IUMSP - Institut universitaire de médecine sociale et préventive
Biopole 2
Rte de la Corniche 10
CH-1010 Lausanne

Lessons learnt about a feasibility study among children and adolescents aged 3 to 17 years to prepare the next national nutrition survey

Report on behalf of the Food Safety and Veterinary Office

Research Project Aramis 5.16.01

Authors

Angéline Chatelan, RD, MSc

Murielle Bochud, MD, PhD

Institut Universitaire de Médecine Sociale et Préventive, Lausanne*

***Address for Correspondence**

Prof. Murielle Bochud

Institut Universitaire de Médecine Sociale et Préventive*

Route de la Corniche 10

CH-1010 Lausanne

**Depuis le 1er janvier 2019, les activités de la Policlinique médicale universitaire, de l'Institut universitaire de médecine sociale et préventive, de l'Institut universitaire romand de santé au travail et de l'association Promotion santé Vaud, sont regroupées dans un Centre universitaire de médecine générale et santé publique, à Lausanne.*

December 2018

Executive summary

Abstract

Little is known about the diet and nutritional status of Swiss children and adolescents. In 2014-2015 the first national nutrition survey, menuCH, has been only performed in adults. Before setting up a national nutrition survey among children and adolescents, age-specific methodologies and acceptability for bio-sample collection needed to be tested in a feasibility study. The aim of this report is to describe this cross-sectional and single-centre small-scale nutrition survey and provide recommendations for the next national nutrition survey. We recruited healthy children aged 3 to 10 years and adolescents aged 11 to 17 years, who were randomly selected from the population registry. We completed this sample with a convenience sample (recruitment by flyers). We assessed dietary intake with two non-consecutive computerized 24-hour dietary recalls (24HDR, assisted by 24-hour food diaries in children under 11 years) and an on-line food propensity questionnaire. We scanned participants' palm skin for its carotenoid concentration using Raman spectroscopy. Bio-sample collection included spot urine, toenails, and capillary and venous blood. Participants' caregiver(s) and paediatricians were informed when results indicated potential nutritional or health problems based on laboratory analyses. Fifty-three children living in and near Lausanne took part in the feasibility study. Participation rate was low in the population registry sample (16%), but acceptation rate was high for bio-sample collection: spot urine (100%), toenail (96% in children), capillary blood (79% in children and 100% in adolescents), and venous blood (83% in adolescents). Tested dietary assessment tools were well accepted by children and adolescents. They would need only minor modifications before the main survey. The score established by the palm skin scanner was fairly correlated to the plasma carotenoid concentration (Pearson's r = 0.69). Personal feedback given to participants' caregiver(s) was appreciated but time-consuming for the study team since four in five adolescents who accepted venous blood collection had at least one marker indicating potential nutritional or health problems. Main recommendations for a national nutritional survey among children and adolescents are 1) to assess diet using two non-consecutive 24HDR (assisted by 24-hour food diary) and a FPQ, 2) to improve the recruitment procedures to increase participation rate, 3) to collect bio-samples and use biomarkers to assess nutritional status more precisely and to establish population references/norms, and 4) to re-think personal feedback to participants and their caregiver(s).

Introduction

Diet is a major determinant of health in all age groups and studying diet and nutritional status of children and adolescents is important for several reasons. First, deficiency in macro- and micronutrients are especially harmful during early life [1-3]. Second, health-related habits and eating behaviours are partly shaped during childhood and adolescence [4-6]. Third, multiple studies have shown a strong association between paediatric and adult obesity: about half of obese school-age children stay obese during adulthood [7]. This percentage may raise up to 90% in obese adolescents [8], depending on the age at baseline and criteria used in the definitions of obesity. Obese children are also at increased risk of suffering from obesity-related health consequences later in life [9]. Currently, little is known in Switzerland about the dietary intake and nutritional status of children and adolescents. The European Food Safety Authority (EFSA) warned about the risk of inadequate intakes in long-chain polyunsaturated fatty acids, iron, and vitamin D in different European countries [10]. In Switzerland, there have been historical concerns for low iodine status [10-12]. We also know that between 15% and 20% of Swiss children and adolescents are overweight or obese [13-15]. However, we lack detailed information about their dietary intake. Only one study in 2010, the FAN study in the Italian-speaking part of Switzerland, showed that the 568 included children aged 6 to 12 poorly followed the national dietary guidelines [16].

EFSA recommends including children and adolescents in national nutrition surveys [17, 18]. Since 2005, almost all countries in Western Europe have included children and adolescents in their national nutrition surveys [17] (Chapter 1.4.2). In Switzerland, they were excluded from the first national nutrition survey, menuCH, conducted in 2014-2015, but should be included in the second national nutrition survey. EFSA highly recommends using a 24-hour food diary in children below 10 years to guide the 24-hour dietary recalls (24HDR) [17]. So far this methodology has never been used at the national level. Within menuCH, dietary intake was only assessed with 24HDRs. Hence, a 24-hour food diary needs to be developed and tested in children before the next national survey. Additionally, no bio-samples were collected in menuCH, and thus experience is lacking regarding collection, storage and analyses of bio-samples. The degree of acceptability to various bio-sample collections among healthy Swiss children and adolescents is also unclear. A feasibility study in a population-based sample of children and adolescents to test 1) age-specific dietary assessment methods, 2) the acceptability of various bio-sample collections, and 3) bio-sample management and analyses, was therefore needed to help plan and budget the next national nutrition survey.

The main aims of this report summary are 1) to describe the planning and conduction of the feasibility study, and 2) to provide recommendations for the next national survey. Of note, this summary does not aim at describing food consumption or nutritional status of the interviewed children and adolescents since the sample size was small. Nevertheless, we present a few results considered as relevant for discussion.

Methods

The performed feasibility study was a cross-sectional, single-centre, small-scale nutrition survey.

Sampling and recruitment

The target population consisted of a representative sample of children and adolescents from the general population residing in, or near, Lausanne. All *a priori* healthy and free-living individuals aged between 3 and 17 years were eligible. The exclusion criteria were having a severe chronic disease, being hospitalized, pregnant, or having an insufficient knowledge of French to understand the study. The intended sample size was 50-70 participants (*i.e.,* about 3-4 individuals per age year).

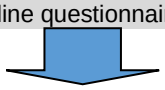
We recruited participants through two methods: population registry and flyers. First, the cantonal authorities refused access to the cantonal population registry for research purposes. Thus, we bought names and addresses for commercial mailing from the foundation BVA (www.bva.ch) for one CHF per name/address. The resulting names and addresses came from the same cantonal population registry. We asked the foundation for a stratified random sample of child-caregiver pairs living in Lausanne and two suburbs of Lausanne (*i.e.,* Prilly and Renens). Invitation letters were sent by waves every month. Each letter included a pre-stamped response card on which the participant and/or his/her caregiver(s) could indicate their contact details (*i.e.,* email address and/or phone) and availabilities for a phone call with the PhD student to explain the study. Second, we completed the population registry sample with a convenient sample in order to compare these two recruitment methods. Participants were recruited by flyers, displayed in several buildings of 'Centre Hospitalier Universitaire Vaudois' (CHUV) in Lausanne.

Overall procedures

Face-to-face interviews with participants and caregiver(s) took place at the Clinical Trial Unit (CTU) in CHUV **(Figure 1**). The PhD student was a registered dietitian with expertise in research and methodologies previously used in menuCH.

1 **Phone call or preparatory interview with the PhD student (dietitian):** If participant interested in taking part to the study, duration: 10-20 min

- Information to participant and/or his/her caregiver(s) about the study
- Inclusion and exclusion criteria
- Schedule of the face-to-face interview
- Instructions for food diary completion for children aged 3 to 10 years
- Sending by mail post or giving the consent form + material for bio-sample collection and dietary assessment
- Emailing the web links for the on-line questionnaire(s)



2 **Face-to-face interview in CHUV with the PhD student (dietitian) and the study nurse :** 1-4 weeks later, duration: 45min-1h30, <u>early morning while fasting, if possible</u>

- Signature of informed consent
- Control of the completeness of web-based questionnaire(s)
- Spot urine (collected at home, first morning specimen)
- Palm skin spectroscopy
- Collection of toenails by the nurse or caregiver (only for children aged 3 to 10 years, optional)
- Collection of venous blood by the nurse (only for adolescents aged 11 to 17 years, optional)
- Collection of capillary blood by the nurse (optional)
- Weight and height measurements
- Breakfast
- First 24-hour dietary recall (24HDR), based on the food diary for children aged 3 to 10 years
- Instructions for the second 24HDR + giving material for dietary assessment
- Schedule of the phone interview

3 **Phone call from the study medical doctor:** 1-2 weeks later, duration: 5-10 min

- Only, if results indicated potential health or nutritional conditions or if the participant or caregiver(s) wanted to discuss or be referred to a medical doctor

4 **Phone call with the study dietitian:** 2-6 weeks later, duration: 45 min

- Second 24HDR
- Questions on the hypothetical acceptance to take picture of consumed foods and collect other types of bio-samples
- Information about compensation and results

5 **Post mailing:** max. 2 months after the phone call

- Compensation for participation
- Individual written results sent to participant and caregiver(s)

Figure 1. Procedures used in the feasibility study for children and adolescents aged 3 to 17 years old.

Dietary assessment and anthropometry

Food consumption information was collected through two non-consecutive 24HDR led by two registered dietitians, trained with the GloboDiet® software [19-21]. The first 24HDR was face-to-face and the second by phone. For children aged 3 to 10 years, the PhD student developed and pretested a detailed 24-hour food diary following EFSA recommendations [17, 22]. The picture book used in menuCH to support study participants in quantifying amounts of consumed foods [23] was complemented with pictures of household measures for toddlers (*e.g.,* small plates, plastic glasses) and baby bottles. The PhD student also established a food propensity questionnaire (FPQ), which was included in the on-line questionnaires (below). Body weight with light clothing (not underwear) was measured to the nearest 0.1 kg, respectively cm, following World Health Organization guidelines [24] and using a Seca 701 scale (Seca GmbH, Hamburg, Germany). Height was measured with a Seca 213 gauge.

Online questionnaires

The PhD student developed three web-based questionnaires in the LimeSurvey platform (LimeSurvey Project, Hamburg, Germany), a free open source survey tool. The first questionnaire was intended for caregiver(s) of children aged 3 to 10 years, the second one for adolescents aged 11 to 17 years, and the third one for adolescents' caregiver(s). Questionnaires assessed eating and drinking behaviours, perceived lack of access to food (financial, geographical and social barriers to healthy eating), food habits and avoidance, meal context, detailed uptake of supplements in vitamins, minerals and other substances, consumption of organic foods, nutrition literacy, weight management and satisfaction, general health, health behaviours of participants and caregiver(s), household eating habits, caregiver(s)' socio-economic status (SES). We used questions similar to those used in menuCH questionnaire, but added questions related for example to perceived lack of access to food from the 2015 Canadian Community Health Survey - Nutrition (https://www.canada.ca/en/health-canada.html), or household's barriers to healthy eating from the 2014 Belgian Food Consumption Survey (https://fcs.wiv-isp.be).

Bio-samples and biomarkers

The first morning void of urine (*i.e.,* overnight urine specimen) was collected at home and brought to the CTU. At the CTU, the PhD student measured palm skin carotenoid concentration on both hands (*e.g.,* lutein, zeaxanthin, α-carotene, β-carotene, and lycopene) using the validated Biozoom® scanner [25-27]. The nurse collected venous (15 ml) and capillary (4 to 10 drops) blood, if accepted by participant and caregiver(s). Two Elma® patches containing local anaesthetics (lidocaine and prilocaine) and relevant instructions on how, where and when

to apply them were given to participants in advance so that they could place the patches at least 1h before on their finger or arm prick. Finally, the nurse collected a piece of each big toenail with a stainless steel clipper or scissors. If participants could attend the face-to-face interview in the morning, the PhD student asked them to be fasting. Those who were fasting were offered a breakfast after bio-sample collection.

Table 1 describes the list of biomarkers analysed per bio-sample, and which laboratory performed the analyses. Fresh venous blood and urine were directly analysed by the central laboratory in CHUV by routine clinical chemistry analyses. The rest of anonymized tubes were stored at -80°C in the IUMSP biobank for further analysis at the end of the study. If accepted by caregiver(s) in the consent forms, we kept reserve aliquots of urine and blood samples for potential further research in relation to nutrition or toxicology. Of note, toenail samples were not analysed for financial reasons, even though they could have been useful for trace elements measurements, such as selenium, copper, zinc, cadmium, *etc*. [38-41].

Other data

During the phone interview, participants and/or their caregiver(s) were asked whether they would accept or refuse collecting other bio-samples (*i.e.,* saliva, 24-hour urine, and faeces) and take pictures of what they or their children ate. These questions were naturally hypothetical since no follow-up study was planned.

Table 1. List of biomarkers according to the three collected bio-samples.

Biomarkers	**Venous blood** *Up to 15 ml*	**Capillary blood** *4 drops*	**Spot urine** *Up to 70 ml*	**Clinical and epidemiological interpretation**
Creatinine	x (plasma)[1]		x[1]	Kidney function and muscle mass
Albumin	x (plasma)[1]	x[4]		Nutritional status and protein intake
Glucose	x (plasma)[1]	x[4]		Glucose homeostasis
Triglycerides (TG)	x (plasma)[1]	x[4]		Lipid metabolism
Total cholesterol	x (plasma)[1]	x[4]		
HDL-cholesterol	x (plasma)[1]	x[4]		
LDL-cholesterol	x (calculation)[1]	x (calculation)[4]		
Bicarbonate (HCO3)	x (plasma)[1]			Acid-base homeostasis
Total proteins	x (plasma)[1]	x[4]		Nutritional status and protein intake
Urea	x (plasma)[1]		x[1]	Protein intake. Main end-product of the catabolism of amino acids
Urate	x (plasma)[1]		x[1]	Production of uric acid - diet rich in proteins
C-Reactive Protein (CRP)	x (plasma)[1]	x[4]		Inflammation
Hs-CRP	x (plasma)[1]			Low grade inflammation
Sodium (Na)	x (plasma)[1]		x[1]	Sodium intake Na/Cr ratio
Potassium (K)	x (plasma)[1]		x[1]	Potassium intake, fruit and vegetables
Total calcium (Ca)	x (plasma)[1]	x[4]	x[1]	Net absorption of calcium; calcium homeostasis
Corrected calcium (Ca)	x (calculation)[1]			
Magnesium (Mg)	x (plasma)[1]		x[1]	Magnesium intake and homeostasis
Phosphate (PO4)	x (plasma)[1]	x[4]	x[1]	Phosphate intake (dairy products, meat, whole grain, nuts, eggs, additives in processed food)
Transferrin	x (plasma)[1]	x[4]		Iron status
Ferritin	x (plasma)[1]	x[4]		
Iron (Fe)	x (plasma)[1]	x[4]		
Lead (Pb)	x (whole blood)[2]		x[2]	Lead intoxication
Chromium (Cr)	x (whole blood)[2]		x[2]	Chromium intake and intoxication
Nickel (Ni)	x (whole blood)[2]		x[2]	Nickel intake and intoxication
Selenium (Se)	x (whole blood and plasma)[2]		x[2]	Selenium intake and status
Iodine (I)			x[2]	Iodine intake
Retinol / Vitamin A	x (plasma)[3]			Vitamin A intake and status
Carontenoids (*e.g.,* α-/ β-carotene, α- / β-cryptoxanthin)	x (plasma)[3]			Carotenoid intake and status
Thiamine / Vitamin B1	x (plasma)[3]			Vitamin B1 intake and status
Folic acid / Vitamin B9	x (plasma)[3]			Vitamin B9 intake and status
Vitamin B12	x (plasma)[3]			Vitamin B12 intake and status
Vitamin C	x (plasma)[3]			Vitamin C intake and status
25-hydroxyvitamin D	x (plasma)[3]			Vitamin D intake and status
α-tocopherol / Vitamin E	x (plasma)[3]			Vitamin E intake and status
Phylloquinone / Vitamin K1	x (plasma)[3]			Vitamin K intake and status

[1] Analyses performed by Lausanne University Hospital. [2] Analyses performed in Federal Food Safety and Veterinary Office, Bern. [3] Analyses performed in Swiss Vitamin Institute, Lausanne. [4] Analyses performed in 'Centre Universitaire Romand de Médecine Légale, Lausanne - Genève', University centre of forensics medicine for French-speaking Switzerland, Lausanne by the start-up DBS System (DBS System / HemaXis, Gland, Switzerland).

Feedback to participants and compensation for participation

Once CHUV laboratory results on fresh urine and blood were available, they were shown to a medical doctor each time biomarker values were outside reference limits. At the end of the study, once all frozen blood and urine tubes had been analysed in the various external laboratories, extreme results were again discussed with the medical doctor. If results indicated potential nutritional or health problems, participant's caregiver(s) were informed, except when they specifically refused receiving any results in the consent form. Test results were then sent to the participant's paediatrician for possible further investigation and/or caregiver(s).

Participants and caregiver(s) received by registered post a compensation for participation (150 CHF in Reka checks plus three cinema vouchers). For ethical reasons, the collection of bio-samples did not lead to any financial benefit. In the same mailing, caregiver(s) received the skin scanner score of their offspring as well as general information about healthy eating according to the Swiss food-based dietary guidelines, *i.e.,* the Food Disk [28] for children, or the Food Pyramid [29] for adolescents. In the same mailing, caregiver(s) who had not been called after the face-to-face interview by the medical doctor were informed that all measured parameters were within reference limits.

Ethical consideration and funding

The research project was submitted via the national web portal of Swissethics, called BASEC (https://submissions.swissethics.ch/en). The 'Commission cantonale d'éthique de la recherche sur l'être humain du canton de Vaud' (CER-VD) approved the study protocol on February 8th 2017: *i.e.,* 1.5 month after its online submission (Project ID: Nutrition Survey 2016-02170). The end of the study was announced to the CER-VD in September 2018. Each recruited child and adolescent was assigned a unique random number. It was used for all collected data (*e.g.,* on blood tubes).

Participant information and informed consents, as required, were different according to participants' age. For participants aged 3 to 10 years, a verbal consent was obtained after a verbal briefing using pictograms. A simplified written information form (2 pages) was given to participants aged 11 and 13 years. As for participants above 14 years, they received the same information form as their caregiver(s) and also signed the consent form. For all participants, at least one legal representative of the participant (very often a parent) signed the written consent.

This feasibility study was fully funded by the Federal Food Safety and Veterinary Office (FSVO). The start-up DBS System (DBS System / HemaXis, Gland, Switzerland) conducted the laboratory analyses on capillary blood for free in exchange of the possibility to compare their results to those given by CHUV laboratory on fresh venous plasma (reference method).

Results and discussion

Sample and participation rate

Out of 194 contacted child-caregiver pairs with valid addresses, 31 (16%) accepted participation. Participation rate was lower among children aged 3 to 12 years (14%) than adolescents aged 13 to 17 years old (22%). Two selected households wanted that two children take part in the study. Our sample from the population registry was probably not representative of the general population due to the low participation rate. However, we have no data regarding non-participants, except age group and home address (not even sex), to compare with our study participants. As a reference, participation rate in menuCH, *i.e.,* among adults selected from the national registry and without collection of bio-samples, was 15% [30]. Participation rate in the feasibility study is only informative for three reasons. First, sample size was small and precision limited. Second, we suppose that selected people who were not eligible (*e.g.,* having no more children aged 3 to 17 years) did not always inform the PhD student about their ineligibility. Third, in the selected zones of residence, immigrations was high (*i.e.,* 41% of foreigners in Prilly to 51% in Renens [31]), which may have limited the number of people with good command of French. In total, 33 participants (31 + 2 siblings) were recruited based on the population registry and 20 by flyers (convenience sample). Since we used two methods to recruit participants, we compared participants' characteristics by recruitment methods (**Table 2**). Participants recruited by flyers seemed to have an overall higher SES and healthier diet.

Table 2. Characteristics of feasibility study participants, stratified by recruitment methods.

	All participants	Recruited via registry	Recruited via flyers
Total number of participants recruited (N)	53	33	20
Sex (male, %)	56	63	45
Age (in years, mean ± SD)	11.2 ± 4.3	11.0 ± 4.3	11.5 ± 4.4
Mother with university/high school degree (%)	55	45	75
Self-reported very good and good health (%)	91	91	90
Limited access to food due to lack of money (occurred sometimes in the last 12 months, %) [1]	8	14	0
Consumption of organic fruit and vegetables (%)	83	79	90
Vegetable intake (portion/day, mean ± SD) [2]	1.3 ± 0.8	1.1 ± 0.8	1.7 ± 0.7
Fruit intake (portion/day, mean ± SD) [3]	1.3 ± 1.0	1.2 ± 1.0	1.5 ± 0.9
Sugary soft drinks intake (g/day, mean ± SD)	203.4 ± 282.8	244.2 ± 313.0	136.2 ± 215.2
Sodium intake (g/day, mean ± SD) [4]	2.3 ± 0.7	2.3 ± 0.7	2.2 ± 0.7
Score from skin carotenoid scanner (from 0 to 10, mean ± SD)	5.8 ± 1.4	5.5 ± 1.2	6.3 ± 1.5
Lead/creatinine ratio in urine (ug/mmol, median [P25-P75]) [5]	0.12 [0.07-0.15]	0.12 [0.08-0.15]	0.11 [0.05-0.22]
Selenium/creatinine ratio in urine (ug/mmol, median [P25-P75])	3.6 [2.8-4.6]	3.8 [2.6-4.7]	3.5 [3.0-4.4]
Iodine/creatinine ratio in urine (ug/mmol, median [P25-P75])	13.7 [10.1-19.6]	12.4 [10.1-17.0]	16.2 [10.0-21.8]

[1] Only asked to caregivers of children (N=24). [2] A portion =120 g of fresh and cooked, 30 g if dried, 2.5 dL of soup, and 100 g of sauce (juice excluding), based on the mean of two non-consecutive 24HDR. [3] A portion = 120 g of fresh and cooked, 30 g if dried, based on the mean of two non-consecutive 24HDR. [4] Estimated from spot urine, using the INTERSALT equation considering potassium [32, 33]. [5] One extreme high value was excluded.

Dietary assessment and anthropometry

The software GloboDiet®, which was used in menuCH to conduct the 24HR among adults, could be applied in the feasibility study without problems. Foods and beverages consumed by the interviewed children and adolescents were similar to those reported by adults in menuCH and thus already present in GloboDiet® database (>1600 foods). However, we identified 19 new food products and 15 new descriptors (often new brands). Three elements regularly consumed by children and adolescents were missing: 1) several types and brands of candies, 2) commercial fruit compotes, and 3) commercial breakfast cereals. The picture book was also adapted to both children and adolescents since pictures of the six different portion sizes were sufficiently dissimilar to correspond to young children eating small portions and young male adolescents eating large portions. Caregivers correctly understood and completed the 24-hour food diary. Both registered dietitians believed that using the food diary (prospective data collection) had increased precision in the collected dietary information, as already documented in literature [34-36]. A few caregivers spontaneously took pictures of meals together with the food diary. This helped dietitians to identify food products and brands more easily, and to

determine portion size more objectively. However, the food diary increased the burden on caregivers.

The FPQ was complete by all participants or their caregiver(s). Ninety-eight per cent of participants or caregivers (50/51) would accept to take pictures of what is consumed. On average, people would accept this constraint for maximum three consecutive days. However, caregivers noted that it was difficult to organize pictures when they were absent: *i.e.,* when the child is at school, doing sports, or being with another family member(s), *etc*. Of note, staff in schools and kindergartens was reluctant or unable to complete the 24-hour food diary or report what was consumed by the child. Measuring weight and height in children and adolescents was performed without problems.

Online questionnaires

All participants and/or caregivers completed the required questionnaires. One caregiver preferred a paper copy. The questionnaire for caregivers of children aged 3 to 10 years was mostly completed by the mother without the child (75%), or both parents without the child (17%). The completion of this questionnaire took a median duration of 38 minutes (P25-P75: 21-63 minutes). The questionnaire for adolescents aged 11 to 17 years was mostly completed by the adolescent and his/her mother (52%) or the adolescents alone (41%). It took them 21 minutes (P25-P75: 18-26 minutes). The questionnaire for the adolescents' caregivers was completed by the mother (86%) or the father (14%) in 10 minutes (P25-P75: 8-13 minutes).

Bio-samples and biomarkers

All spot urine samples were collected. However, specific problems were observed in four out of 53 participants (8%). One child forgot to collect the first morning specimen. Therefore, we collected the second morning specimen (only small amount) at the CTU. One teenage collected the second urine specimen due to study protocol misunderstanding. One child aged 3 years old had no need to urinate in the morning of the interview. The first morning specimen was thus collected at the CTU at the end of the face-to-face interview. Finally, another participant collected only a small amount of urine for no specific reason.

Out of the 48 participants who accepted capillary or venous blood collection, 37 (78%) came in the morning and were fasting. Seven participants (15%) attended the face-to-face interview in the afternoon, when fasting was no longer possible. Finally, four participants (aged 5, 7, and 9 years) reported not being fasting.

Most adolescents aged 11 to 17 years (24/29, 83%) accepted venous blood collection. Age (11-12 years vs. 16-17 years) did not play a role in the acceptation. Providing Emla patches helped to reduce the pain at the puncture point. The patches were placed on time at the right place for the majority of participants. Out of the 24 collected samples, 24 could be analysed in CHUV and FSVO laboratories and 22 in Swiss Vitamin Institute (SVI). CHUV laboratory informed that two fresh blood samples had been haemolysed. Five important results in terms of health and nutrition surveillance are to be reported. First, 29% of adolescents (7/24, 3 boys and 4 girls) had ferritin below 30 ug/l. Of them, four (1 boy and 3 girls) had ferritin even below 15 ug/l. Thus, 17% of tested adolescents had very low iron reserve. Second, 3/24 adolescents (13%) had LDL-cholesterol (calculated values) above 3 mmol/l. Among those, two had LDL-cholesterol value close to 4 mmol/l: the first one probably due to familial hypercholesterolemia and the second one secondary to obesity. Third, 8% of adolescents (2/24) had plasma vitamin B12 concentration below 120 pmol/l (norms defined by SVI in female and male adults: 162 - 796 pmol/l). Fourth, there was some indication that lead in blood has decreased since 2010 (**Table 3**, adapted from [37] by FSVO). Fifth, we found no recently published norms for vitamin status in European children. Thus, we had to interpret values based on data among American children [38, 39], old studies conducted in Switzerland [40] or more recent studies but in Turkey [41] or studies in sick children [42] or adults [43-45].

Table 3. Blood lead concentration between 2010 and 2017 in children aged 10 to 18 years old from the French-speaking area of Switzerland [37].

	Previous study - 2010		**Our study - 2017**	
	Female	*Male*	*Female*	*Male*
N	21	26	9	14
Mean (ug/l)	12.1	15.4	6.6	9.6
P95 (ug/l)	16.7	32.3	16.9	14.2

All adolescents (29/29) and 19/24 children (79%) accepted capillary blood collection. Children under 5-6 years old often cried. Above this age, they could better understand the advantages and disadvantages, and gave a clearer consent or refusal. Despite instructions, the Emla patches were often placed on the wrong finger (*e.g.,* index instead of the little finger). In addition, patches produced vasoconstriction, which limited the amount of blood drops possible to be extracted. Out of the 48 collected samples, 41 could be analysed. The amount of collected capillary blood in the seven other samples was insufficient to conduct analyses. Results are mixed regarding the interest to measure capillary blood instead of venous blood. Out of 13 measured parameters, three parameters (*i.e.,* CRP, iron, and ferritin) showed a high

concordance between measured values in fresh venous plasma (reference method) and frozen capillary plasma (Lin's concordance correlation coefficient r > 0.90). **Figure 2** shows a comparison between the two methods for three parameters with variable degree of correlation in 22 participants: ferritin (good), HDL-cholesterol (fair), and albumin (poor). Several explanations were produced by the start-up DBS System to explain these phenomena (*not detailed in this report summary*).

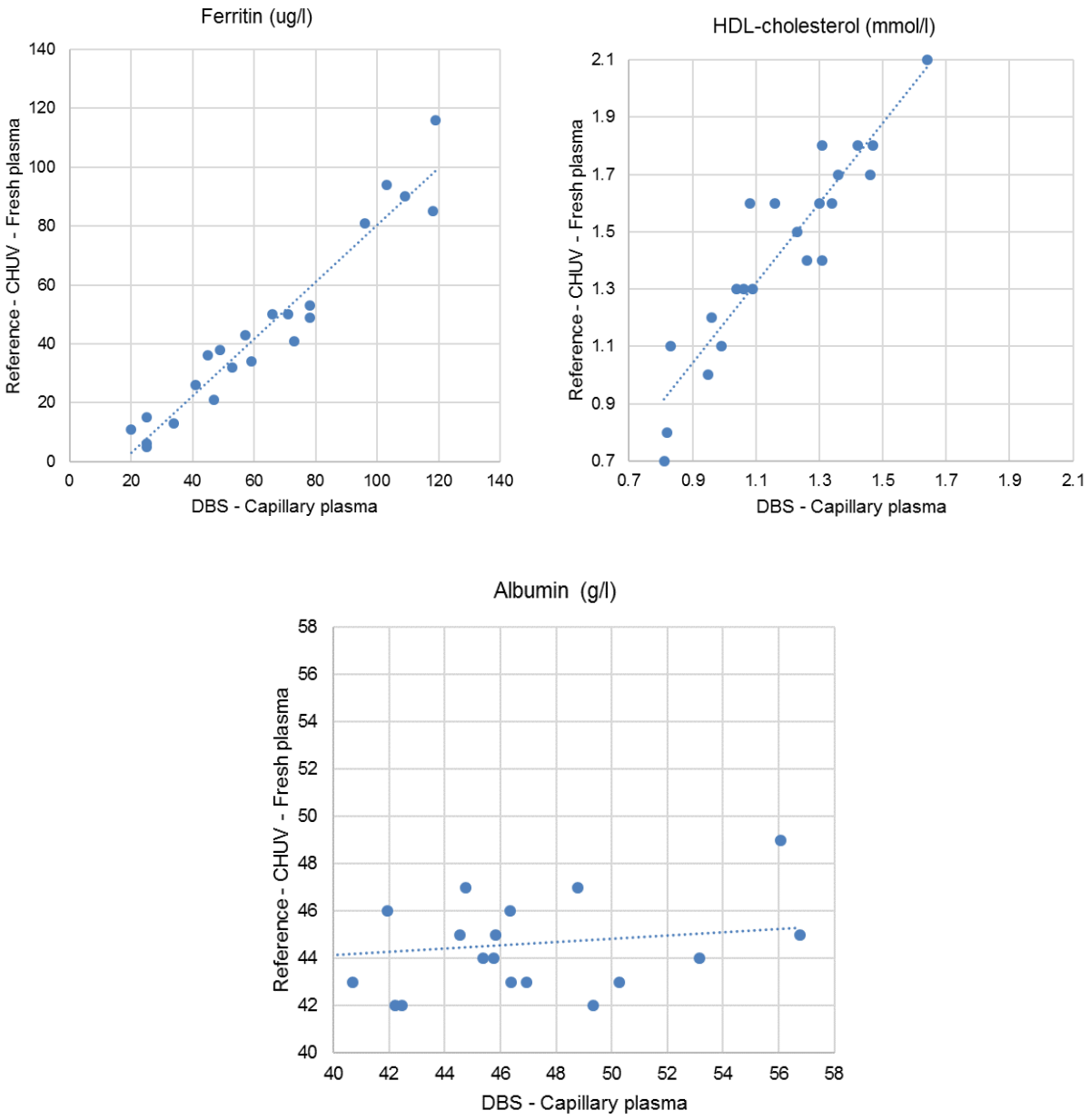


Figure 2. Correlation between ferritin (N=22, Pearson's r = 0.97, slope = 0.97 and constant = -16), HDL-cholesterol (N=22, Pearson's r = 0.92, slope = 1.39 and constant = -0.21), and albumin (N=22, Pearson's r = 0.21, slope = 0.07 and constant = 41) measured in frozen capillary plasma by DBS System (horizontal axis) and fresh plasma in CHUV laboratory (reference method, vertical axis).

Out of 24 children, 23 (96%) accepted toenail collection. The collection of toenails was less easy than expected because nails flied away while clipping and were thus lost on the floor. Sometimes, it was also hard to collect them because nails were short. Because we did not analyse collected nails, we did not know if collected quantities were sufficient and if nail polish had an impact on metal values.

Procedures to assess skin carotenoid concentration using Raman spectroscopy were quick (2-3 min for both hands), simple and well accepted by children and caregivers (100% of acceptation rate). The mean score of the two measures given by the Biozoom® scanner was fairly correlated to measured carotenoid plasma concentration in adolescents (N=22, Pearson's correlation coefficient: r = 0.69, $P < 0.001$, Spearman's correlation coefficient: r = 0.55, $P = 0.008$, **Figure 3**). This value corresponds to literature: r = 0.79 in 68 adults [27]. Additionally, the mean score by Biozoom® device was to some extent correlated to the usual intake of fruit and vegetables assessed by two non-consecutive 24HDR and a FPQ (N=52, Pearson's correlation coefficient: r = 0.34, $P = 0.013$, Spearman's correlation coefficient: r = 0.43, $P = 0.002$, *data not shown*).

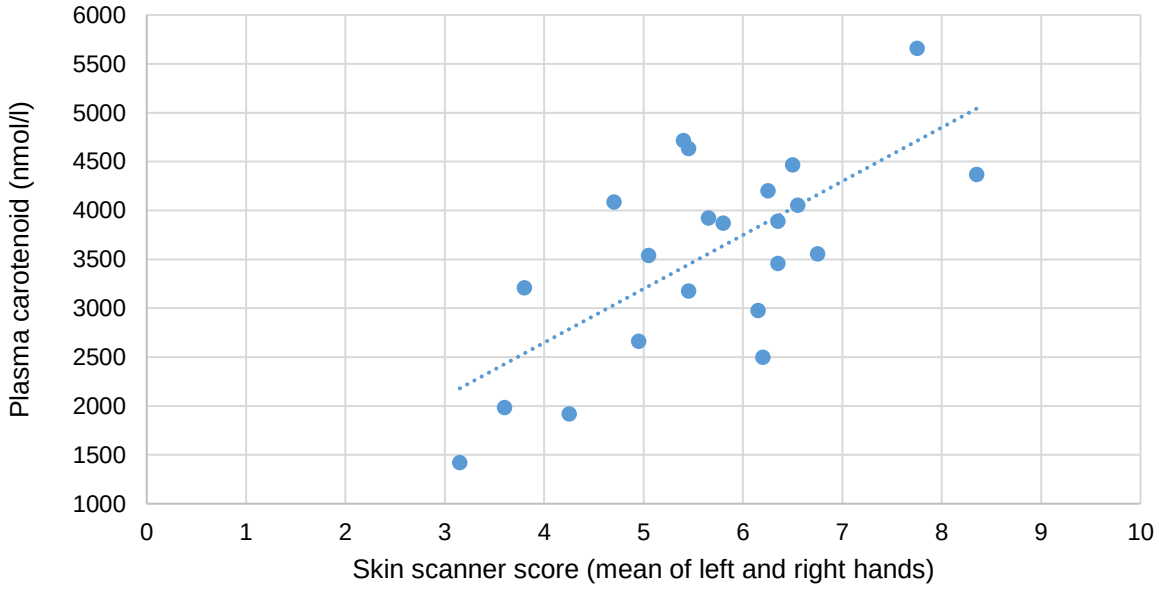


Figure 3. Comparison between mean score measured using Biozoom® skin scanner on both hand palms and carotenoid measured in plasma (N=22, Pearson's r = 0.69, $P < 0.001$).

All participants/caregivers would accept to provide saliva. Twenty per cent of them (10/51) would agree to collect 24-hour urine any weekday and 55% (28/51) would accept only if collection would be a weekend day or holiday. The most common causes for refusal were practical complication (10/51, 20%) and embarrassment (4/51, 8%). Regarding stool collection,

59% (30/51) would agree. As expected, caregivers from children (74%) were more inclined to collect stool than adolescents (46%). Thirty-seven per cent (19/51) would refuse because of embarrassment, and 4% (2/51) for practical complications due to constipation. These data must be interpreted with caution because they reflect often answers and opinions of the caregivers in the absence of the child or young adolescent (not on the phone). In addition, answers were collected after two interviews, when a trustful relationship with the study staff had been established.

Feedback to participants and compensation for participation

Because the selected parameters analysed in fresh urine in CHUV were mainly nutritional parameters and not direct health indicators (Table 1), no out-of-norms values required information to the participant, his/her caregiver(s) and his/her paediatrician. Among adolescents who accepted venous blood tests, 20/24 (83%) had to be re-contacted. This high proportion reflects the fact that reference values are not clearly established in children and adolescents. No participants/caregivers were re-contacted for extreme values based on capillary blood due to lack of accuracy and reference value for this exploratory method. Interpreting results, re-contacting caregivers and preparing letter for paediatricians was time-consuming: 1h15 per participant.

Generally speaking, caregivers were interested in all types of personalised feedback, in particular information when biomarkers were outside the reference limits. Because compensation was sent by post, it was hard to estimate how much went really to the child/adolescent or to the caregiver(s). When asked informally, most participants and caregivers would have preferred being compensated with cash instead of vouchers. Swissethics' guidelines and recommendations for the compensation in research projects did not take a position regarding passing on cash to children and adolescents [46]. After contacting the CER-VD, the president recommended not to send cash to children and adolescents and to use vouchers as we did.

Ethical consideration

Submission of research projects has been simplified since menuCH. Since January 2016, on-line submission is centralized and uniformed across cantons. BASEC provides clear information and checklists of needed documents for project submission.

Main recommendations for next national nutrition survey

Age of participants

For the next national nutrition survey, we recommend excluding children below school age (under 5 years) to facilitate bio-sample collection, especially for capillary blood and spot urine. Waiting during the face-to-face interview was also long for those young children. Regarding the cut-off age between children and adolescents, we observed that assistance of caregiver(s) was almost always required to complete the on-line questionnaire and 24HDR for participants under 14 years. We suggest having a cut-off at 14 years for all questionnaire and diet-related data, as defined by Swissethics (*i.e.,* adolescents above 14 years are considered as adults). This means that the 24-hour food diary and the questionnaire would mainly be completed by the caregiver(s) until 13 years old. However, for blood sampling, such an age cut-off should not be made. Blood sampling should be proposed to every participant aged 5 to 17 years, because we observed no differences in acceptation or puncture tolerance between young adolescents (aged 11-12 years) or older adolescents (aged 16-17 years).

Sampling and recruitment

A good recruitment methodology is key to have high participation rate and reduced risk of participation bias. For the main survey, we recommend using the same national population registry as in menuCH: *i.e.,* national sampling frame for person and household surveys [47]. For an optimal recruitment rate, more investment than only writing one letter is definitely needed to motivate people in taking part in a survey. Access to personal phone numbers or emails of potential participants is important. When they are unavailable, sending several times the invitation letter with the pre-stamped response card on which the participant and/or his/her caregiver(s) could indicate their contact details and availabilities are a good alternative to reach more participants.

The stratified random selection of people among a population registry has four main advantages. First, selection bias is limited when a stratified random sample is used (probability sampling technique) [48]. Literature [48, 49] and our results among participants recruited via flyers suggested a convenience sample (non-probability sampling technique) increases the risk of selection bias towards families with healthier eating habits. Second, participation rate can be easily calculated based on the ratio survey participants / contacted child-caregiver pairs. Third, when information about non-participants (*e.g.,* addresses, dates of birth) is available, we can track who did or did not participated in the survey to estimate participation bias and try to correct it with an appropriate weighting strategy. Because SES influences diet and its quality [50, 51], information about SES of participants and non-participants would be

ideal for the weighting strategy. Fourth, the sample can be redirected during the recruitment phase in case there is an unbalanced mid-study sample. For example, if too many girls accept participating at the beginning of the recruitment, we could invite in the next wave(s) more boys and use the weighting strategy to re-balance the sample according to the original reference population [48]. However, this recruitment procedure requires legal access to national population registries. Additionally, costs related to sampling and contacting selected people in the population may be high [48].

Of note, kindergarten and public schools are good entry points to reach high participation and high representativeness of the sample if well designed. However, this recruitment method requires strong commitment in the different cantons. This requires also commitment in the institutions, which are selected for the study. Moreover, recruiting in institutions creates data clustering that needs to be accounted for in statistical analyses. There is indeed a loss of variability, since children in a same school or a same class have some common characteristics (intra-cluster correlation).

Dietary assessment and anthropometry

To ensure dietary assessment quality, 24HDR should be conducted by registered dietitians. Having health professionals leading the interviews is even more important when bio-samples are collected and caregiver(s) ask questions specific to nutritional biomarkers. GloboDiet® and the menuCH picture book can be used without major adaptations for a national nutrition survey in children and adolescents. The use of the 24-hour food diary is a key asset for increasing the precision in the data collection in young children. It is important that the on-line questionnaires includes a FPQ. The latter increase the intra-individual precision when modelling usual intake from short-term dietary measurements such as 24HDR [52-54] .

In theory, prospectively taking pictures of consumed foods during the interviewed days would be widely accepted by participants and caregivers. It could complement, or even replace, the 24-hour food diary and thus reduce burden on participants or caregivers. It would also help dietitians in data entry. An on-line survey platform is important for the next national nutrition survey 1) to share completed food diaries and/or pictures of foods between caregivers and dietitians, and 2) to have on-line access to the picture book.

Relying exclusively on a smart-phone application (*e.g.,* electronic food diary with or without digital photography) without supervision of a nutrition professional is premature for the next national nutrition survey due to several factors. First, young children do not possess smart-phones and are often away from the main caregiver while eating or drinking. This means that caregivers plus other people (*e.g.,* school staff, sports trainers, other family members) should

be involved and trained on how to use the applications, which seems complicated. Second, technical and scientific advances in digital nutritional epidemiology, such as portion size estimation, food recognition, linkage with local food composition database, are still needed to precisely analyse and interpret the pictures/data [55, 56]. Third, the smart-phone application would need to be adapted to the Swiss food market, available in the three main languages, linked to the Swiss Food Composition Database [57], and validated. To our best knowledge, such an application does not exist in Switzerland yet.

Bio-samples and biomarkers

Collecting spot urine samples was relatively well collected by children aged over 4-5 years. In addition, spot urine collection, preparation for laboratories and analyses necessitate limited financial resources (*e.g.,* purchase of beakers and tubes). We recommend collecting spot urine in all children and adolescents during the main survey.

Collection of blood requires more constraints: *e.g.,* fasting participants and more staff, such as study nurse for collection and sample processing, and higher costs for analyses. However, acceptation of venous blood collection was relatively high among adolescents who took part in the feasibility study. The puncture was well tolerated. Acceptation of capillary blood was also high and well tolerated in children above 5-6 years old. However, so far the array of validated clinical and/or nutritional parameters is limited. Venous blood sampling should be preferred and capillary blood kept as a second choice in case venous blood collection is refused. For these participants, nutritional parameters such as iron and lipid status could be assessed, considering further improvement in the collection system and in the laboratory analyses by DBS System or other providers.

Toenails could be a good way to obtain biomarkers with a minimally invasive procedure, but should not be the only collected bio-sample. However, if they are collected for the main survey, clarification with laboratories should be made to define the exact nail quantity required for proper analyses and if nail polish should be removed. We also recommend asking the caregiver(s) to collect nails at home, at their convenient time (*i.e.,* when nails are long and/or free from polish) and in a relaxed atmosphere (*i.e.,* not after blood collection), especially for young children. Toenails should however not be the main type of bio-samples.

We recommend assessing skin carotenoid concentration using Raman spectroscopy in the main survey. In conclusion, we highly recommend using objective nutritional biomarkers in the next national nutrition survey to establish reference values among children (*e.g.,* vitamin status) and to complement food consumption data in the assessment of nutritional status in

the population. Of note, assessing the uptake of vitamin and mineral supplements is important if nutritional biomarkers are collected.

Feedback to participants

If bio-samples are collected at a large scale, a systematic check of laboratory parameters has to be organized to detect potential health and nutritional disorders. Then, a medical doctor, if possible, a multilingual paediatrician, has to interpret these laboratory parameters together with other data collected by the dietitians and nurses. When necessary, he/she should then contact the participant/caregiver(s) and their paediatrician. This should be done as many times as medically required but as few times as possible to limit caregiver(s)' worry and survey staff's time. We realised that developing a one-size-fits-all algorithm/decision tree to interpret data is difficult due to the relative limited information we had on health background. The feasibility study showed that assessing the nutritional status of children and adolescents with biomarkers was hard and specialists in this field are scarce. To save time and costs, a solution or an algorithm/decision tree should be discussed with professionals or paediatrics associations before the main survey start.

Conclusion

Studying diet in a population-based sample of Swiss children and adolescents is important and proved to be feasible in Lausanne. Participation rate was low, yet similar to what was observed in adults participating in menuCH. In the next national nutrition survey we recommend using a stratified random sample of the national population registry and improving recruitment procedures (*e.g.,* several written reminders). Acceptation rate for bio-sample collection was high to very high for Raman spectroscopy, spot urine, capillary blood, venous blood, and toenails. We strongly recommend using objective nutritional biomarkers in the next survey to better assess nutritional status and to establish reference values for Swiss healthy children and adolescents. Detailed dietary assessment is essential to assess food consumption and is complementary to biomarkers. The tested dietary assessment tools in this feasibility study (*e.g.,* computed assisted 24HDR, 24-hour food diary and on-line FPQ) would need only minor modifications before the main survey. Personal feedback given to participants' caregiver(s) was appreciated by participants but time-consuming for survey staff; it needs further reflexion. This report will help plan and budget the next national nutrition survey.

References

1. Gernand, A.D., et al., Micronutrient deficiencies in pregnancy worldwide: health effects and prevention. Nat Rev Endocrinol, 2016. 12(5): p. 274-89.
2. Nyaradi, A., et al., The role of nutrition in children's neurocognitive development, from pregnancy through childhood. Front Hum Neurosci, 2013. 7: p. 97.
3. Soliman, A., V. De Sanctis, and R. Elalaily, Nutrition and pubertal development. Indian J Endocrinol Metab, 2014. 18(Suppl 1): p. S39-47.
4. Mikkila, V., et al., Longitudinal changes in diet from childhood into adulthood with respect to risk of cardiovascular diseases: The Cardiovascular Risk in Young Finns Study. Eur J Clin Nutr, 2004. 58(7): p. 1038-45.
5. Kelder, S.H., et al., Longitudinal tracking of adolescent smoking, physical activity, and food choice behaviors. Am J Public Health, 1994. 84(7): p. 1121-6.
6. Law, M., Dietary fat and adult diseases and the implications for childhood nutrition: an epidemiologic approach. Am J Clin Nutr, 2000. 72(5): p. 1291s-1296s.
7. Serdula, M.K., et al., Do obese children become obese adults? A review of the literature. Prev Med, 1993. 22(2): p. 167-77.
8. Freedman, D.S., et al., The relation of childhood BMI to adult adiposity: the Bogalusa Heart Study. Pediatrics, 2005. 115(1): p. 22-7.
9. Biro, F.M. and M. Wien, Childhood obesity and adult morbidities. Am J Clin Nutr, 2010. 91(5): p. 1499S-1505S.
10. European Food Safety Authority (EFSA), Scientific Opinion on nutrient requirements and dietary intakes of infants and young children in the European Union. EFSA Journal, 2013. 11(10): p. 3408.
11. Federal Commission for Nutrition (FCN), Iodine supply in Switzerland: Current Status and Recommendations. Expert report of the FCN. 2013, Federal Office of Public Health: Zurich, Switzerland.
12. Zimmermann, M.B., et al., Increasing the iodine concentration in the Swiss iodized salt program markedly improved iodine status in pregnant women and children: a 5-y prospective national study. Am J Clin Nutr, 2005. 82(2): p. 388-92.
13. Lasserre, A.M., et al., Overweight in Swiss children and associations with children's and parents' characteristics. Obesity (Silver Spring), 2007. 15(12): p. 2912-9.
14. Schneider, H., W. Venetz, and C. Gallani Berard, Overweight and obesity in Switzerland. Part 2: Overweight and obesity trends in children. 2009, Federal Office of Public Health: Basel, Switzerland.

15. Aeberli, I., et al., Stabilization of the prevalence of childhood obesity in Switzerland. Swiss Med Wkly, 2010. 140: p. w13046.

16. Suggs, L.S., S. Della Bella, and P. Marques-Vidal, Low adherence of Swiss children to national dietary guidelines. Prev Med Rep, 2016. 3: p. 244-9.

17. European Food Safety Authority (EFSA), Guidance on the EU Menu methodology. EFSA Journal, 2014. 12(12): p. 3944.

18. European Food Safety Authority (EFSA), General principles for the collection of national food consumption data in the view of a pan-European dietary survey. EFSA Journal, 2009. 7(12): p. 1435.

19. Slimani, N., et al., The standardized computerized 24-h dietary recall method EPIC-Soft adapted for pan-European dietary monitoring. Eur J Clin Nutr, 2011. 65 Suppl 1: p. S5-15.

20. Crispim, S.P., et al., Two non-consecutive 24 h recalls using EPIC-Soft software are sufficiently valid for comparing protein and potassium intake between five European centres--results from the European Food Consumption Validation (EFCOVAL) study. Br J Nutr, 2011. 105(3): p. 447-58.

21. Crispim, S.P., et al., Two non-consecutive 24 h recalls using EPIC-Soft software are sufficiently valid for comparing protein and potassium intake between five European centres--results from the European Food Consumption Validation (EFCOVAL) study. Br J Nutr, 2011. 105(3): p. 447-58.

22. European Food Safety Authority (EFSA), Guidance on the EU Menu methodology [Appendix 5.3.3: Example of a one-day food diary for toddlers and children based on the PANCAKE project]. EFSA Journal, 2014. 12(12): p. 3944.

23. Camenzind-Frey, E. and C. Zuberbühler, menuCH - Schweizerisches Fotobuch / Livre Photo Suisse / Manuale Fotografico Svizzero (Picture book for menuCH). 2013, Bern, Switzerland: Federal Office of Public Health / Federal Food Safety and Veterinary Office.

24. World Health Organization. MONICA Manual, Part III: Population Survey. Section 1: Population Survey Data Component. 4.6 Height, weight, waist and hip measurement. [cited 2016 Sep 30]; Available from: http://www.thl.fi/publications/monica/manual/part3/iii-1.htm#s4-6.

25. Meinke, M.C., et al., Influences of Orally Taken Carotenoid-Rich Curly Kale Extract on Collagen I/Elastin Index of the Skin. Nutrients, 2017. 9(7).

26. Yu, R.X., et al., Spectroscopic biofeedback on cutaneous carotenoids as part of a prevention program could be effective to raise health awareness in adolescents. J Biophotonics, 2014. 7(11-12): p. 926-37.

27. Darvin, M.E., et al., Multiple spatially resolved reflection spectroscopy for in vivo determination of carotenoids in human skin and blood. Laser Physics Letters, 2016. 13(9): p. 1-7.

28. Société Suisse de Nutrition. Disque alimentaire suisse (Swiss Food Disk). [cited 2016 Nov 20]; Available from: http://www.sge-ssn.ch/fr/disque-de-lalimentation/.

29. Swiss Society for Nutrition / Federal Food Safety and Veterinary Office. Pyramide alimentaire suisse 2011 (Swiss Food Pyramid 2011). [cited 2016 Nov 20]; Available from: http://www.sge-ssn.ch/fr/toi-et-moi/boire-et-manger/equilibre-alimentaire/pyramide-alimentaire-suisse/.

30. Chatelan, A., et al., Major Differences in Diet across Three Linguistic Regions of Switzerland: Results from the First National Nutrition Survey menuCH. Nutrients, 2017. 9(11).

31. Statistique Vaud. Bilan démographique, grands groupes d'âges et population étrangère, par commune, Vaud, 2010-2016 (Demographics in the canton of Vaud, Switzerland). [cited 2018 Jul 14]; Available from: http://www.scris.vd.ch/Default.aspx?DocID=6999&DomId=2987.

32. Leyvraz, M., et al., Urine spot samples can be used to estimate 24-h urinary sodium excretion in children. J Nutr (in press).

33. Cogswell, M.E., et al., Validity of predictive equations for 24-h urinary sodium excretion in adults aged 18-39 y. Am J Clin Nutr, 2013. 98(6): p. 1502-13.

34. Crawford, P.B., et al., Comparative advantage of 3-day food records over 24-hour recall and 5-day food frequency validated by observation of 9- and 10-year-old girls. J Am Diet Assoc, 1994. 94(6): p. 626-30.

35. Lucchiari, C., M. Masiero, and G. Pravettoni, Methods for nutrition monitoring in cancer patients: a cognitive perspective. Ecancermedicalscience, 2012. 6: p. 259.

36. Ralph, J.L., et al., Diet assessment methods: a guide for oncology nurses. Clin J Oncol Nurs, 2011. 15(6): p. E114-21.

37. Dudler, V., Plombémie infantile en Suisse (Lead in blood of Swiss children). 2018, Federal Food Safety and Veterinary Office: Bern, Switzerland.

38. Mayo Medical Laboratories. Vitamin A, Serum / Vitamin E, Serum / Vitamin K1, Serum / Vitamin B12 Assay, Serum / Ascorbic Acid (Vitamin C), Plasma / Thiamine (Vitamin B1), Whole Blood / 25-Hydroxyvitamin D2 and D3, Serum / Folate, Serum. [cited 2018 Jul 17]; Available from: https://www.mayomedicallaboratories.com/test-catalog/search.php?s=q=vitamin%26access=p%26entqr=1%26sort=date:D:L:d1%26output=xml_no_dtd%26client=MayoMedLabs%26ud=1%26oe=UTF-8%26ie=UTF-8%26numgm=6%26as_sitesearch=http://www.mayomedicallaboratories.com/test-catalog/Overview%26site=MCSITestCatalog%26getfields=*%26ulang=%26ip=192.168.232.100%26entqrm=0%26entsp=a__MedLab%26wc=200%26wc_mc=1%26start=0.

39. Hicks, J.M., et al., Vitamin B12 and folate. Pediatric reference ranges. Arch Pathol Lab Med, 1993. 117(7): p. 704-6.

40. Winklhofer-Roob, B.M., M.A. van't Hof, and D.H. Shmerling, Reference values for plasma concentrations of vitamin E and A and carotenoids in a Swiss population from infancy to adulthood, adjusted for seasonal influences. Clin Chem, 1997. 43(1): p. 146-53.

41. Akin, F., et al., Vitamin B12 levels of subjects aged 0-24 year(s) in Konya, Turkey. J Health Popul Nutr, 2014. 32(4): p. 615-22.

42. Conway, S.P., et al., Vitamin K status among children with cystic fibrosis and its relationship to bone mineral density and bone turnover. Pediatrics, 2005. 115(5): p. 1325-31.

43. World Health Organization (WHO), Serum and red blood cell folate concentrations for assessing folate status in populations. 2015, WHO: Geneva, Switzerland.

44. Thane, C.W., L.Y. Wang, and W.A. Coward, Plasma phylloquinone (vitamin K1) concentration and its relationship to intake in British adults aged 19-64 years. Br J Nutr, 2006. 96(6): p. 1116-24.

45. Sadowski, J.A., et al., Phylloquinone in plasma from elderly and young adults: factors influencing its concentration. Am J Clin Nutr, 1989. 50(1): p. 100-8.

46. Swissethics. Rémunération des patients participant à un projet de recherche (Study participant compensation). [cited 2018 Jul 17]; Available from: https://www.swissethics.ch/doc/leitfaden_pos/entschaedigungen_pkl_f.pdf.

47. Federal Statistical Office. Stichprobenrahmen für Personen- und Haushaltserhebungen (Swiss persons and households registry). [cited 2017 Apr 28]; Available from: https://www.bfs.admin.ch/bfs/de/home/grundlagen/volkszaehlung/volkszaehlung-teil-gesamtsystem/stichprobenrahmen.html.

48. Bornstein, M.H., J. Jager, and D.L. Putnick, Sampling in Developmental Science: Situations, Shortcomings, Solutions, and Standards. Dev Rev, 2013. 33(4): p. 357-370.

49. Coggon, D., R. G., and D.J.P. Barker, Measurement error and bias. In: Epidemiology for the uninitiated. 5th ed. 2003, The BMJ: London, United Kingdom.

50. Wang, D.D., et al., Improvements In US Diet Helped Reduce Disease Burden And Lower Premature Deaths, 1999-2012; Overall Diet Remains Poor. Health Aff (Millwood), 2015. 34(11): p. 1916-22.

51. Darmon, N. and A. Drewnowski, Does social class predict diet quality? Am J Clin Nutr, 2008. 87(5): p. 1107-17.

52. Subar, A.F., et al., The food propensity questionnaire: concept, development, and validation for use as a covariate in a model to estimate usual food intake. J Am Diet Assoc, 2006. 106(10): p. 1556-63.

53. Souverein, O.W., et al., Comparing four methods to estimate usual intake distributions. Eur J Clin Nutr, 2011. 65 Suppl 1: p. S92-101.

54. Laureano, G.H., et al., Comparison of the ISU, NCI, MSM, and SPADE Methods for Estimating Usual Intake: A Simulation Study of Nutrients Consumed Daily. Nutrients, 2016. 8(3): p. 166.

55. McClung, H.L., et al., Dietary Intake and Physical Activity Assessment: Current Tools, Techniques, and Technologies for Use in Adult Populations. Am J Prev Med, 2018. 55(4): p. e93-e104.

56. Martin, C.K., et al., Measuring food intake with digital photography. J Hum Nutr Diet, 2014. 27 Suppl 1: p. 72-81.

57. Federal Food Safety and Veterinary Office. Swiss Food Composition Database. [cited 2017 Jul 13]; Available from: http://naehrwertdaten.ch/request?xml=MessageData&xml=MetaData&xsl=Start&lan=en&pageKey=Start.