participation to 18 years.

2.1 Food sales data

We used 2011 food sales data from Migros, the largest food sales chain in Switzerland. The market share of Migros in 2011 was approximately 37.7% for food products (GfK Switzerland AG, 2012). Since we were interested only in food sales for home consumption, we limited our analysis to supermarkets that sold food products and excluded restaurants, catering services,

take-out restaurants and nonfood stores, which resulted in 553 supermarkets (Güsewell *et al.*, 2019). These supermarkets were located in 445 distinct postcode areas, which are the basis for the analysis. The food sales data were provided as annual sales for each product group in Swiss Francs (CHF). A more detailed description of the data was published elsewhere (Güsewell *et al.*, 2019). We calculated the percentages of each food category from the total amount of food sales and log-transformed them. In addition, we defined for each postcode the mean neighborhood Swiss-socioeconomic position (mean SSEP), as described elsewhere (Panczak *et al.*, 2012) and the urban/rural status of the region to the data at postcode level.

2.2 Purchasing data

The Swiss HBS is a yearly representative survey of the household spending and income of private households in Switzerland that was initiated in 2000 (Bolliger, 2013). Since then, the study has been running continuously and Swiss households are randomly selected from the Federal Statistical Office sample register on a monthly basis (Federal Statistical Office, 2010). The participating households record all their expenses and income in survey documents for a period of one month. Additionally, they receive telephone support from experienced specialists (Bolliger, 2013). A large part of the survey collects data on food spending as well as the amount of food purchased. Since both were highly correlated, we only focused on the amount of food purchased, which was described in kilograms or liquid, described as liter per month in each household and log-transformed it. For our analysis, we used data from 2009 to 2014. In total, 19,101 households were included. To correct for the effects of nonparticipation, the data of all households in the sample were weighted. A more detailed description of the data collection, recruitment procedure, participation rate and sample weight strategy was published elsewhere (Bolliger, 2013). To make the data comparable, we divided the amount of food by the number of people living in a household. Furthermore, the number of children under 15 years living in a household and the household income were considered as covariates.

2.3 Consumption data

2.3.1 MenuCH. MenuCH is a representative Swiss national nutrition survey conducted between 2014 and 2015 that assessed food consumption with two nonconsecutive 24 h recalls. Participants were drawn from a stratified random sample provided by the Federal Statistical Office as published elsewhere (Federal Statistical Office, 2010). They had to be 18–75 years old and permanent residents in Switzerland. The mean food intake was recorded in grams and subsequently log-transformed. In total, 2,057 participants were included in the analysis. To correct for the effects of nonparticipation, the data were weighted according to the menuCH weighting strategy, including calibration for weekdays and seasons (Pasquier *et al.*, 2017). A more detailed description of the data collection, recruitment procedure and participation rate was published elsewhere (Bochud *et al.*, 2017).

2.3.2 Swiss Health Survey. The SHS is a representative survey of health condition, health behavior and the use of health services of people living in Switzerland and has been conducted every five years since 1992 (Storni *et al.*, 2018). Participants were drawn from a random sample provided by the Federal Statistical Office as published elsewhere (Federal Statistical Office, 2010). They had to be ≥ 15 years old and permanent residents in Switzerland. Data collection was conducted through telephone interviews followed by a written questionnaire. One part of the survey also focuses on food consumption in Switzerland. In this study, we included the 2012 and 2017 waves, which included 21,597 participants in 2012 and 22,134 in 2017. For 2017, no information on milk and dairy products was available. Both survey years were analyzed separately. Participants were asked about their food intake per week. The possible answers were given in days/week: never; ≤ 1 , 2–3, 4–5, or 6 days; or daily. To correct for the effects of nonparticipation, the data were weighted. A

more detailed description of the data collection, recruitment procedure, participant rate and sample weights strategy was published elsewhere ([Bundesamt für Statistik, 2013, 2018](#)).

2.3.3 Swiss Food Panel. The Swiss Food Panel (SFP) is a longitudinal survey about Swiss eating behavior. SFP 1.0 was conducted between 2010 and 2014, and SFP 2.0 was initiated in 2017. Participants were randomly selected, had to be ≥ 20 years old and permanent residents in the German-speaking or French-speaking parts of Switzerland. Data collection was conducted through written questionnaires. For this study, only cross-sectional data from 2010 for SFP 1.0 and 2017 for SFP 2.0 were used. SFP included no information about the Italian-speaking region. In 2010, 6,161 participants were included, and 5,587 were included in 2017. Both survey years were analyzed separately. Participants were asked about their respective food intake in portions. The answer choices ranged from seldom/never, several times a year/month/week to daily. A more detailed description of the data collection, recruitment procedure and participant rate was published elsewhere ([Hartmann *et al.*, 2013](#); [Hagmann *et al.*, 2018](#)).

2.3.4 Swiss survey on salt. The Swiss survey on salt (SSS) was conducted in 2010/2011 to estimate the mean dietary salt intake of people living in Switzerland based on a single 24-h urine collection ([Chappuis *et al.*, 2011](#)). In addition, the SSS also included questions about the consumption of foods, except milk and dairy products. Participants were drawn from a stratified random sample provided by the Federal Statistical Office as published elsewhere ([Federal Statistical Office, 2010](#)). They had to be ≥ 15 years old and permanent residents in Switzerland ([Chappuis *et al.*, 2011](#)). In total, 1,539 participants were included. The intake of fruit and nuts, and vegetables was measured in portions/day: never or <1 , 1–2, 3–4, or >5 portions/day, and the intake of meat and fish was measured in portions/week: never; rarely; or 1, 2, 3, 4, 5, 6, or 7 portions/week. A more detailed description of the data collection, recruitment procedure and participant rate was published elsewhere ([Chappuis *et al.*, 2011](#)).

2.4 Covariates in the consumption studies

In addition to food categories and language region, information about sex, age and education level was available for all consumption studies. Age was categorized into three groups: 18–35, 36–55 and >55 years. As a higher education level has previously been positively associated with a healthy diet ([Marques-Vidal *et al.*, 2015](#)), we considered the level of education in the analyses. Education level was also categorized into three groups: primary (no degree or with a compulsory school degree), secondary (completed high school or apprenticeship) and tertiary (higher degree requesting a high school diploma). Various studies also found differences in food consumption between rural and urban areas ([Guerrero *et al.*, 2009](#); [Hagmann *et al.*, 2018](#)). We therefore, considered this covariate (except for SSS) and coded it binary as “urban” or “rural” ([Swiss Federal Statistical Office, 2020](#)). The general Swiss population consists of approximately 38% people with a migration background ([Swiss Federal Statistical Office, 2019b](#)) with different culture-bound food consumption. Therefore, we included, except for SFP 2017, information on nationality, which was also binary coded as “Swiss” or “non-Swiss”.

2.5 Food categories

To compare the eight different data sets, we only defined large food categories, which were available in most studies. Five different food categories, adapted from [Chatelan *et al.* \(2017\)](#) and modified in the current study, were considered: vegetables, fruit and nuts, meat (including red and processed meat from mammals and white meat from poultry), fish (including fish, seafood, processed fish and processed seafood) and milk and dairy (including all kinds of mammal milk and dairy products). Since we defined only large major categories, we assume that these food groups have not changed massively over these years.

2.6 Statistics

In all analyses we followed a logical approach of first assessing food sales, then food purchases and finally food consumption. To compare the five food categories between the three language regions and between the three perspectives (sales, purchasing and consumption), standardized z-scores were calculated for the weighted study samples (if available). All results are presented as the mean of z-scores, where zero indicates the overall mean of the population. A positive z-score indicates sales, purchase or consumption above the overall population mean, a negative value below the overall population mean. For sales and purchasing data, the estimated marginal mean of each food category in each language region was calculated using linear regression (weighted for purchasing data). Sales data were controlled for urbanity and SSEP mean. Purchasing data were controlled for children younger than 15 years living in a household and household income.

For the consumption data six different studies were available. We assumed that the language region had a different effect on food consumption, depending on the study. Thus, we assumed variance between the language regions within a study, but also between the six studies. Therefore, we used linear random effect models (Faraway, 2016) to estimate the marginal mean of each food category in each language region. This model allows to estimate the effect of the language region and at the same time to control for the language regions in the six studies. If we would pool the six studies, the variance between the studies would not be accounted for and the result could be biased.

If available, sample weights of the respective studies were considered in the analysis. First, we controlled for sex, age and education. Since no information on urbanity was available for SSS, we excluded the SSS in a further analysis and controlled for urbanity. Likewise, we excluded SFP 2017 (no information on nationality) and additionally controlled for nationality. In a subanalysis of the consumption studies, we stratified the analysis according to sex, age and education level.

To examine the influence of each independent variable on food consumption, we removed each independent variable from the model one at a time and calculated the Akaike's information criterion (AIC). Next, the difference between the AIC for the full model M and the model with the omission of an independent variable k was calculated, i.e. $\Delta AIC_k = AIC_k - AIC_M$. The larger ΔAIC_k is, the more important the variable in the model. All statistical analyses were performed using R Version 3.6.0 (R Core Team, 2019). The R package "nlme" (Pinheiro et al., 2020) was used to calculate the random effect models, and "ggplot2" (Wickham, 2016) was used to produce the figures.

3. Results

Table 1 shows the characteristics of each study. Regarding the language regions, the study participants were similarly distributed in all studies, except the SSS. In the SSS, the German-speaking region was underrepresented, whereas the Italian-speaking region was overrepresented. The participants in both SFPs were older than those in other studies. Comparing the education level, the education level was highest in the menuCH and SFP studies. Furthermore, the degree of urbanity was similar in the menuCH and SFP studies, whereas the percentage of participants living in an urban area was higher in both SHSs.

Figure 1 presents the estimated marginal mean by food category for all three perspectives (sales, purchase and consumption). The findings for milk and dairy, and fish products were consistent among the three perspectives. Compared to the German-speaking region, significantly less milk and dairy products were sold, purchased and consumed in the French- and Italian-speaking regions (for p -values, see Supplementary Table S2). In contrast, fish was significantly more important in the French- and Italian-speaking regions. Regarding meat, vegetables, and fruit and nuts, the patterns between the three perspectives were not

	Sales Migros (%)	Purchase HBS* (%)	menuCH* (%)	SHS 2012* (%)	Consumption SHS 2017* (%)	SFP 2010 (%)	SFP 2017 (%)	SSS (%)	Understanding cultural dietary differences
<i>Language regions</i>									
German	72.4	71.4	68.8	71.3	71.1	70.5	72.2	54.2	
French	23.1	23.9	25.7	24.2	24.4	29.5	27.8	31.8	
Italian	4.5	4.7	5.6	4.5	4.5	–	–	14.0	
<i>Sex</i>									
Men	–	–	49.8	49.0	49.4	47.7	48.1	48.5	
Women	–	–	50.2	51.0	50.6	52.3	51.9	51.5	
<i>Age</i>									
18–35	–	–	30.3	30.5	30.6	12.1	14.2	31.3	
36–55	–	–	40.7	35.6	35.2	42.0	31.3	32.9	
>55	–	–	29.0	33.9	34.2	45.9	54.5	35.8	
<i>Education</i>									
Primary	–	–	4.7	17.9	16.4	9.4	7.6	16.1	
Secondary	–	–	42.6	53.4	49.8	38.7	39	44.1	
Tertiary	–	–	52.6	28.7	33.8	51.9	53.4	39.8	
<i>Urbanicity</i>									
Urban	46.1	–	54.6	73.2	74.0	48.2	46.3	–	
Rural	53.9	–	45.4	26.8	26.0	51.8	53.7	–	
<i>Nationality</i>									
Swiss	–	–	74.0	77.0	75.7	83.0	–	86.6	
Non-swiss	–	–	26.0	23.0	24.3	17.0	–	13.4	
<i>mean SSEP</i>									
1. Quartile	16.0	–	–	–	–	–	–	–	
2. Quartile	24.5	–	–	–	–	–	–	–	
3. Quartile	26.8	–	–	–	–	–	–	–	
4. Quartile	32.7	–	–	–	–	–	–	–	
Note(s): *weighted									

Table 1.
Characteristics of
each study

consistent. For example, the Italian-speaking region sold more fruit and nuts, and vegetables than the German-speaking region but consumed less, whereas the German-speaking region sold less and consumed more.

Figure 2 illustrates the estimated marginal mean z-scores of consumption studies stratified by sex, age and education level. Irrespective of the included covariates, it appeared that fish consumption was significantly higher in the French- and Italian-speaking regions, whereas milk and dairy consumption was highest in the German-speaking region (for *p*-values, see [Supplementary Table S3](#)). Moreover, the older the participants, the higher the fruit and nut, and vegetable consumption was, independent of language region and sex. However, in all language regions, men ate less fruit and nuts, and vegetables and more meat than women, especially men between 18 and 34 years. Nonetheless, meat consumption decreased as men got older. Vegetable consumption was higher in those with higher education level.

Table 2 reveals that the most important variables in regard to consumption differ between food categories. For fruit and nuts sex was the most important factor in explaining the model followed by age. For vegetable consumption, education was the most, and sex was the second most important factor. Sex was also the most important factor for meat consumption,

Figure 1. Estimated marginal mean of z-scores for each food category by language region and perspective. Sales were adjusted for mean SSEP and urbanity; purchasing was adjusted for household income and number of children younger than 15 years old living in a household; and consumption was adjusted for sex, age and education

Understanding cultural dietary differences

Figure 2. Estimated marginal mean z-scores of each food category by language region for consumption stratified by sex, age and education level. All results were mutually adjusted for all variables

	Fruits and nuts	Vegetables	Meat	Milk and dairy	Fish
Language region	79.66	139.78	245.38	251.34	2265.82
Education	832.38	1915.02	877.84	376.22	1055.94
Age	1262.77	635.42	257.36	161.17	199.32
Sex	1461.54	1484.10	3281.36	19.34	-1.55

Table 2. Δ AIC (Akaike's information criterion) for consumption data. The higher the Δ AIC is, the more important the variable

followed by education. In contrast, sex was an unimportant factor in explaining the consumption of milk and dairy and of fish. However, the language region was the most important variable in explaining fish consumption and second important for milk and dairy. In contrast, the language region was the least important factor in explaining fruit and nuts, vegetables and meat consumption. Similar results were obtained for models of sales and purchase data (see [Supplementary Table S4](#)). Regarding sales and purchases, the language region played the most important role for fish and milk and dairy products and a less important role for fruit and nuts and vegetables. However, in the sales data SSEP was the

most important factor in explaining fruit and nuts, vegetable and meat sales. Whereas meat consumption decreased the higher the SSEP, the sales of fruit and nuts, and vegetable increased with increasing SSEP (see [Supplementary Table S2](#)).

[Figure 3](#) presents the results stratified by urbanity (excluding the SSS survey) and nationality (excluding SFP, 2017). This indicates again that fish consumption was higher in French- and Italian-speaking areas, independent of urbanity and nationality. However, fish consumption was higher among non-Swiss participants than among Swiss participants, which was also found in the German-speaking region. Non-Swiss participants residing in the German- and French-speaking regions consumed fewer vegetables than Swiss participants did. In the German-speaking region, non-Swiss participants ate less meat and milk and dairy products than Swiss participants. Moreover, participants living in a rural area in the German- or Italian-speaking region ate more meat and milk and dairy products than participants living in an urban area. In the Italian-speaking region, participants residing in rural areas consumed fewer vegetables than participants residing in urban areas. Considering the AIC, including nationality and urbanity (see [Supplementary Table S5](#)), it is also obvious that nationality is the second most important factor after language region for the estimation of fish consumption. Nationality was not an important factor for fruit and nuts, vegetables, meat and milk and dairy consumption. Urbanity was the third important factor for meat and fish consumption.

Figure 3. Estimated marginal mean of z-scores of each food category by language region for the consumption studies stratified by nationality and urbanity. The results were mutually adjusted for all the variables and for sex, age and education

4. Discussion

In the present study we showed that Switzerland is a country with partially heterogeneous food consumption behavior. In addition to previously published studies conducted in Switzerland that have reported higher fish and lower dairy consumption in the French- and Italian-speaking regions (Keller *et al.*, 2012; Chatelan *et al.*, 2017; Krieger *et al.*, 2019; Pestoni *et al.*, 2019), we completed the picture with sales and purchase data. However, a less clear pattern could be observed between sales, purchase and consumption data for meat, vegetables, and fruit and nuts.

One reason might be that food sales could only be obtained from one supermarket chain in Switzerland, which covers approximately 38% of the market share in Switzerland but is not equally distributed between the language regions (Güsewell *et al.*, 2019). In eastern Switzerland, which is in the German-speaking region, the distribution of the Migros stores is lower than that in the other parts of Switzerland (Güsewell *et al.*, 2019). For that reason, it might be possible that people living in eastern Switzerland buy vegetables, fruit and nuts, and meat at other local stores rather than Migros. Furthermore, we can only present results from one supermarket chain and cannot generalize the results. Taking the Italian-speaking region as an example, Migros sold more fruit and nuts, and vegetables in the Italian-speaking region than in the French- and German-speaking regions, but there is no information on whether supermarkets in general sold more fruit and nuts, and vegetables in the Italian-speaking region. Considering the consumption results, the Italian-speaking region seemed to not consume more fruit and nuts, and vegetables than the Swiss mean.

Moreover, we were not able to estimate the extent of cross-border shopping in the surrounding countries, which could influence the purchasing results. It is known that in 2015, at least 57% of Swiss people shopped abroad once a month (GfK Switzerland AG, 2016). This was especially prevalent in the Italian-speaking part. In our data, this is particularly evident when comparing the sales and purchase data for meat. We speculate that meat products, such as salami and ham, might often be bought in Italy, which might be the reason why the sale of meat products in the Italian part was very low in our study. However, the higher number of purchases in the Italian-speaking region suggests that meat products were probably bought in Italy and not in Switzerland.

We observed that the Italian-speaking region consumed less food in general than the Swiss mean, with the exception of fish. Our food categories were relatively broad and did not account for all food categories, such as cereals, starch products, pasta or rice. Swiss studies (Chatelan *et al.*, 2017; Krieger *et al.*, 2019) have shown that many people from the Italian-speaking region follow a dietary pattern with high intake of cereals and starchy products. Switzerland shares many dietary habits with the cultures by which it is surrounded (Chatelan *et al.*, 2017; Krieger *et al.*, 2019; Pestoni *et al.*, 2019), which means that the Italian-speaking region might have similar dietary patterns as Italy, which have been shown to be high in starch and cereal products (Slimani *et al.*, 2002; Naska *et al.*, 2006; Leclercq *et al.*, 2009; Freisling *et al.*, 2010; WHO, 2016).

The current study revealed a higher fruit and nuts, vegetable and meat intake in the French- and German-speaking regions than in the Italian-speaking region. Although the dietary patterns of Switzerland may be influenced by the neighboring countries (Chatelan *et al.*, 2017; Krieger *et al.*, 2019) our results differ from those of other European studies with respect to fruit and vegetable consumption. Several studies have characterized Italy as having a high fruit and vegetable intake, in contrast to France and Germany, which have rather low intakes (Slimani *et al.*, 2002; Naska *et al.*, 2006; Leclercq *et al.*, 2009; Heuer *et al.*, 2015); this finding could not be confirmed in the respective language regions in the current study. In contrast, meat consumption in the German-speaking region was lower than expected compared to the findings of other studies (Linseisen *et al.*, 2002; Naska *et al.*, 2006; Heuer *et al.*, 2015). Additionally, we could not categorize meat consumption into red, white or

processed meat. However, it has been illustrated that Germany has a high consumption of processed meat, whereas Italy and France consume unprocessed red and white meat (Linseisen *et al.*, 2002; Slimani *et al.*, 2002; Naska *et al.*, 2006; Leclercq *et al.*, 2009). International studies have also confirmed a lower fish and higher milk and dairy consumption in Germany than in Italy or France (Slimani *et al.*, 2002; Naska *et al.*, 2006). However, one needs to consider that the language regions were not equally represented in the studies. The SSS overrepresented the Italian- and French-speaking regions; whereas, the menuCH and SHS studies underrepresented the Italian-speaking region (Swiss Federal Statistical Office, 2019a). Moreover, the SFP did not sample the Italian-speaking region at all.

The results stratified by sex and age confirmed the findings of previously published studies, which also showed that women consume more fruit and nuts and vegetables and less meat than men (Keller *et al.*, 2012; Heuer *et al.*, 2015; Chatelan *et al.*, 2017; Storni *et al.*, 2018).

Our findings concerning education were also in line with the results of previous publications (De Irala-Estévez *et al.*, 2000), which have shown that the higher the education, the higher the fruit and nuts, and vegetable consumption. For meat, milk and dairy, and fish, the differences in our study were not as clear. However, independent of education level, people from the French- and Italian-speaking regions consumed more fish. We are aware that income besides education might be also associated with food consumption (Abulai, 2002; Hiza *et al.*, 2013), however most of the included studies have a lot missing data for income. For that reason, we decided only to include education in the analysis.

Considering the results of the differences in Δ AIC, although language region was a factor explaining food sales, purchase and consumption, it was only important for fish, and milk and dairy. Regarding fruit and nuts, vegetables and meat consumption, language region was the least important factor in the explanation of the models; education, sex and age were much more important. However, to the best of our knowledge, this is the first time that the importance of each explorative variable has been examined within the Swiss context. Previous studies have demonstrated significant differences in food consumption between language regions (Chatelan *et al.*, 2017; Krieger *et al.*, 2019; Pestoni *et al.*, 2019) but did not present the respective contribution of language region to explain the model compared to variables such as age, sex or education level.

In the current study, differences in food intakes between urban and rural areas were present. Participants living in rural areas seemed to consume more meat, and milk and dairy products than people living in urban areas. A study using data from SFP 2017 also suggested differences between urban and rural settings, which may reflect more conservative attitudes in rural communities, where changes in health behaviors might be slower than in urban areas (Hagmann *et al.*, 2018).

Swiss people have different food intakes than non-Swiss people. This may once more indicate that food consumption in Switzerland is influenced by neighboring countries and by the diversity of the nationalities of people living in Switzerland (Marques-Vidal *et al.*, 2015; Krieger *et al.*, 2019; Pestoni *et al.*, 2019). Unfortunately, we only had information about the language regions in which the non-Swiss participants lived, but not about the specific nationality. However, we assume that many of the non-Swiss participants living in the Italian-speaking region originated from Italy. According to the Swiss Federal Office 2013: 16.1% of the population in the Italian-speaking part and 59.1% from all migrants in the Italian-speaking part were from Italy (Swiss Federal Statistical Office, 2014). Our findings from non-Swiss participants in the Italian-speaking region are in line with findings from studies which have analyzed eating pattern in Italy (Slimani *et al.*, 2002; Naska *et al.*, 2006; Leclercq *et al.*, 2009). We found that non-Swiss people in the Italian-speaking region consumed more fruits and nuts, vegetables and fish, whereas they consumed less milk and dairy products than Swiss-participants.

We assume, that for the French- and German-speaking regions nationalities of the migrants were much more divers (Swiss Federal Statistical Office, 2014), which made it

impossible to draw a conclusion about the differences between Swiss and non-Swiss participants. This emphasizes the importance to include nationalities of participants in food studies. Moreover, the Swiss population consists of approximately 38% of people with a migration background (including 1st and 2nd generations) (Swiss Federal Statistical Office, 2019b). Switzerland is not only influenced by the neighbor countries, but also from Balkan countries, Spain, Portugal, Turkey and other European countries (Swiss Federal Statistical Office, 2014), with different culture-bound eating behaviors (Volken *et al.*, 2014). To better understand differences in eating patterns due to cultural influences the exact nationalities or migration background from 1st and 2nd generation migrants needs to be known. As seen in our results, it is not sufficient to have only information about “Swiss” and “non-Swiss”, since the interpretation of results within this dichotomy is difficult.

Strength of this study was that cross-cultural eating and consumer behaviors could be examined without major constraints normally occurring in cross-culture studies. In Switzerland, a multilingual country with influences from neighboring countries but having only one nutrition policy, health system, similar product prices and per capita income, cross-cultural studies are possible without major bias. Furthermore, each of the included studies had different advantages and limitations. By analyzing and summarizing a number of studies, we were able to assemble a more representative sample and obtain a broader view of different food consumption patterns in Switzerland in the three language regions than single studies allow.

The present study also has some limitations. First, we only included one supermarket chain, which is one of the largest chains in Switzerland but is not equally distributed in language regions (Güsewell *et al.*, 2019). In future studies, more supermarket chains need to be included to obtain a broader view of food sales in Switzerland. Second, the methods to collect food data substantially vary across studies. We therefore expect different exposure misclassification to occur. However, we mitigated some of these differences by using *z*-scores. Third, the survey years between the studies differ. But, using random effect models, the variances between the studies were considered. Moreover, we only defined large food categories, and we believe that these food groups did not change massively over the years. Unfortunately, for sales data, only data from 2011 were available, which could lead to a bias by comparing data from recently conducted sales studies with older sales data. Fourth, not all food categories were available in all data sets, and the specificity of food categories varies. That is why we defined only five large food categories and did not analyze food categories in more detail. Finally, the numbers of available covariates were also different in the studies; for that reason, we restricted our analyses to minimal covariates that were available in all studies.

5. Conclusion

This study confirms noticeable differences in food consumption, purchasing and sales between the three main language regions of Switzerland. We illustrated that when possible issues of cross-culture studies between countries are eliminated (as in this study), cultural dietary differences are still visible, even in a small country like Switzerland. For the first time, the complexity of studying food consumption, purchasing and sales in one study was shown. This study indicates the importance of further studies which consider these three perspectives to understand the cultural differences in eating and consumption behavior even better. For example, more detailed studies about cross-border shopping and intercultural exchange in border regions would broaden the understanding of consumer behavior. Such results might help to individualize dietary recommendations on cultural levels, because up to now, at least in Switzerland, cultural differences are not considered in nutrition campaigns or recommendations. Furthermore, these results shall inform similar studies in other multilingual or multicultural countries of Europe.

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Appendix

The supplementary material is available online for this article.

Corresponding author

Katarina L. Matthes can be contacted at: katarina.matthes@iem.uzh.ch