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Food patterns and chronic obstructive pulmonary disease in the SAPALDIA cohort

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Nina Steinemann, M.Sc.
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With permission from
the Faculty 09
Agricultural Science, Nutritional Science, and Environmental Management
Justus-Liebig-University Giessen
Dean: Prof. Dr. Klaus Eder

Examining committee:

Chair: Prof. Dr. Joachim Aurbacher
1. Supervisor: Prof. Dr. i. R. Ingrid-Ute Leonhäuser
2. Supervisor: Prof. Dr. Gunter P. Eckert
3. Supervisor: Prof. Dr. Christine Brombach
Examiner: Prof. Dr. Gertrud Morlock
Examiner: Prof. Dr. Hermann Boland

Date of defense: February 22, 2019

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List of Abbreviations

BMI	Body Mass Index
CoLaus	Ongoing prospective survey investigating the biological and genetic determinants of cardiovascular disease in the population of Lausanne, Switzerland (www.colaus.ch)
2D	Two-dimensional
3D	Three-dimensional
DALY / DALYs	Disability-Adjusted Life Year / Disability-Adjusted Life Years
4-d FR	4-day weighed Food Record
FEF2575	Forced Expiratory Flow at 25–75% of FVC
FEV1	Forced Expiratory Volume in 1 second
FEV1 / FVC	Forced Expiratory Volume in 1 second / Forced Vital Capacity
FFQ / FFQs	Food Frequency Questionnaire / Food Frequency Questionnaires
FR	Food Record
FVC	Forced Vital Capacity
g	Gram
GOLD	Global Initiative for Chronic Obstructive Lung Disease
kcal	Kilocalories
kg	Kilogram
menuCH	First National Nutrition Survey menuCH
MMP12	Matrix Metalloproteinase 12
MONICA study	Monitoring Trends and Determinants in Cardiovascular Disease
n	Sample Size / Number of
NCDs	Noncommunicable Diseases
P	P value
Pa_{CO2}	Partial Pressure of Carbon Dioxide in Arterial Blood
Pa_{O2}	Partial Pressure of Oxygen in Arterial Blood
PCA	Principal Component Analysis
PCF	Principal Component Factor analysis
r_c	Corrected Correlation
r_o	Observed Correlation
SAPALDIA	Swiss Cohort Study on Air Pollution and Lung and Heart Diseases in Adults
SD	Standard Deviation
S2w/S2b	Ratio of the within- and between-person variances
WHO	World Health Organization
ZHAW	Zurich University of Applied Sciences

1 Introduction

1.1 Preliminary remarks

The present cumulative dissertation is based on the scientific work that was carried out by the doctoral candidate from March 2012 to September 2018 in collaboration with the Zurich University of Applied Sciences (ZHAW) in Wädenswil, Switzerland, and the Swiss Tropical and Public Health Institute, University of Basel, Switzerland. The core of this doctoral thesis is made up of two publications (original articles) that were published in international peer-reviewed journals. These two articles resulted from the close collaboration with the Swiss Cohort Study on Air Pollution and Lung and Heart Diseases in Adults (SAPALDIA).

1.2 The SAPALDIA Study – leading research questions

The SAPALDIA study is the largest epidemiological cohort study in Switzerland that has been ongoing for more than 25 years. It was designed to assess the health effects from long-term exposure to air pollution and integrates physiological assessments and bio samples. SAPALDIA was initiated in 1991 with a baseline survey (SAPALDIA 1) to investigate the relationship between air pollution and lung diseases in adults recruited as random samples from inhabitant registries (18–60 years, N=9651). The multi-center cohort study includes eight distinct urban and rural areas representing the demographic, cultural and environmental diversity of Switzerland (Aarau, Basel, Davos, Geneva, Lugano, Montana, Payerne, Wald). A first follow-up assessment of participants (SAPALDIA 2) was conducted in 2002. The methods and participation of SAPALDIA 1 and 2 have been described elsewhere [1, 2].

In SAPALDIA 3, which was conducted in 2010–2011, a second follow-up assessment was conducted. In addition to the existing core variables, it was aimed to investigate detailed information on dietary intake. In SAPALDIA 2 very basic questions on food intake were included. This rather rough assessment of dietary intake consisted of 15 questions on the frequency of several food groups' consumption, i.e. vegetables (cooked and raw vegetables), fruits (citrus fruits and other fruits), meat and sausages, fish, potatoes, milk, olive oil, alcohol (red wine and other alcoholic drinks), and vitamins (i.e. supplements). The questions asked were the following, e.g. for meat: "How many days per week do you eat meat and sausages in general?" For raw vegetables, fruits and citrus fruits a second question was added asking for "How many times per day do you eat a fruit?".

In order to describe and analyze potential associations between food patterns and lung function outcomes, there was a need for more systematic and deeper insights to get reliable data of dietary intake. The epidemiological setting of the SAPALDIA study was predetermined for using a food frequency questionnaire (FFQ), since it still represents the most frequently used dietary assessment tool in epidemiological studies (see also chapter 2.2.2, page 10). The FFQ, which was developed at the ZHAW in Wädenswil (Zurich, Switzerland) (www.ernaehrungserhebung.ch), was an appropriate instrument to apply for dietary assessment in SAPALDIA 3 for a number of reasons. The FFQ was designed to assess average food intake over the previous 4 weeks and was targeted at the Swiss adult population, considering all three national Swiss languages and therefore also reflecting the same diverse dietary habits and underlying cultural background as the SAPALDIA cohort (see German version of the FFQ in the Appendix, p. XI). However, each dietary assessment tool comprises measurement errors and therefore challenges an accurate estimate of dietary intake. In order to apply a robust tool, which will be able to compile data in a valid and reproducible manner, the FFQ had to be validated first. The information collected by the FFQ needed to be compared with information collected by a more accurate dietary assessment method. The FFQ validation study therefore presented the "precondition study" in order to be able to address the main research questions in the context of food patterns and chronic obstructive pulmonary disease (COPD) in the SAPALDIA cohort.

Study approval was given by the central Ethics Committee of the Swiss Academy of Medical Sciences and the Cantonal Ethics Committees for each of the study areas. Written informed consent was obtained from all participants prior to conducting any of the health examinations.

1.3 Structure of the present work

The present doctoral thesis comprises the following sections:
First of all, in the scientific background (p. 3–15) the addressed research area is applied in connection with current scientific investigation (state of the art research), and all the crucial topics that were covered in the doctoral thesis, are addressed and investigated. Subsequently, the resulting study aims and research questions that were elaborated, are presented.

The results part (p. 23–45) includes the two original articles in English. Prior to each article a short summary is given. Due to the contribution of several authors to these papers, the personal contribution of the doctoral student is separately shown. Both articles are structured in the following sections: scientific background, description of the study cohort and applied methods, presentation of the results, discussion and conclusions.

The discussion part (p. 46–50) summarizes and discusses the main results of the two original articles and situates these into the context of the thesis main research questions. Finally, the synopsis of the scientific work, that was carried out by the doctoral candidate is given, including an outlook for further investigations in the research area.

2 Scientific background

2.1 Chronic obstructive pulmonary disease (COPD)

The following chapter depicts the theoretical background and state of the art methods relating chronic obstructive pulmonary disease (COPD), which is one of the major targets of the research agenda of the SAPALDIA cohort. The present thesis reflects COPD as one thematic priority in the context of food patterns in the SAPALDIA cohort.

2.1.1 Definition and classification of COPD

Chronic obstructive pulmonary disease (COPD) is a chronic inflammatory disease of the respiratory tract characterized by airflow limitation that is not fully reversible. Typical symptoms include cough, sputum production and/or dyspnea. The diagnosis is confirmed by spirometry and shows values for a post- bronchodilator forced expiratory volume in 1 second (FEV 1) < 80% of the predicted value in combination with an FEV1 /FVC (forced vital capacity) < 70% [3, 4]. Where spirometry is unavailable, clinical symptoms and signs, such as abnormal shortness of breath and increased forced expiratory time, can be used to help with the diagnosis. Although a low peak flow is concurrent with COPD, it shows poor specificity due to an overlap with other lung diseases and due to poor performance. Therefore, when ever applicable, efforts should me made to perform a standardized spirometry. Chronic cough and sputum production often occur previously to the development of airflow limitation, but not all individuals with these symptoms go on to develop COPD.

Table 1: Classification of COPD by Severity [3]

Stage	Characteristics
0: At Risk	Normal spirometry Chronic symptoms (cough, sputum production)
I: Mild COPD	FEV1/FVC < 70% FEV1 ≥ 80% predicted With or without chronic symptoms (cough, sputum production)

Stage	Characteristics
II: Moderate COPD	FEV1/FVC < 70% 30% ≤ FEV1 < 80% predicted (IIA: 50% ≤ FEV1 < 80% predicted) (IIB: 30% ≤ FEV1 < 50% predicted) With or without chronic symptoms (cough, sputum production, dyspnea)
III: Severe COPD	FEV1/FVC < 70% FEV1 < 30% predicted, or the presence of respiratory failure,* or clinical signs of right heart failure

* Respiratory failure: Pa_{O2} < 8.0 kPa (60 mm Hg) with or without Pa_{CO2} > 6.7 kPa (50 mm Hg) while breathing air at sea level.

Table 1 shows an overview of the classification of COPD by Severity [3]. It is a pragmatic approach aiming at practical implementation and therefore should only be regarded as an educational tool. All FEV1 values refer to postbronchodilator FEV1. Stage 0 is characterized by having a risk for COPD development, i.e. sputum production and chronic cough. Spirometry values of lung function are still normal. Stage I is defined by a mild COPD implying airflow limitation and often associated with chronic cough and sputum production. At this stage, the affected persons often are not aware about the abnormal lung function. Stage II refers to moderate COPD, which is characterized by a higher level of airflow limitation (30% ≤ FEV1 < 80% predicted) and usually the presence of progressive symptoms such as shortness of breath during exertion. At this stage patients typically doing doctor visits due to dyspnea or an exacerbation of their disease. The Stages IIA and IIB indicate that exacerbations are particularly occurring in patients with an FEV1 below 50% predicted. The presence of repeated exacerbations has an impact on the health-related quality of life and requires therefore an appropriate and timely management. Stage III is defined by severe COPD, i.e. the presence of severe airflow limitation (FEV1 < 30% predicted) or even worse characterized by respiratory failure or clinical signs of right heart failure. At this stage, there exists a clear impairment of quality of life and exacerbations may be life threatening.

2.1.2 Burden of COPD

Epidemiology

Prevalence and morbidity data greatly underestimate the total burden of COPD because the disease is usually diagnosed at a later stage, until its clinical manifestation. The inaccurate and variable definitions of COPD have made it difficult to estimate the morbidity and mortality of COPD in developed and developing countries. Furthermore, mortality data also underestimate COPD as a cause of death due to the fact that COPD is more likely to be cited as a contributory than as an underlying cause of death, or even may not be cited at all. In the Global Burden of Disease Study conducted under the auspices of the World Health Organization (WHO) and the World Bank [5, 6], the worldwide prevalence of COPD in 1990 was estimated to be 9.34/1,000 in men and 7.33/1,000 in women. In countries where cigarette smoking has been or still is very common, there was the highest prevalence of COPD, whereas in countries where smoking is less common, there was the lowest prevalence of COPD. According to the WHO, COPD accounted for the fifth leading cause of death in 2002. Recent estimates assume that the number of total deaths from COPD will increase by more than 30% in the next 10 years unless urgent actions in primary and secondary prevention are taken to reduce the underlying risk factors, especially tobacco use. Estimates show that COPD will become the third leading cause of death worldwide in 2020 [4].

Social burden of COPD

The Global Burden of Disease Study [5, 6] estimated the proportion of mortality and disability assigned to major diseases and injuries applying a composite measure of the burden of each health problem, the disability-adjusted life year (DALY = the sum of years lost because of premature mortality and years of life lived with disability, adjusted for the severity of disability). According to predictions, COPD will account for the fifth leading cause of DALYs lost worldwide in 2020 (in 1990 it ranked twelfth), behind ischemic heart disease, major depression, traffic accidents, and cerebrovascular disease (Table 2).

Table 2: Leading causes of disability-adjusted life years (DALYs) lost worldwide: 1990 and 2020 (projected) [5, 6]

Disease or Injury	Rank 1990	Percent of Total DALYs	Rank 2020	Percent of Total DALYs
Lower respiratory infections	1	8.2	6	3.1
Diarrheal diseases	2	7.2	9	2.7
Perinatal period conditions	3	6.7	11	2.5
Unipolar major depression	4	3.7	2	5.7
Ischemic heart disease	5	3.4	1	5.9
Cerebrovascular disease	6	2.8	4	4.4
Tuberculosis	7	2.8	7	3.1
Measles	8	2.6	25	1.1
Road traffic accidents	9	2.5	3	5.1
Congenital anomalies	10	2.4	13	2.2
Malaria	11	2.3	19	1.5
COPD	12	2.1	5	4.1
Trachea, bronchus, lung cancer	33	0.6	15	1.8

2.1.3 Risk factors of COPD

Risk factors of COPD include both genetic and environmental factors, and the disease etiology usually is explained by an interaction of these two types of factors. The host factor that is best documented is a rare hereditary deficiency of α_1-antitrypsin. Single genes that have been related to a lung function decline were described recently (e.g. the gene-encoding matrix metalloproteinase 12 (MMP12)) [7], but it still remains unclear whether these genes are directly responsible for COPD or are simply markers of causal genes. The major factors that contribute to the environmental exposures are tobacco smoke, heavy exposure to occupational dusts and chemicals (vapors, irritants, and fumes), and indoor/outdoor air pollution [4]. Cigarette smoking still presents the most well studied risk factor for COPD. However, it is not the only risk factor and epidemiological data point out, that non-smokers also can develop chronic airflow limitation or COPD [4]. Other environmental factors include age and gender, lung growth and development, socio-economic status, asthma and bronchial hyper-reactivity, chronic bronchitis, and infections in childhood and adolescence [8].

The role of sex as a risk factor for COPD has changed recently. In the past, most studies showed that COPD prevalence and mortality were greater among men than women, but more recent data from developed countries show that the prevalence of the disease is now almost equal in men and women, which probably reflects the changing patterns of tobacco smoking [9]. Some studies have even proposed that women are more susceptible to the effects of tobacco smoke than men, leading to a higher disease severity for the equivalent amount of consumed cigarettes [10, 11]. This is an important observation given the increasing rate of smoking among women in both developed and developing countries [4].

Regarding socio-economic status and the risk of developing COPD, there is strong evidence of an inverse association [12]. However, it remains unclear which component of poverty contributes the most to an increasing risk of developing COPD. Several exposures or lifestyle patterns are discussed, such as indoor and outdoor pollutants, poor nutrition, crowding, infections, or other potential factors in relation to a low socio-economic status [4].

2.1.4 Nutrition and COPD

Cigarette smoking has been established as the predominant risk factor for COPD, but not all smokers develop COPD, and never smokers can also be affected by the disease. Among other environmental risk factors of COPD, dietary habits may also contribute importantly to the disease aetiology. As COPD has been associated with oxidative stress, dietary factors and nutrients with a potential protective role in the oxidative and inflammatory process have been considered to have a relation in the genesis or evolution of the disease. Consequently, these nutrients contain antioxidant vitamins C, E, beta-carotene and other carotenoids, vitamin A, fatty acids and some minerals and micronutrients such as magnesium, selenium and zinc [13, 14].

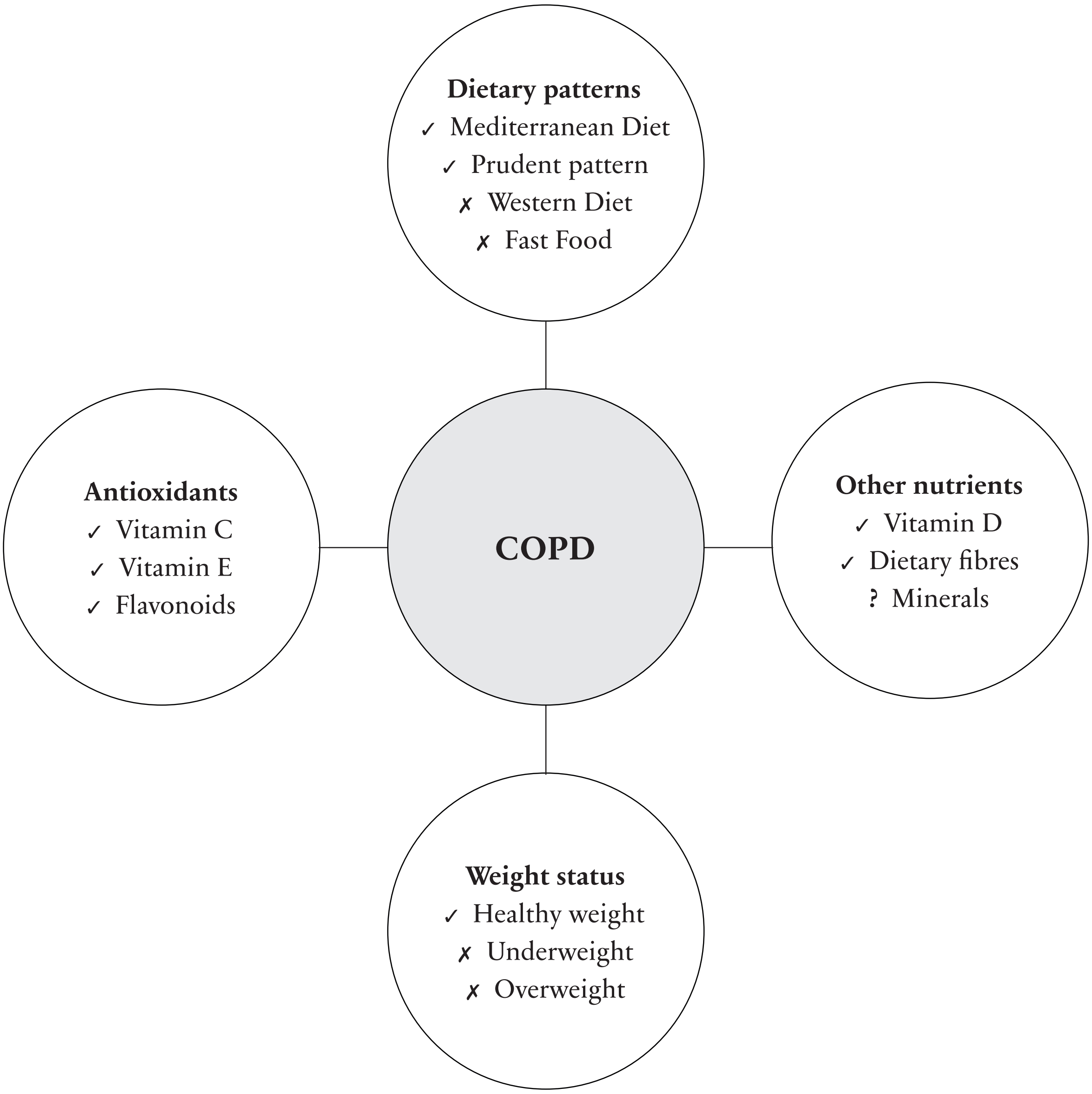
Several epidemiological studies revealed a benefit of a diet rich in antioxidants, omega-3 fatty acids and dietary fibres to protect from loss of lung function and from COPD symptoms [15–23]. A protective effect of fruit and vegetable intake has also been shown in several cohort studies [24–30]. In the review of Boeing and colleagues, a preventive effect of COPD with increasing fruit and vegetable intake was also reported [31]. Moreover, a case control study from Japan showed a significantly lower risk of COPD with increasing total vegetable intake [32]. In line with that, recently published cross-sectional studies found that higher scores in the "Prudent" dietary pattern were associated with a lower prevalence of COPD and better lung function [33, 34]. A similar finding was also shown in the review by Berthon and Wood, which demonstrated evidence on the impact of higher fruit and vegetable intakes as important modifiable risk factors for COPD [14].

With respect to the prevention of COPD in smokers, a recently published Editorial by Varraso and Shaheen [35] suggested a potential protective effect of a diet rich in fruit and vegetables to prevent COPD.

Recently, there is growing interest to examine the relationship between red meat and processed meat consumption and the risk of COPD. A current prospective cohort study investigated the association between long-term red meat consumption and the risk of COPD and found an increased risk of COPD for women with higher intakes of long-term processed red meat consumption, in particular among ex-smokers [36].

In view of the above statements, nutritional behavior and dietary intake seem to be a relevant determinant in the developing process of COPD. Although more evidence is needed from intervention and clinical studies in humans, there is an obvious link between some nutrients and dietary patterns and COPD. The dietary patterns that are associated with beneficial effects for preventing COPD are characterized by a high fruit and vegetables intake, a Mediterranean diet, and a high fish and omega-3 fatty acids consumption. In contrast, a "Western" dietary pattern and Fast Food intake presumably have adverse effects on the risk of COPD. Figure 1 shows subsequently a diagram with potential associations between nutritional behavior and COPD.

Figure 1: Relationship of Nutrition and COPD (adapted from Berthon 2015)



Dietary factors associated with COPD: ✓ evidence suggests positive effect, ✗ evidence suggests negative effect, ? evidence is lacking [14]

2.2 Dietary assessment methods

The following chapter introduces the field of nutritional epidemiology and gives an overview of dietary assessment methods, and in particular the FFQ. It states the advantages and disadvantages of the FFQ and considers the design of validation studies. The chapter therefore aims to establish a basis for the FFQ validation study, which was carried out as a precondition study for the main analyses addressing food patterns and COPD in the SAPALDIA cohort.

2.2.1 Overview

Valid and scientifically based assessments of dietary intake at the population level are imperative for further investigations on the impact of diet on health and disease. The field of nutritional epidemiology and questions on the assessment of dietary intake has gained increasing interest due to the worldwide discussion on chronic disease and general public health issues [15, 37–40]. Among environmental and lifestyle determinants, nutritional behavior represents a major target for the prevention of several non-communicable diseases, such as cancer, cardiovascular diseases, diabetes, chronic obstructive pulmonary disease and other chronic diseases [41–46]. A number of methods have been used to assess usual dietary intake at the population level [47]. The following figure 2 shows an overview of "traditional" dietary assessment methods [48].

Figure 2: Overview of dietary assessment methods (adapted from Oltersdorf, 1995)

Indirect Methods

Nutrient-economic outline data

Food Balance Sheets

Direct Methods

Nutritional requirement
Nutritional Status

Food Intake

Retrospective Methods

- 24-hour Recall
- Diet history
- Food Frequency Questionnaire
- Food List/ Purchase List
- Archaeological Method

Prospective Methods

- Weighed Food Record
- Inventory Method
- Diet Journal
- Account staff Method
- Tape Recording Method

However, one of the great difficulties in this discipline presents the complex nature of diet. Dietary intake involves a wide-range of complex exposures that are strongly linked. More precisely, factors for exposure cannot be seen as present or absent, but as continuous ones, and most of the time in quite a narrow range of variation [49]. Also the fact that eating habits evolve over periods of years and changes in diet therefore are often made subconsciously, contributes to the great challenge in assessing food intake.

As a consequence, the accuracy and reliability of measuring diet still presents an ongoing challenge [47, 50, 51]. Even though weighed food records and 24-hour recalls have been widely used, their substantial burden on respondents plus their economic constraints make them inapplicable for large epidemiological studies. Meanwhile food frequency questionnaires (FFQs) are relatively inexpensive, are associated with less burden on the respondents, and do not require trained interviewers [52, 53]. Thus, they represent the most commonly used tools in epidemiological studies [54].

Recently, there is growing interest in methods for assessing food intake using computer-assisted technologies. Due to advancing technologies and growing awareness in personalized health and medicine there is a growing interest for the application of new technologies in dietary assessment [55].

For example, the use of mobile phone technology in epidemiological research has increased rapidly over the last decade and offers multiple advantages in the application and handling as a dietary assessment tool. A currently published study by Ambrosini et al. found good feasibility for applying the commercially developed App “Easy diet diary” in epidemiological research. However, their small sample size (N=50) and the majority of female participants (82%) do not allow generalizing this finding for large epidemiological studies [56]. A similar finding showed Béjar and Vàzquez-Limòn in their recently published study (2017), where 119 participants completed their food consumption with the App “e-EPIDEMIOLOGY” during 28 consecutive days. The food data showed good agreement with the validated FFQ short paper [57]. A review of image-assisted and image-based dietary assessment methods by Boushey et al. [58] indicated that these methods could improve the accuracy of conventional dietary methods by implementing details of eating occasion via pictures. As a result of this, underreporting could be markedly reduced in comparison to the traditional assessment methods. However, studies with larger sample sizes are needed to further investigate the feasibility and validity of these new assessment tools.

In support of choosing the best dietary assessment tool when performing epidemiological research, Cade et al. performed two Delphi studies that included 57 experts from North America, Europe, Asia and Australia, and elaborated Best Practice Guidelines for dietary assessment in health research (www.nutritools.org) [59].

2.2.2 Food frequency questionnaire (FFQ)

<u>History</u>

The origins of the FFQ are found in the 1950’s. As discussed by Willett a detailed dietary history interview was developed in 1947 by Burke, trying to assess diet intake of individuals [49]. This method was composed of a 24 h recall, a three-day food record and a checklist of foods consumed over the preceding month. Although it was a time consuming and expensive method, and beyond that highly skilled professionals were needed, some benefits regarding the development of the FFQ were observed. The food checklist, which was used in dietary history interviews, represented an important basis for the FFQ design. During the 1950's and 1960's a first evaluation of their role in dietary assessment took place and investigators demonstrated that the frequencies highly correlated with the total weights of the investigated foods.

During the 1980's and 1990's data derived from the FFQ, became more interpretable by a continuous improvement of the method. Already in this period, multiple investigators described the FFQ as the most suitable method for assessment of food intake in many epidemiologic applications.

Definition

The FFQ measures usual food intake and can be classified as quantitative, semi-quantitative or non-quantitative. The principle of the FFQ approach is based on collecting an average long-term diet, e.g. over some weeks, months or also years. In contrast to short-term methods such as the diet record, the FFQ focus on a longer exposure period instead of only a few specific days. According to Willett, the concept of cognitive research is interesting concerning the benefits and use of long-term methods. Corresponding to the concept of generic vs. episodic memory, it is easier to describe a usual frequency of food consumption than telling what foods were eaten at a specific meal in the past. Even when the focus is on a specific meal, subjects have difficulty to recall their food intake at that time. Therefore, considering this theory, general questions are more suitable to get an accurate assessment of food intake [49].

The basic structure of the FFQ consists of two components, a food list and a frequency response section for subjects to report how often each food was consumed. Further questions regarding the quantity, composition and preparation methods may be added. In practice, study participants are asked to fill in the FFQ booklet and to report the frequency of consumption and portion size over a defined period of time, e.g. the last month.

Since it is relatively easy to administer and quite inexpensive, the FFQ is still the most common dietary assessment tool used in large epidemiologic studies of diet and health. Furthermore, an adaptation of a FFQ for population studies can be attained by little effort. As discussed by McPherson et al. (2000), its application is useful for the prediction of health outcomes at both the group and the individual level [60].

In view of the recent development over the last decade there is a rapid increase of mobile phone technology in epidemiological research, additionally intensified through the trend of personalized nutrition / medicine [55].

2.2.3 Advantages and Disadvantages of the FFQ (Limitations of the FFQ)

In addition to the mentioned advantages, the FFQ is also associated with some critical aspects, which must be considered. The food list for the FFQ needs to be population-specific in order to be appropriate and to accurately assess usual food intake. McPherson et al. (2000) describe that FFQs with long detailed food lists had better agreement with validation standards than did FFQs with short lists [60]. However, a large number of listed food items within the food groups could lead to a high variety of level of detail in the different food groups. Food groups including more items may lead to a cumulative effect and a tendency for over-reporting regarding that specific food group (e.g. fruits). Conversely, food groups containing only one item (e.g. egg) may lead to an underreporting effect due to the aggregation of foods (e.g. scrambled egg, fried egg, etc.) to the main group. This presents a challenge in the estimation of food intake [61].

One of the major problems in dietary assessment by FFQ involves the accurate estimation of portion size. The quantification of portion sizes accounts for a main source of error, especially in the case when the assessment of food intake must be recalled from memory [49]. In this complex process perception and conceptualization play an important role, which are influenced substantially by culturally based differences [62]. In order to optimize this process, several measurement aids such as 2D or 3D models can be used to improve the estimates of food amounts eaten. McPherson et al. (2000) emphasize that participants have problems to recall past events. Even by the addition of photographs as measurement aids, participants still had difficulty in estimating portion sizes, and the accuracy of the method did not improve. Assistance by books with life-size photographs might present an opportunity to help in estimating portion sizes of foods consumed [60].

In addition, the seasonality aspect must be taken into account. Given that the FFQ consists of a fixed food list, it could present a challenge for study participants to estimate their intake under consideration of the respective season [61]. Moreover, depending on the length of the food list, the FFQ could also be time consuming for participants.

To sum up, the subsequent table 3 gives an overview of potential advantages and disadvantages of the FFQ as a dietary assessment method.

Table 3: Overview of the advantages and disadvantages of the FFQ

Advantages	Disadvantages
– Self-administration possible – Useful tool to estimate usual food intake and to rank individuals by food or nutrient intakes – Little time required (if checked by an interviewer) – Mostly pre-coded => facilitates simple data handling – Relatively inexpensive – No effect on eating patterns – Small respondents' burden – Suitable for large population surveys – Identification of food patterns – Relatively high response rate	– Memory required – Actual intake may influence reporting of intake in the past – Imprecise recall period – Complex calculations required to estimate frequencies – Quantification of food intake may be inaccurate => poor estimation of recall portions or use of standard portion sizes – Not open-ended – High aggregation level of food types – Limited possibilities for food specification

Adapted from Birò et al. [62]

2.2.4 FFQ Validation studies

Due to the (above) discussed error sources and limitations of FFQs, their collected information need to be compared with information collected by a more accurate dietary assessment method. Validity presents one of the possible approaches and describes basically a comparison of the FFQ with an independent standard. Its objective is to assess the degree to which the FFQ really measures the aspect of diet that it was designed to measure [63]. This assumes a comparison with a superior, but always an imperfect standard. Validity can be assessed diversely. Most common analyses are evaluations by correlation coefficients intending to order subjects by different methods, and comparisons of absolute levels, which involve an examination of means and standard deviations. Although some first insights into the validity of the FFQ are therefore possible, the information content has to be considered critically. A comparison of means and standard deviations provide limited information in the sense that some compensating errors could occur, for example that important food items were not included in the FFQ but that the portion sizes were extremely high, which could then result in similar mean values.

As a result to assess the validity of a FFQ, it is important to compare individual estimates of nutrient intake based on the questionnaire with those measured by a more accurate method, that is, a gold standard or reference method. As discussed by Willett, a perfect measure of food intake does not exist, thus in validation studies it is not a concern about a comparison of an operational method with absolute truth. Given that all methods have error and that there is no perfect standard, the term "relative validity" rather than "absolute validity" is often used when assessing the validity of a FFQ, as shown in the literature [49].

When considering the selection of a reference method, it is crucial to examine the particular errors of each method and to assess their magnitude. Due to the fact that the correlation between two methods will be artificially inflated when their errors are similar (e.g. FFQ and 24-h recall), McPherson et al. recommends that the errors of the assessment methods should be as independent as possible [60]. In evaluating an ideal reference method and in striving for preconditions as good as possible for the validation, Willett also emphasizes independent errors of both methods, therefore avoiding misleadingly high estimates of validity. To strive for a better examination of validity, Willett suggests to add a biochemical analysis [49].

Several approaches for the validation of FFQs exist. Because of their dissimilar error structures, weighed food records represent the gold standard as a reference method in FFQ validation studies, and they are still the most applied reference method in FFQ validation studies [49]. Other reference methods to assess the validity of FFQs include 24-h recalls or dietary history interviews [64, 65].

2.3 Dietary pattern analysis

The following chapter describes the theoretical background and methodological approach of analyzing dietary patterns. In the field of nutritional epidemiology, the approach of analyzing dietary patterns currently ranks high among the state of art methods. In comparison to US data, there are not many European studies addressing this approach, and in Switzerland no study has yet reported dietary pattern analysis and the prevalence of COPD. Therefore, it was decided to derive dietary patterns in order to analyze food patterns and COPD in the SAPALDIA cohort.

2.3.1 Background

There is ample evidence in literature about the relationship between diet and health outcomes [66, 67]. Therefore, the investigation of food consumption and nutrient intake at an individual level is well established. It represented the standard approach when exploring risk-benefit relationships for years, without considering diet as a whole [67]. However, the independent effects of individual foods on the health are difficult to establish because diets are eaten in specific combinations and contexts, i.e. strong correlations can exist between nutrients, foods and also other life style aspects. In order to get a broader picture of dietary behavior, authors suggested to assess dietary patterns rather than focus on nutrients [26, 68–70]. In particular when studying determinants of chronic disease, recently there is an increasing interest in analyzing diet as a whole [71]. Using these multidimensional approaches, such as the identification of dietary patterns, a better estimation of reliable associations between diet and health can be determined, taking into account the complexity of diet. Furthermore, the multidimensional approach of dietary patterns can be used to explore and define relevant determinants for further public health interventions and to promote healthier food behaviors in specific population groups [67, 72].

2.3.2 A priori approach

Dietary patterns can be defined by two approaches. The so-called a priori approach is a hypothesis-driven approach and uses diet-quality indices based on dietary guidelines and recommendations. In this approach, expert knowledge and scientific evidence available prior to the study is used to define the dietary patterns. The adherence to dietary patterns is often measured by applying a scoring method. These measures are useful in characterizing dietary intake at a population level to investigate the impact on health [71, 72].

The a priori approach does not consider intake data from the study participants to define dietary factors. One weakness is that diet-quality scores rely on selected aspects of diet and do not account for the correlation structure of food and nutrient intake. Consequently, these scores do not reflect the overall effects of diet but only the formal sum of non-adjusted single effects [73].

2.3.3 A posteriori approach

Beside hypothesis-driven approaches the application of a posteriori or data-driven approaches, i.e. exploratory approaches based on statistical dimension-reduction methods have been widely used to derive dietary patterns. In this case, dietary patterns are derived directly from the data and do not consider researchers assumptions. Principal component analysis (PCA), factor analysis or cluster analysis are the most frequently applied dimension-reduction techniques in nutritional epidemiology [73–76]. PCA or factor analysis define groups by intercorrelated dietary items (factors), whereas cluster analysis groups individuals into dietary patterns on the basis of their reported mean food intakes [71].

2.3.4 Factor analysis (PCF)

In the application of dietary pattern analysis, factor analysis or principal component factor analysis (PCF) intend to explain the total variation in food intake in terms of linear functions called principal components. The first principal component is the standardized linear function of food variables with maximal variance; the second principal component maximizes the variance among all functions orthogonal to the first component, and so forth. Like this, a large number of food variables are reduced to a smaller set of variables that determine the major dietary factors in the study population. In order to get uncorrelated factors at the end, an orthogonal rotation is commonly applied. For each factor, scores are obtained that define the position of each individual along a gradient.

To summarize factor analysis examines the correlation matrix of food variables and defines the underlying characteristics, i.e. factors that accounts for most of the variation in the data [73, 74].

On the basis of the above considerations, it was decided to perform a factor analysis as a posteriori approach to determine dietary patterns for the present study.

3 Aims and methods of the current studies

3.1 The FFQ Validation study

The following chapter describes the aims, methodical procedure and set-up of the FFQ Validation study. The objective was to examine the relative validity of the FFQ in order to obtain a robust and valid dietary assessment tool that could be implemented in the SAPALDIA study.

3.1.1 Study aims, population and recruitment

In the present study, a paper form FFQ, developed at the ZHAW in Wädenswil (Zurich, Switzerland) (www.ernaehrungserhebung.ch), was validated against a 4-day weighed food record (4-d FR). It aimed at assessing dietary intake of adults, focussing not only on the energy and macronutrients intake (carbohydrates, protein, fat and fibre), but also considering food group intake. A comparable online FFQ has been validated with a 4-d FR among adolescents, focusing on both the energy and macronutrient intake and validation at the food group level [77]. The results of this validation study showed good agreement for the energy and macronutrient intake except for protein, and a good agreement for frequently consumed foods at the food group level.

The FFQ was designed to be implemented in the SAPALDIA study. This population is diverse and consists of German-, French- and Italian-speaking participants, all representing different eating cultures. In order to depict eating patterns with one instrument (in all three national Swiss languages), a robust tool is needed, which will be able to compile data in a valid and reproducible manner. In order to validate the tool, an environment to mimic similar challenging circumstances to establish proof of the robustness and usability of the instrument was chosen. The study group was a German speaking, randomized sample which included all age groups representing the target population of the SAPALDIA cohort.

The study participants were recruited in October 2012 through advertisements, via email, telephone and word of mouth in the area of Jena, Germany. Finally, sixty adults could be enrolled in the validation study, which took place between November 2012 and January 2013. Inclusion criteria were a minimum age of 18 years, a healthy status without chronic diseases requiring medication, not pregnant or breastfeeding. Written informed consent was obtained from all participants prior to the validation study. Participants were asked to complete both dietary assessment tools, i.e. the FFQ in paper format and a 4-d FR as the reference method within a period of 4 weeks. There was no reimbursement for the study participants apart from being allowed to keep the scales at the end of the assessment method. Additionally, there was a raffle for eight vouchers each with a value of 25 euros.

3.1.2 Dietary assessment

Prior to the completion of the FFQ, the subjects filled in a weighed FR on 4 consecutive days (including both weekdays and weekend days). The study group was randomized into two groups with 30 subjects who filled in the 4-d FR continuously from Wednesday to Saturday and the other 30 subjects from Sunday to Wednesday. A paper template was handed out to each participant with instructions how to fill in the 4-d FR. The subjects were asked to weigh each food item or meal prior to its consumption and to record the leftovers. An additional instruction how to use the scales was given. The 4-d FRs were returned within a period of one to three weeks.

The 127-itemed, semi-quantitative paper form FFQ (see Appendix A, p. XI) was filled in self- administered subsequently to the completion of the 4-d FR, assessing the period of the previous 4 weeks, thus covering the same time of the weighed FR. The FFQ was designed to assess the habitual food intake of adults and collected consumption information for 127 food items (www.ernaehrungserhebung.ch). The selection of food items was done according to the most typically consumed food products in Switzerland and additionally complemented with findings of the MONICA study, the CoLaus study and household budget data [78–80]. The portion sizes of food items were defined in accordance with data described in the MONICA study and the National Nutritional Survey II in the Federal Republic of Germany [81, 82]. The study participants were asked to specify, on average, the frequency, portion size and number of portions of each food item consumed during the previous 4 weeks. The frequency was asked in 9 categories from “never” to “daily” and the number of portions could be specified. The amounts of food were in gram or decilitre/centilitre, and as a measurement aid for estimating portion size, three pictures of each food item were shown. Additional information was collected on preparation and cooking methods, use of specific types of oil, butter and margarine, and the take-out foods consumed. Furthermore, information on the use of dietary supplements was collected, and a ‘users data sheet’ was handed out to collect demographic information, as well as additional information on the current diet (e.g. weight reduction diet), physical activity, household size and smoking habits.

3.1.3 Data pre-processing

The FFQ paper form and the 4-d FR were both checked for completeness and possible errors prior to data entry and food coding. After scanning, each FFQ questionnaire was checked for completeness, missing values and structurally impossible answers (e.g. two boxes checked where only one should be checked). The subsequent data management procedures considered the sections on frequency, the number of portions and the portion size. A detailed description of data management procedure is shown elsewhere [61]. The most frequent missing values were found in the number of portions (N = 93 over all questionnaires). Previous studies showed that there are in general fewer missing values in more frequently consumed foods [83]. Implausible energy intakes and bias from wrongly reported food habits were assessed using a cut-off at the 75th percentile plus 1.5 times the interquartile range (3553.3 kcal) and the 25th percentile minus 1.5 times the interquartile range (190.9 kcal) [84]. Accordingly two FFQs with an over-reporting of energy intake (4250.3 kcal, 5414.3 kcal) were excluded. Their corresponding energy values in the 4-d FR were well within the plausible range (2099.7 kcal, 2119.9 kcal).

3.1.4 Data post-processing

As the present FFQ Validation study did not only focus on the energy and macronutrient intake, but also assessed the respective relative validity on the food group level, the 127-food items listed in the FFQ were grouped into 25 predefined food groups, based on the similarity of type of food and nutrient composition (see Appendix B, p. LXV). The categorization was done following a similar grouping already used in the National Nutritional Survey II in the Federal Republic of Germany [82]. The mean intake of each food item per day was calculated using frequency, portion size and number of portions: Frequency × [number of portions × 100] × portion size /28. In order to receive the nutrient intakes per day, the calculated food data were linked to the Swiss Food Composition Database (www.naehrwertdaten.ch) and, where necessary, completed using the German Nutrient Data Base (www.bls.nvs2.de). The nutrient data that originated from the 4-d FR were entered in an online input mask that was designed at the ZHAW (www.ernaehrungserhebung.ch). Consequently, each food item listed in the 4-d FR was matched to the corresponding food item listed in the FFQ.

3.1.5 Statistical methods

Descriptive statistics such as means, medians and interquartile ranges were used to present energy, nutrients and food groups intakes. To assess the agreement between the FFQ and 4-d FR, the mean difference and percentage difference were calculated as the mean of all individual differences between the FFQ and 4-d FR ([Mean (FFQ – 4-d FR)]/[mean (4-d FR)]. For the examination of relative validity, the Spearman's correlations were assessed and corrected for the day-to-day variation within-person using the de-attenuation method [49]. The corrected correlation, r_c, was calculated using the following formula:

$$\mathbf{r_c = r_o \sqrt{[+(S^2_w/S^2_b)]/n},}$$

where r_o is the observed correlation, S2w/S2b is the ratio of the within- and between-person variances and n is the number of replicates per person for the given variable. Within-person variation and between person variation were calculated from replicated 4-d FR.

For visualization, Bland–Altman diagrams and Box–Whisker plot were drawn. The Wilcoxon rank-sum test was used to examine reporting behavior between participants groups. The statistical analysis was calculated using R version 3.0.1, SAS version 9.4 (2012–2012 SAS Institute Inc., Cary NC, USA) and Microsoft® Excel 2007. P values less than 0.05 were considered significant, all tests were performed two sided.

3.2 The COPD study

The following chapter describes the aims, methodical procedure and set-up of the COPD study, focusing on potential associations between dietary intake and the occurrence of COPD in the SAPALDIA cohort.

3.2.1 Study aims and research questions

The aims of this study were to derive and analyze dietary patterns of the SAPALDIA cohort with respect to the prevalence of COPD, and to examine associations between dietary parameters and lung function outcomes. An overall and superior objective was to provide a basis for nutritional intervention programs for public health and prevention policy in the field of COPD.

The following research questions were addressed:

1) Is there an association between the consumption of fruits and vegetables and the prevalence of COPD?
2) Do people with lower fruit and vegetables intake have a higher risk of COPD?
3) Are there different dietary patterns to be identified when examining the dietary intake and the prevalence of COPD? i.e. a healthy, balanced diet vs. a less healthy, unbalanced diet?

Based on the theoretical background and the raising ongoing interest in performing dietary pattern analysis when addressing epidemiological research, we aimed to derive dietary patterns for Swiss adults and to assess their association with lung function and COPD in the SAPALDIA cohort.

3.2.2 Study population

For the current study, subjects from the second follow-up assessment of the SAPALDIA study (= SAPALDIA 3) were included. In SAPALDIA 3, which was conducted in 2010–2011, detailed information about dietary intake and physical activity was obtained in a random subset of participants. 2178 SAPALDIA participants with complete data on lung function, smoking history, physical activity and dietary intake were considered. To focus on irreversible airway obstruction characterizing COPD, data from post-bronchodilation measurements of lung function being used in the GOLD definition of COPD was used (i.e. requiring the ratio FEV1/FVC to be lower than 0.7 after bronchodilation).

Written informed consent was obtained from all participants prior to conducting any of the health examinations.

3.2.3 Dietary intake and identification of dietary patterns

Dietary intake was collected using a paper form food frequency questionnaire (FFQ) designed to assess average food intake over the previous 4 weeks (www.ernaehrungserhebung.ch). The validated, 127-item, semi-quantitative paper form FFQ was handed out to SAPALDIA 3 participants after the attendance of a spirometry during an in-persons health examination. The study participants filled in the FFQ self- administered (detailed written instructions on how to handle the questionnaire were handed out to participants) [61]. Subjects were guided to indicate their consumption of each of the 127 food items during the past 4 weeks in terms of average frequency, portion size and number of portions. Detailed information about the structure of the applied FFQ is summarized in chapter 3.1.2 "Dietary assessment".

To prepare for dietary pattern analysis, the 127 food items listed in the FFQ were grouped into 25 predefined food groups on the basis of similarity of type of food and nutrient composition (more details are written in chapter 3.1.4 "Data post-processing").

To derive dietary patterns, principal component factor analysis (PCF) was performed on the predefined food groups. Food group consumption (originally given in g/d) was adjusted for body weight (g food/kg body weight per day). In order to achieve better interpretability, the factors were transformed using Varimax rotation. Following this procedure, the number of factors retained was based on the eigenvalues and interpretability. Although there were 6 factors with eigenvalues > 1, the 3 strongest factors were retained because of their clear interpretability. Their structure is summarized in the Appendix, Table C, p. LXX. The "predominant" food groups in factor 1 were vegetables, fruits, water, tea and coffee, fish and nuts. In contrast, factor 2 was based on the food groups meat, sausage, egg, fish and alcohol. Furthermore, factor 3 was characterised by sweet spreads, bread, dessert and potatoes. Factor 1 seemed to represent vegetable foods and fish consumption, while Factor 2 seemed to represent consumption of animal foods and alcohol. The characteristic features of Factor 3 were foods rich in carbohydrates.

3.2.4 Assessment of lung function and other variables

Spirometry was done before and after inhalation of a bronchodilatator. For this study, lung function parameters that were assessed after the inhalation of salbutamol were considered. The following variables were included for the present analysis: FEV1 (forced expiratory volume in 1 second), the ratio between FEV1 and FVC (forced vital capacity) and FEF25–75% (mean of the flow between the 25th and the 75th percentile of exhaled volume). In addition, COPD was defined as FEV1/FVC < 0.7.

Other covariates included anthropometric data such as height and weight, both measured in the study centres, the latter by using calibrated scales (SECA 877, SECA GmbH & Co., Hamburg, Germany). Additional parameters were assessed in a computer-assisted interview based on a standardised questionnaire and led by trained field workers: sociodemographic variables such as educational level (low, medium, high), civil status (married, divorced, widowed, single) and employment status (employed, home, training/military/long vacation/unemployed, pension); detailed information on smoking status (never, former, current) and total amount of pack-years smoked, and the number of cigarettes per day, on exposure to environmental tobacco smoke in the last 12 months (yes/no), and on parental smoking in childhood (yes/no). In addition, two physical activity variables (moderate and vigorous) were derived based on four short questions from the Swiss Health Survey questionnaire in 2012 [85].

3.2.5 Data pre-processing

After scanning the FFQ paper forms, each questionnaire was checked for completeness, missing values and structurally impossible answers (e.g. two boxes checked where only one was selectable). The following data management procedures were applied. If indications of frequency, portion size and number of portions were completely missing, the frequency information "never" was assigned to the respective food item. If at least one of frequency, portion size or number of portions was indicated, the following strategy was applied: Missing values of frequency or number of portions were imputed by the respective mean value for the given food item. Missing values of portion sizes were imputed by pre-set standard portion sizes.

To check for implausible energy intakes, the distribution of the total energy intake computed from the FFQ reports was considered. Upper and lower cut-offs for exceedingly high and low energy intakes, respectively, were defined at the 75th percentile plus 1.5 times the interquartile range (3868.3 kcal) and the 25th percentile minus 1.5 times the interquartile range (242.3 kcal) [84]. In total, 118 out of 2991 FFQs (3.9%) were excluded due to implausible energy intakes.

3.2.6 Statistical methods

Descriptive statistics such as means and standard deviations were used for quantitative variables, and frequency distributions for categorical variables. As already mentioned, PCF was performed to identify dietary patterns. In order to analyze the relationships between dietary patterns and lung function outcomes and COPD, multiple mixed linear and logistic regression models with random intercepts by study area were applied. All models included the basic variables sex, age and age squared as well as interactions between sex and the two age variables, and those for quantitative lung function variables also included height and an interaction between sex and height. Three different models with increasing adjustment for potential confounder variables were applied: Model 1 contained the basic variables and the three dietary factors along with a priori selected potential confounder variables (smoking status, pack-years smoked, daily number of cigarettes smoked, exposure to passive smoking in the last 12 months, parental smoking in childhood, educational level, civil status, employment status and physical activity, as described in the previous section 3.2.4). Model 2 (referred to as "main model") was further adjusted for total energy intake and Model 3 additionally included body mass index (BMI). BMI was not included in the basic model because it may be both a confounder and an intermediate endpoint of dietary habits.

In addition, several sensitivity analyses were conducted:

1) All analyses were repeated in lifetime non-smokers to check for the overall effects of smoking on lung function.
2) To assess potential confounding by seasonal variations in diet and in lung function, we ran models with additionally including the month of interview as categorical variable.

3) Given previous findings suggesting a protective effect of omega-3 fatty acids [17] and fibre [23] on the risk of COPD, we added the four separate consumption variables for fatty and lean fish, and for whole grain and refined bread as additional covariates to the models to see whether associations with the three dietary patterns were robust to adjustment for these specific dietary items.
4) To address potential participation bias, additional analyses using inverse probability weighting were conducted [86]. For this purpose, the probability of being included in the present analysis was modelled using predictor variables assessed in the entire SAPALDIA 3 sample.

All statistical analyses were performed using the statistical software STATA (StataCorp, Release 13.1 Statistical Software, College Station, TX: StataCorp LP, Texas, USA).

4 Results

4.1 Paper I: Relative Validation of a Food Frequency Questionnaire to estimate Food Intake in an Adult Population

Steinemann N, Grize L, Ziesemer K, Kauf P, Probst-Hensch N, Brombach C: Relative validation of a food frequency questionnaire to estimate food intake in an adult population. Food Nutr Res 2017;61:1305193. http://dx.doi.org/10.1080/16546628.2017.1305193

4.1.1 Abstract

Background: Scientifically valid descriptions of dietary intake at population level are crucial for investigating diet effects on health and disease. Food frequency questionnaires (FFQs) are the most common dietary tools used in large epidemiological studies. *Objective*: To examine the relative validity of a newly developed FFQ to be used as dietary assessment tool in epidemiological studies. *Design*: Validity was evaluated by comparing the FFQ and a 4-day weighed food record (4-d FR) at nutrient and food group levels, Spearman's correlations, Bland–Altman analysis and Wilcoxon rank sum tests were used. Fifty-six participants completed a paper format FFQ and a 4-d FR within 4 weeks. *Results*: Corrected correlations between the two instruments ranged from 0.27 (carbohydrates) to 0.55 (protein), and at food group level from 0.09 (soup) to 0.92 (alcohol). Nine out of 25 food groups showed correlations > 0.5, indicating moderate validity. More than half the food groups were overestimated in the FFQ, especially vegetables (82.8%) and fruits (56.3%). Water, tea and coffee were underestimated (−14.0%). *Conclusions*: The FFQ showed moderate relative validity for protein and the food groups fruits, egg, meat, sausage, nuts, salty snacks and beverages. This study supports the use of the FFQ as an acceptable tool for assessing nutrition as a health determinant in large epidemiological studies.

4.1.2 Publication

<u>Personal contribution from the doctoral candidate to the manuscript</u>

The doctoral candidate designed and conducted the FFQ validation study. She also coordinated the data management procedures and derived conclusions from the statistical analyses. She wrote the following research article and coordinated its publication in the *Food and Nutrition Research* Journal. The manuscript was published in March 2017.

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Relative validation of a food frequency questionnaire to estimate food intake in an adult population

Nina Steinemann[a,b], Leticia Grize[c,d], Katrin Ziesemer[a], Peter Kauf[e,f], Nicole Probst-Hensch[c,d] and Christine Brombach[a]

[a]Institute of Food and Beverage Innovation, Zurich University of Applied Sciences, Life Sciences and Facility Management, Waedenswil, Switzerland; [b]Epidemiology, Biostatistics and Prevention Institute, University of Zurich, Zurich, Switzerland; [c]Department of Epidemiology and Public Health, Swiss Tropical and Public Health Institute, Basel, Switzerland; [d]University of Basel, Basel, Switzerland; [e]Institute of Applied Simulation, Zurich University of Applied Sciences, Life Sciences and Facility Management, Waedenswil, Switzerland; [f]PrognosiX AG, Richterswil, Switzerland

ABSTRACT

Background: Scientifically valid descriptions of dietary intake at population level are crucial for investigating diet effects on health and disease. Food frequency questionnaires (FFQs) are the most common dietary tools used in large epidemiological studies.

Objective: To examine the relative validity of a newly developed FFQ to be used as dietary assessment tool in epidemiological studies.

Design: Validity was evaluated by comparing the FFQ and a 4-day weighed food record (4-d FR) at nutrient and food group levels, Spearman's correlations, Bland–Altman analysis and Wilcoxon rank sum tests were used. Fifty-six participants completed a paper format FFQ and a 4-d FR within 4 weeks.

Results: Corrected correlations between the two instruments ranged from 0.27 (carbohydrates) to 0.55 (protein), and at food group level from 0.09 (soup) to 0.92 (alcohol). Nine out of 25 food groups showed correlations > 0.5, indicating moderate validity. More than half the food groups were overestimated in the FFQ, especially vegetables (82.8%) and fruits (56.3%). Water, tea and coffee were underestimated (−14.0%).

Conclusions: The FFQ showed moderate relative validity for protein and the food groups fruits, egg, meat, sausage, nuts, salty snacks and beverages. This study supports the use of the FFQ as an acceptable tool for assessing nutrition as a health determinant in large epidemiological studies.

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Introduction

Dietary intake and, therefore, questions on dietary assessment for nutritional epidemiology play an important role in the worldwide discussion on chronic disease and general public health issues [1–5]. Among environmental and life-style determinants, nutritional behaviour represents a major target for the prevention of several non-communicable diseases, such as cancer, cardiovascular diseases, diabetes, chronic obstructive pulmonary disease and other chronic diseases [6–11]. A number of methods have been used to assess usual dietary intake at the population level [12]. However, the accuracy and reliability of measuring diet still presents an ongoing challenge [12–14]. Although weighed food records and 24-hour recalls have been widely used, their substantial burden on respondents and their economic constraints make them inapplicable for most large epidemiological studies. Food frequency questionnaires (FFQs) are relatively inexpensive, put less burden on the respondents, and do not require trained interviewers [15,16]. Therefore, they represent the most commonly used tools in epidemiological studies [17]. However, due to lower accuracy, the information collected by FFQs needs to be compared with information collected by a more accurate dietary assessment method. This will be a measure of the relative validity of the FFQ in comparison with the reference method, i.e. to which degree the method captures what it is designed to measure [18]. Several approaches for the validation of FFQs exist. Because of their dissimilar error structures, weighed food records represent the gold standard as a reference method in FFQ validation studies [19].

CONTACT Nina Steinemann nina.steinemann@uzh.ch; Christine Brombach christine.brombach@zhaw.ch ZHAW Life Sciences and Facility Management, Institute of Food and Beverage Innovation, Centre for Nutrition, Einsiedlerstrasse 34, CH-8820 Waedenswil, Switzerland

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A comparable online FFQ has been validated with a 4-day weighed food record (4-d FR) among adolescents, focusing on both the energy and macronutrient intake and validation at the food group level [20]. The results of this validation study showed good agreement for the energy and macronutrient intake except for protein, and a good agreement for frequently consumed foods at the food group level.

In the present study, we validated a FFQ in paper format to assess the dietary intake of adults versus a 4-d FR. In addition to the energy and macronutrients intake (carbohydrates, protein, fat and fibre), the food group intake was also examined.

The FFQ was designed to be implemented in a randomized Swiss population, the Swiss Cohort Study on Air Pollution and Lung and Heart Diseases in Adults (SAPALDIA). This population is diverse and consists of German-, French- and Italian-speaking participants, all representing different eating cultures. In order to depict eating patterns with one instrument (in all three national Swiss languages), we need a robust tool, which will be able to compile data in a valid and reproducible manner. In order to validate the tool, we chose an environment to mimic similar challenging circumstances to establish proof of the robustness and usability of the instrument. We therefore chose a German speaking, randomized sample which included all age groups representing the target population of the SAPALDIA cohort.

Methods

Study population and design

In October 2012, study participants were recruited through advertisements and via email, telephone and word of mouth in the area of Jena, Germany. Sixty subjects were enrolled in the validation study, taking place between November 2012 and January 2013. For inclusion in the study, subjects were required to be at least 18 years of age, without chronic diseases requiring medication and not pregnant or breastfeeding. Written informed consent was obtained from all subjects for participation in this validation study. Participants completed both a FFQ in paper format and a 4-d FR as the reference method, within a period of 4 weeks. Both methods will be described in detail below. The subjects participating in the study were not reimbursed apart from being allowed to keep the scales at the end of the assessment method. In addition, there was a raffle for eight vouchers each with a value of 25 euros.

Dietary assessment

The 4-d FR (reference method): At the beginning of the study, participants filled in a 4-d FR. The 4 days had to consist of both weekdays and weekend days. The study population was randomized into two groups with 30 subjects who filled in the 4-d FR continuously from Wednesday to Saturday and the other 30 subjects from Sunday to Wednesday. A paper template was handed out to each participant, consisting of 8 pages: 2 pages for each day. Each sheet was sub-divided into four columns in which the food and beverages consumed were recorded as: amount in grams or millilitres, specified food, type of meal (breakfast, lunch, dinner, snacks) and general comments. The participants were asked to weigh each food item or meal prior to its consumption and to record the leftovers. They were instructed to use the scales for each meal, including out-of-the home consumption, i.e. restaurants and canteens (cafeterias). The participants returned the completed 4-d FR within a period of 1-3 weeks.

Paper form FFQ (test method): Subsequently, the 127-itemed, semi-quantitative paper form FFQ was handed out and filled in self-administered. The FFQ covered the period of the previous 4 weeks, and thus covered the time of the weighed food record. The FFQ was designed at the ZHAW (Zurich University of Applied Sciences) to assess the habitual food intake of adults and collected consumption information for 127 food items (www.ernaehrungserhebung.ch). The 127 food items were selected according to the most typically consumed food products in Switzerland and, in addition, complemented the findings of the MONICA study, the CoLaus study and household budget data [21–23]. The portion size of each food item was defined according to the data described in the MONICA study, including a standard portion size of ± 30% for a small and a big portion size, respectively, as in the National Nutritional Survey II in the Federal Republic of Germany [24,25]. Subjects were asked to indicate, on average, the frequency, portion size and number of portions of each food item (out of 127) they consumed during the previous 4 weeks. The frequency was asked in nine categories ranging from ‘never’ to ‘daily’. If a food item was eaten several times a day, participants were asked to take this into account indicating the number of portions. The participants indicated the portion size in the three categories ‘small’, ‘pre-set’ and ‘big’ (specified by pictures placed next to each food item to make the indication of portion sizes comparable among the participants). For each category, a metric amount in grams or decilitres/centilitres was assigned.

Additional information collected included preparation and cooking methods, use of specific types of oil, butter and margarine, and the take-out foods consumed. The FFQ also collected information on the frequency of use of dietary supplements. The FFQ was pretested on several user groups. In addition, a 'users data sheet' was handed out (together with the food record and the FFQ paper form) to collect demographic information (age, sex, height, weight, educational level, job position, residential area), as well as additional information on the current diet (e.g. weight reduction diet), physical activity, household size and smoking habits.

Statistical analysis

Data pre-processing

Prior to data entry and food coding, the FFQ paper form and the 4-d FR were checked for completeness and possible errors. Two out of a total of 60 subjects did not return the questionnaires. Participants who completed fewer than 4 days of the 4-d FR were excluded, i.e. two out of the remaining 58 participants (completion rate = 3 days). After scanning the FFQ paper forms, each questionnaire was checked for completeness, missing values and structurally impossible answers (e.g. two boxes checked where only one should be checked). The following data management procedures included the sections on frequency, the number of portions and the portion size. If there were neither indications of frequency nor portion size nor number of portions, the frequency information 'never' was assigned to that food item. If at least one of frequency, portion size or number of portions was indicated, the following strategy was applied: if there were missing values of frequencies or number of portions, the mean value of the frequency or number of portions relating to that food item was entered. Missing values of portion sizes were corrected with an entry of a pre-set standard portion size. From a total of 58 questionnaires (58 × 127 × 3 = 22,098 possible entries), 43 (74%) FFQs showed missing information on the mentioned categories. However, in 32 of the 43 (74.4%) questionnaires there were fewer than five missing entries per questionnaire. The most frequent missing values were found in the number of portions (N = 93 over all questionnaires). Previous studies showed that there are in general fewer missing values in more frequently consumed foods [26].

To check for implausible energy intakes and to avoid a bias from wrongly reported food habits in the FFQ, the distribution of the total energy intake computed from the FFQ reports was examined. A cut-off was defined at the 75th percentile plus 1.5 times the interquartile range (3553.3 kcal) and the 25th percentile minus 1.5 times the interquartile range (190.9 kcal) [27]. This led to the exclusion of two FFQs with an over-reporting of energy intake (4250.3 kcal, 5414.3 kcal). The corresponding energy values in the 4-d FR for both excluded FFQs were well within the plausible range (2099.7 kcal, 2119.9 kcal).

Data post-processing

Based on the similarity of type of food and nutrient composition, the 127-food items listed in the FFQ were grouped into 25 predefined food groups, see the first column in Table 3.

The categorization corresponded to a similar grouping already used in the National Nutritional Survey II in the Federal Republic of Germany [25]. The mean intake of each food item per day was calculated using frequency, portion size and number of portions: Frequency × [number of portions × 100] × portion size /28. In order to receive the nutrient intakes per day, the calculated food data were linked to the Swiss Food Composition Database (www.naehrwertdaten.ch) and, where necessary, completed using the German Nutrient Data Base (www.bls.nvs2.de). The 4-d FR data was entered in an online input mask that was designed at the ZHAW (www.ernaehrungserhebung.ch). Therefore, each food item from the 4-d FR was matched to the corresponding FFQ food item.

Statistical methods

Correlation between macronutrients and food groups of 4-d FR and FFQ were assessed with Spearman's rho, since some of the macronutrients showed clear deviations from normally distributed residuals to a linear model (assessed through the Shapiro–Wilk test, Kolmogorov–Smirnoff test and QQplot).

Descriptive statistics for energy, nutrients and food groups intake are presented as means, medians and interquartile ranges. To evaluate the agreement between the FFQ and 4-d FR, the mean difference and percentage difference were calculated as the mean of all individual differences between the FFQ and 4-d FR ([Mean (FFQ – 4-d FR)]/[mean (4-d FR)].

For the examination of relative validity, the Spearman's correlations were corrected for the day-to-day variation within-person using the de-attenuation method [19]. The corrected correlation, r_c, was calculated using the following formula:

$$r_c = r_o\sqrt{[+(S^2{}_w/S^2{}_b)]/n},$$

where r_o is the observed correlation, $S^2{}_w/S^2{}_b$ is the ratio of the within- and between-person variances and n is the number of replicates per person for the given variable. Within-person variation and between person variation were calculated from replicated 4-d FR.

For visualization, Bland–Altman diagrams and Box–Whisker plot were drawn. The Wilcoxon rank-sum test was used to examine reporting behaviour between participants groups. The statistical analysis was calculated using R version 3.0.1, SAS version 9.4 (2012–2012 SAS Institute Inc., Cary NC, USA) and Microsoft® Excel 2007. P values less than 0.05 were considered significant, all tests were performed two sided.

Results

The characteristics of the 56 study participants are given in Table 1. The mean age was 40 years, ranging from 22 to 85 years and 60.7% were women. The mean height was 172.5 cm and the mean weight 72.3 kg. The mean body mass index was 24.2, ranging from 19.8 to 32.0.

The energy and macronutrient intake as reported in the FFQ was compared to that of the 4-d FR. Table 2 shows the means, medians and interquartile ranges for both instruments. Their mean and percentage differences are also given, as well as the correlations (Spearman's rho) between the two methods, including the variance ratio and the de-attenuated (corrected) correlation coefficients. The final analysis included 54 subjects. The mean differences between FFQ and 4-d FR for carbohydrates, fibre and protein intake were positive, and negative for energy and fat intake. The correlations of intake derived from FFQ versus 4-d FR ranged between 0.27 (for carbohydrates) and 0.55 (for protein). Except for carbohydrates, all correlations were statistically significant.

The ratio of within- and between-person variance calculated from the 4-d FR was between 0.64 and 1.79, and the de-attenuated (corrected) correlation coefficients were similar or slightly higher than the crude correlations (Table 2).

To examine the agreement in energy intake between the 4-d FR and FFQ, a Bland-Altman plot is presented in Figure 1. On average, the energy intake in the FFQ was slightly lower (50.2 kcal) than reported in the 4-d FR. A slight tendency for larger (absolute) differences between the instruments with increasing energy intake was observed for both men and women. Reporting behaviour between men and women did not differ ($P = 0.90$, Wilcoxon rank sum test), even though male participants reported higher energy intakes with both instruments ($P < 0.0001$, Wilcoxon rank sum test).

Table 3 shows the comparison of the food group intake as reported in the FFQ and 4-d FR, overall and stratified by gender, sorted by the magnitude of Spearman's rho.

The corrected Spearman correlation coefficients ranged from 0.92 (alcohol) to 0.09 (soup). All correlations were significant except those for dessert, cheese, preparation fats and savoury spreads, composite foods, sauces, legumes and soups. Those food groups with a lower or non-significant correlation tended to include less frequently consumed foods, e.g. legumes and sauces. The correlations of 18 (72%) out of a total of 25 food groups were significant.

The mean difference between FFQ and 4-d FR varied among intakes, and there were almost as many foods that were underestimated (n = 12) as overestimated (n = 13) when compared with the reference method (Table 3). In general, frequently consumed foods such as bread, meat, fruits, vegetables, dairy products, cheese and sweet spreads were overestimated in the FFQ in comparison to the intakes assessed by the 4-d FR. No gender differences were observed for these food groups except for dairy products and dessert, which showed an underestimation in the FFQ for women compared to men (−0.6 g v. 20.4 g, −4.5 g v. 17.2 g). Vegetable and fruit intake were

Table 1. Characteristics of participants of the validation study by gender.

Characteristic*	Male	Female	Total
n (%)	22 (39.3)	34 (60.7)	56
Age, *years*	40.9 ± 19.7	39.9 ± 18.1	40.0 ± 18.6
Weight, *kg*	81.0 ± 9.7	69.6 ± 19.0	72.3 ± 9.1
Height, *cm*	181.4 ± 4.7	166.7 ± 5.6	172.5 ± 5.2
Body mass index, *kg/m²*	24.6 ± 2.8	25.1 ± 7.1	24.2 ± 3.0
PAL†	1.8 ± 0.2	1.7 ± 0.2	1.8 ± 0.2
Smoking, ever, *n (%)*	7 (31.8)	6 (17.6)	13 (23.2)
Highest level of education completed, *n (%)*			
Compulsory education	0 (0.0)	1 (2.9)	1 (1.8)
Secondary school	3 (13.6)	11 (32.4)	14 (25.0)
Tertiary degree	19 (86.4)	22 (64.7)	41 (73.2)
Place of residence, *n (%)*			
Urban	20 (90.9)	25 (73.5)	45 (80.4)
Rural	2 (9.1)	9 (26.5)	11 (19.6)

PAL, Physical Activity Level.
*Values are expressed as mean ± standard deviation or n (%)
†Expressed as a multiple of 24-hour basal metabolic rate [28]

Table 2. Relative validity of daily energy and macronutrient intakes estimated by the FFQ and 4-d FR, and correlations between FFQ and 4-d FR (n = 54) .

Macronutrient	FFQ intake			4-d FR intake			Mean difference (FFQ − 4-d FR)		Correlation between methods		
	Mean	Median	IQR†	Mean	Median	IQR†	Mean	%‡	Spearman's r	Variance ratio§	Corrected Spearman's r
Energy (kcal/d)	1858.7	1821.5	1432.0–2262.4	1908.8	1778.7	1543.6–2058.5	−50.2	−2.6	0.32*	0.97	0.36
Carbohydrates (g/d)	250.2	240.1	184.1–302.8	183.6	184.1	150.6–201.2	66.6	36.3	0.24	1.20	0.27
Fibre (g/d)	26.2	23.9	19.5–30.6	21.1	18.4	15.0–23.4	5.1	24.3	0.41**	0.64	0.44
Protein (g/d)	89.8	94.3	68.8–110.9	73.1	71.6	59.4–91.0	16.8	23.0	0.46***	1.79	0.55
Fat (g/d)	67.3	66.6	48.7–78.6	77.3	72.6	58.0–96.3	−10.0	−12.9	0.37**	1.26	0.42

*P < 0.05, **P < 0.01, ***P < 0.001
†IQR = Interquartile range = 25th percentile to 75th percentile
‡[(Mean (FFQ − 4-d FR)]/[mean (4-d FR)]} x 100
§Variance within subjects/Variance between subjects
Spearman correlation coefficient was adjusted using the de-attenuation method [19]

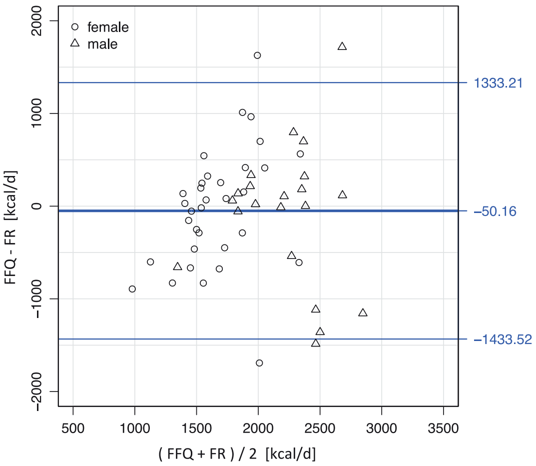

Figure 1. Bland–Altman plot of the energy intake as computed from 4-day weighed food record (4-d FR) and food frequency questionnaire (FFQ) reports.
(Calculated for the whole sample, but different symbols label values for male and female participants.)

particularly overestimated by the FFQ by 138.1 g (82.8%) and 102.4 g (56.3%), respectively.

Food intakes that were underestimated in the FFQ comprised beverages (water, tea and coffee, soft drinks with and without sugar, alcoholic beverages), soup, sauce, preparation fats and savoury spreads, salty snacks, meat alternatives, eggs and cereals and grains. The lowest degree of underestimation was observed for water, tea and coffee with −200.4 ml (−14.0%).

Regarding gender, differences were found only for meat alternatives and soft drinks without sugar. Women, on average underestimated their intake of soft drinks without sugar (−28.2 g v. 5.8 g in men), while men on average underestimated their consumption of meat alternatives in the FFQ (−3.2 g v. 1.1 g in women).

In addition, the relative deviations of FFQ and 4-d FR are shown for each food group (Figure 2). In order to obtain comparability among the food groups, differences between FFQ and 4-d FR were divided by the mean reported intake value of the corresponding food group in the 4-d FR. The ordering of the food groups on the x-axis is according to decreasing magnitudes of Spearman's rho (see Table 3).

Discussion

This study focused on assessing relative validity of a paper form FFQ with a 4-d FR. The validity was

Table 3. Relative validity of food groups intake (g/d) estimated by the FFQ and 4-d FR (overall and by gender), and correlations between FFQ and 4-d FR (n = 54). The ordering is according to decreasing overall Spearman's rho.

	FFQ intake			4-d FR intake			Mean difference (FFQ − 4-d FR)		Correlation between methods		
Food Groups	Mean	Median	IQR†	Mean	Median	IQR†	Mean	%‡	Spearman's r	Variance ratio§	Corrected Spearman's r
Alcoholic Beverages	111.6	48.2	14.3–161.4	127.9	0.0	0–250	−16.3	−12.7	0.71***	2.70	0.92
Men	206.1	150.7	65.7–260.0	227.9	125.0	0–387.5	−21.8	−9.6	0.68**	3.43	0.93
Women	51.5	35.7	7.1–64.3	64.2	0.0	0–100	−12.8	−19.9	0.65***	2.17	0.81
Meat	96.4	84.4	42.9–152.1	73.1	57.4	34.0–111.8	23.4	32.0	0.68***	–	–
Men	107.3	87.9	59.3–154.3	96.4	100.5	57.5–133.3	10.9	11.3	0.49*	–	–
Women	89.6	69.7	32.1–122.1	58.3	37.8	21.3–77.5	31.3	53.7	0.69***	–	–
Water, tea and coffee	1228.9	1075.0	725–1600	1429.3	1285.1	900.0–1794.8	−200.4	−14.0	0.66***	0.29	0.68
Men	1043.9	857.1	616.07–1325	1305.9	1182.0	838.3–1522.0	−262.0	−20.1	0.84***	0.39	0.88
Women	1346.7	1250.0	771.43–1650	1507.8	1320.3	915.0–2177.5	−161.2	−10.7	0.55**	0.25	0.57
Soft drinks with sugar	94.7	42.9	21.4–107.1	153.0	22.8	0–225.0	−58.3	−38.1	0.66***	1.80	0.79
Men	122.3	50.0	21.4–142.9	179.8	100.0	0–360.8	−57.5	−32.0	0.73***	1.96	0.89
Women	77.2	42.9	14.3–85.7	136.0	0.0	0–198.3	−58.8	−43.3	0.59***	1.66	0.70
Fruits	284.1	191.3	114.3–371.6	181.7	123.8	55.0–273.5	102.4	56.3	0.59***	0.66	0.64
Men	265.5	180.0	110.7–297.9	201.5	119.3	59.5–273.5	64.0	31.8	0.57**	0.40	0.60
Women	295.8	201.8	117.1–379.3	169.1	162.0	55.0–231.3	126.8	75.0	0.58***	1.15	0.66
Sausage	35.2	25.9	12.5–44.7	31.6	32.5	5.8–41.3	3.6	11.4	0.59***	1.00	0.66
Men	49.9	38.6	25.7–65.4	40.8	38.5	24.5–51.8	9.1	22.3	0.50*	1.19	0.57
Women	25.9	17.1	9.6–34.6	25.8	26.3	4.5–37.8	0.1	0.4	0.44*	2.62	0.57
Sweet spreads	21.1	12.5	4.5–30.4	13.0	7.9	0–24.0	8.1	62.6	0.49***	–	–
Men	23.8	21.4	5.4–31.3	15.9	14.5	0–25.8	7.9	50.0	0.33	1.87	0.40
Women	19.4	12.5	4.5–26.8	11.1	5.5	0–14.0	8.2	74.1	0.58***	–	–
Soft drinks without sugar	23.0	0.0	0.0	38.0	0.0	0.0	−15.0	−39.5	0.48***	0.27	0.50
Men	5.8	0.0	0.0	0.0	0.0	0.0	5.8	–	–	–	–
Women	34.0	0.0	0.0	62.2	0.0	0.0	−28.2	−45.4	0.55**	0.28	0.57
Cereals and grains	42.9	30.3	21.4–55.7	83.3	51.5	0–150.0	−40.4	−48.5	0.42**	1.69	0.50
Men	54.4	51.4	26.8–77.2	72.0	37.5	0–110.0	−17.6	−24.4	0.56**	1.40	0.65
Women	35.6	28.9	20.4–48.2	90.5	55.0	0–150.0	−54.9	−60.6	0.40*	2.35	0.50
Egg	21.6	15.5	11.8–35.4	24.2	15.0	0–35.0	−2.5	−10.5	0.41**	2.37	0.52
Men	26.1	23.6	11.8–35.4	40.3	32.3	0–54.8	−14.2	−35.3	0.56**	2.39	0.71
Women	18.8	11.8	5.9–23.6	13.9	13.0	0–18.8	4.9	35.1	0.26	6.67	0.42
Bread	145.5	137.5	92.9–182.1	134.9	133.4	96.3–173.8	10.6	7.9	0.40**	1.70	0.48
Men	162.3	140.0	100.0–214.3	160.6	163.0	132.5–192.0	1.7	1.1	0.14	1.22	0.16
Women	134.9	125.9	80.4–158.2	118.6	103.3	91.0–146.5	16.3	13.7	0.55**	2.68	0.71
Meat alternatives	2.2	0.0	0.0	2.8	0.0	0.0	−0.6	−21.4	0.40**	2.35	0.50
Men	2.9	0.0	0.0	6.1	0.0	0.0	−3.2	−53.0	0.35	2.02	0.43
Women	1.8	0.0	0.0	0.8	0.0	0.0	1.1	140.0	0.47**	–	–
Dairy products	152.0	124.4	67.9–177.7	144.4	117.0	50.0–199.5	7.6	5.2	0.40**	0.32	0.42
Men	187.4	150.0	67.9–225.9	167.0	150.0	93.8–233.8	20.4	12.2	0.42	1.08	0.47
Women	129.4	108.9	74.3–157.1	130.0	96.8	28.0–187.5	−0.6	−0.4	0.32	0.20	0.33
Nuts	4.3	1.3	0–6.4	2.5	0.0	0.0	1.8	73.0	0.37**	5.98	0.58
Men	4.6	2.1	1.1–6.4	2.0	0.0	0.0	2.7	136.5	0.18	0.72	0.20
Women	4.1	1.1	0–6.4	2.8	0.0	0.0	1.3	45.1	0.46**	–	–
Salty snacks	1.8	0.0	0–2.1	3.7	0.0	0.0	−1.9	−50.5	0.32*	7.12	0.53
Men	2.7	1.1	0–3.2	3.5	0.0	0.0	−0.8	−23.5	0.45*	2.52	0.57
Women	1.3	0.0	0–1.6	3.8	0.0	0.0	−2.5	−66.4	0.28	–	–

(*Continued*)

Table 3. (Continued).

Food Groups	FFQ intake			4-d FR intake			Mean difference (FFQ − 4-d FR)		Correlation between methods		
	Mean	Median	IQR†	Mean	Median	IQR†	Mean	%‡	Spearman's r	Variance ratio§	Corrected Spearman's r
Fish	24.4	20.4	8.2–34.3	14.5	0.0	0–20.0	9.9	68.1	0.31*	–	–
Men	30.8	23.6	12.9–37.5	11.3	0.0	0–9.0	19.4	171.2	0.37	–	–
Women	20.3	19.3	6.4–27.9	16.5	13.5	0–22.5	3.8	23.0	0.34	–	–
Potato	63.6	51.7	28.9–90.0	92.4	69.8	0–135.0	−28.8	−31.2	0.31*	5.36	0.47
Men	82.7	78.2	48.2–106.1	116.7	132.0	0–182.0	−34.0	−29.1	0.32	4.40	0.46
Women	51.4	43.4	24.7–67.5	77.0	61.5	19.5–121.3	−25.5	−33.2	0.31	7.68	0.53
Vegetables	305.0	271.6	170.9–426.4	166.9	137.3	48.3–243.3	138.1	82.8	0.29*	1.84	0.35
Men	333.8	267.9	188.6–492.9	190.8	164.5	48.3–294.0	143.0	75.0	0.30	1.40	0.35
Women	286.6	275.3	170.9–378.2	151.7	136.3	62.3–200.0	135.0	89.0	0.25	2.56	0.32
Dessert	60.2	48.5	28.3–78.1	56.2	50.0	16.8–81.0	4.0	7.1	0.25	2.66	0.32
Men	71.1	48.1	37.5–84.8	53.9	44.0	18.8–76.0	17.2	32.0	−0.04	2.11	−0.05
Women	53.2	52.4	21.3–72.8	57.7	56.4	16.8–92.3	−4.5	−7.8	0.43*	3.20	0.58
Cheese	57.7	44.2	33.0–61.1	38.1	28.5	16.5–54.0	19.7	51.6	0.25	3.85	0.35
Men	62.7	38.2	34.3–54.1	45.5	35.2	21.5–67.5	17.2	37.9	0.33	5.16	0.50
Women	54.6	49.3	33.0–66.4	33.4	23.5	16.5–47.3	21.2	63.5	0.21	3.38	0.29
Preparation fats and savoury spreads	15.9	10.9	5.9–23.6	24.4	19.9	7.3–34.3	−8.5	−34.7	0.23	0.62	0.25
Men	18.8	12.9	7.5–25.0	27.9	26.0	10.3–36.5	−9.1	−32.5	0.17	0.56	0.18
Women	14.1	8.9	5.9–18.9	22.2	13.3	6.0–27.5	−8.1	−36.5	0.22	0.65	0.24
Composite foods	45.7	21.4	2.9–57.9	29.8	0.0	0.0	15.9	53.5	0.22	5.23	0.33
Men	69.0	45.4	5.7–122.2	42.7	0.0	0–85.0	26.3	61.6	0.39	11.54	0.77
Women	30.9	15.5	2.9–40.0	21.6	0.0	0.0	9.3	43.2	0.05	3.08	0.07
Sauce	12.2	9.3	4.9–15.4	36.4	26.9	0–55.8	−24.2	−66.4	0.15	9.49	0.28
Men	10.3	9.4	5.7–12.9	40.8	32.5	0–72.5	−30.5	−74.7	0.17	7.15	0.28
Women	13.4	9.1	4.9–20.0	33.6	23.8	0–50.0	−20.1	−60.0	0.17	10.90	0.33
Legumes	4.8	2.1	0–6.4	2.0	0.0	0.0	2.8	139.6	0.13	1.84	0.16
Men	5.3	3.2	0–6.4	3.0	0.0	0.0	2.3	78.0	0.13	1.40	0.15
Women	4.5	2.1	0–4.3	1.4	0.0	0.0	3.1	223.1	0.16	2.56	0.20
Soup	18.1	8.9	0–21.4	29.8	0.0	0.0	−11.6	−39.1	0.06	4.41	0.09
Men	12.8	7.1	0–21.4	16.0	0.0	0.0	−3.2	−20.2	0.01	4.38	0.01
Women	21.5	10.7	3.6–21.4	38.5	0.0	0.0	−17.0	−44.1	0.06	4.25	0.09

*P < 0.05, **P < 0.01, ***P < 0.001
†IQR = Interquartile range = 25th percentile to 75th percentile
‡{[Mean (FFQ − 4-d FR)]/[mean (4-d FR)]} x 100
§Variance within subjects/Variance between subjects. The ratio is not given when the variance between subjects is zero.
The Spearman correlation coefficient was adjusted using the de-attenuation method [19]

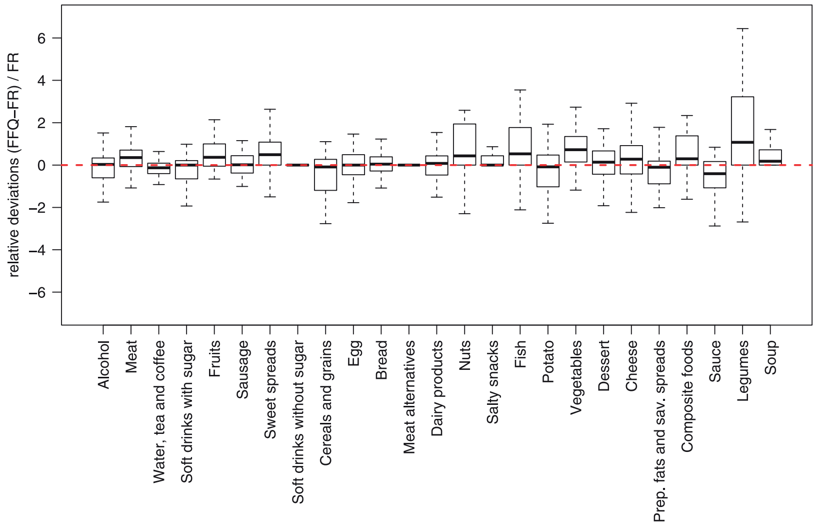

Figure 2. Participants' relative differences in the food frequency questionnaire (FFQ) and the 4-day weighed food record (4-d FR) for each food group. The dashed line gives the zero difference between the medians of the two instruments. The unsystematic reporting difference between the two instruments is shown as the spread of the distributions indicated by the width of the boxes and the range of the whiskers.

assessed both, at the macronutrient and food group levels. From the 60 eligible participants, 58 completed the 4-d FR and FFQ according to the experimental design, but 56 subjects were considered for the analysis.

The relative validity of the FFQ, compared to the 4-d FR, varied among intakes of energy, macronutrients and food groups (Tables 2 and 3). The FFQ overestimated as well as underestimated the absolute intake of various nutrients and foods, which was comparable to other validation studies [29,30]. We observed that in general, frequently consumed foods tended to be overestimated in the FFQ compared to the 4-d FR, in particular vegetables and fruit intake, as reported in other FFQ validation studies [13,31]. Food items consumed daily (e.g. bread, dairy products) are better estimated by the FFQ as described in other studies [32,33]. These food groups may represent in general more frequently consumed foods for this study population, as they reflect common dietary habits. In contrast, food groups such as soup, sauce, preparation fats and savoury spreads and meat alternatives were underestimated in the FFQ when compared with the 4-d FR. These items may include rather rarely consumed foods, on the other hand, they may include food groups that are difficult to estimate portion size and rather tended to be ignored (e.g. sauce and preparation fats and savoury spreads). Furthermore, it should be considered that information on some of the food items was collected in a predefined manner in the FFQ compared to the open-end tool of the 4-d FR, where food items were weighed right at the time of consumption. For example, preparation fats and savoury spreads may have not been reported in the FFQ.

The application of correlation coefficients to assess relative validity in FFQ validation studies is still under debate, but there is a common agreement that correlations above 0.5 are moderate or good, and that correlations below 0.4 indicate a low degree of linear correlation [18,34]. Therefore, nine out of 25 food group intakes can be considered to have an acceptable validity for assessing intakes on a group level (all statistically significant, Table 3).

The correlation coefficients for energy and macronutrient intakes showed in general similar or lower values than those observed in other studies [9,13,29,31]. Protein and fibre intakes exhibited good correlations with values of 0.55 and 0.44. The lowest degree of linear association was found for carbohydrates ($r = 0.27$), which was also considerable at the food group level for legumes ($r = 0.16$), vegetables ($r = 0.35$) and desserts ($r = 0.32$). This finding may be related to the fact that some of the foods contributing to carbohydrate intake are consumed less frequently than weekly or only by a limited number of persons. Similarly, only five persons reported the consumption of legumes in the 4-d FR. Several persons reported legumes intake only once a month in the FFQ. The FFQ retrospectively assesses the diet covering the previous 4 weeks and the 4-d FR prospectively covers the actual dietary intake of 4 consecutive days.

Results obtained through the Bland–Altman method for energy intake showed slightly lower intakes on average for the FFQ than reported in the 4-d FR (50.2 kcal), with a slight tendency for larger (absolute) differences between the instruments with increasing energy intakes. This result could be partly explained by a higher tendency of underreporting in the FFQ for calorie-dense foods compared with the 4-d FR. Similar findings were reported in another study [33].

The results of this study point to relevant differences in reporting food intake between men and women. Compared to men, women reported a significantly higher intake of meat, fruits, sweet spreads and cheese in the FFQ compared with the 4-d FR. In response to social desirability, it is well known that women may be more likely to over-report food items related to a positive health image, e.g. fruits and vegetables, whereas sweets and cakes are usually associated with a rather negative health image and thus tend to be underreported [35]. In addition, the FFQ used for this study included a list of several fruits (n = 15) that also could lead to an over-reporting of fruit intake, as discussed elsewhere [36]. This poses a challenge to participants in estimating the overall fruit consumption [36]. Similar findings were observed for meat (n = 8) and cheese (n = 7) in this study. Additionally, the order of requested food items in the FFQ (e.g. meat is asked at the first position) could explain the significant differences between the two instruments.

For cereals and grains, women reported a significantly lower intake in the FFQ than in the 4-d FR, compared to men. Irrespective of the gender difference, reporting the portion sizes of these food items in the FFQ (e.g. noodles, rice, corn) could have been a challenge due to difficulties in the volume estimation by means of the food pictures.

There are some limitations in our study. First, the study participants from Jena, Germany may not be representative of the target Swiss population, for which the FFQ was designed. Therefore, this fact has to be kept in mind when citing this validation.

As previously discussed, the applied assessment tools contain several limitations. Despite the fact that the weighed food record (FR) is often denoted as the gold standard, it might cause a bias that has to be considered. On the one hand it is an invasive instrument that can induce changes in dietary habits, on the other hand it may not capture longer-term dietary patterns well. The FFQ in contrast, even though aiming at capturing food intake over longer time periods, faces the challenge of recall and difficulties in estimating portion size [19].

Due to the short sequence of data collection between the 4-d FR and FFQ, the awareness of an individual's food habits could potentially affect the way the FFQ is filled in and therefore might also result in inflated correlations. A solution to this problem could be to let half of the group fill out the FFQ first and the other half to fill out the 4-d FR first.

Both instruments are time consuming for participants. While the FFQ is only filled in once and takes about 30–45 minutes, the time investment related to the FR is higher. It is an open-end tool performed several times per day for a fixed period of time and thereby puts a higher burden on daily life for weighing and recording food intake. In order to minimize the respondents' burden, the use of emerging technologies, e.g. internet – based assessment tools presents a promising approach to tackle this challenge [37].

As already mentioned, an additional limitation of the FFQ could be the large number of listed food items within the food groups (from 1 for legumes to 22 for vegetables). This leads to a high variety of level of detail in the different food groups. Food groups including more items may lead to a cumulative effect and a tendency for over-reporting regarding that specific food group (e.g. fruits). Conversely, food groups containing only one item (e.g. egg) may lead to an under-reporting effect due to the aggregation of foods (e.g. scrambled egg, fried egg, etc.) to the main group. This presents a challenge in the estimation of food intake.

In addition, the seasonality aspect must be taken into account. Due to the assessment period in the winter season, only a selected number of season-specific foods were reported in the 4-d FR, whereas the FFQ consists of a fixed food list and the study participants have to estimate their intake under consideration of the respective season. Another limitation of the study was the small sample size, which represents one of the most limiting factors of the current study. A sample size of a minimum of 50 subjects but preferably 100 or more is recommended for validation studies [18]. Sample size post-calculations indicated that with a minimum sample size of 50, the power to detect significant correlations of 0.35, 0.40 and 0.45 would respectively be 0.74, 0.85 and 0.94 (two-tailed and alpha = 0.05).

Further, we did not use biomarkers or other objective reference measures to assess validity, which presents a major limitation of this study. The FFQ assessed dietary intake over a period of four weeks and inclusion of concentration biomarkers in plasma or in adipose tissue would have added valuable information about its validity [38–40]. Nonetheless, there is a lack of biomarkers to reflect wider aspects of dietary intake, and the use of biomarkers for validation of dietary assessment methods is costly.

In conclusion, the 127-food itemed self-administered FFQ showed moderate relative validity for protein and various foods such as fruits, egg, meat, sausage, nuts, salty snacks, beverages such as water, tea and coffee, soft drinks with sugar and alcoholic beverages, thus showing comparable results with other FFQ validation studies and acceptable validity for the other macronutrients and frequently consumed food groups. Therefore, it can be considered as an appropriate tool to assess and characterize usual dietary intake of adults in epidemiological studies. But in these studies, the observed gender differences in under- and over-reporting of specific food items and groups may need to be considered in interpreting observed gender differences in the association between nutrition and health.

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NS and CB designed the research, NS and KZ conducted the research, LG and PK performed the statistical analysis and NS, KZ and PK wrote the paper. NPH and CB provided guidance in drafting the manuscript. All authors read and approved the final manuscript. We thank the volunteers for participating in the study.

Disclosure statement

No potential conflict of interest was reported by the authors.

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ORCID

Leticia Grize http://orcid.org/0000-0001-5096-5693

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4.2 Paper II: Associations between dietary patterns and post-bronchodilation lung function in the SAPALDIA cohort

Steinemann N, Grize L, Pons M, Rothe T, Stolz D , Turk A, Schindler C, Brombach C, Probst-Hensch N: Associations between dietary patterns and post-bronchodilation lung function in the SAPALDIA cohort. Respiration 2018;4:1–10. doi: 10.1159/000488148.

4.2.1 Abstract

Background: Chronic obstructive pulmonary disease (COPD) is not restricted to smokers. Dietary habits may contribute to the disease occurrence. Epidemiological studies point to a protective effect of fruit and vegetable intake against COPD. *Objective*: To investigate the associations between dietary patterns and parameters of lung function related to COPD in the Swiss Cohort Study on Air Pollution and Lung and Heart Diseases in Adults (SAPALDIA). *Methods*: Data were included from the second follow-up assessment of the SAPALDIA cohort in 2010–2011 using a food frequency questionnaire. Principal component factor analysis was used to derive dietary patterns, whose association with FEV1, FEV1/FVC, FEF2575 and COPD was investigated by applying multivariate regression analyses. *Results*: After adjustment for potential confounders, the “prudent dietary pattern” characterised by the predominant food groups vegetables, fruits, water, tea and coffee, fish and nuts was positively associated with FEV1 (increase of 40 ml per SD, $P<0.001$). Also for factor 3 (“high-carbohydrate diet”) we found a significant positive association with FEV1 (with an increase per SD of 36 ml, $P=0.006$). *Conclusions*: The main results are consistent with a protective effect of a diet rich in fruits, vegetables, fish and nuts against age-related chronic respiratory disease. If confirmed in prospective cohorts, our results may guide nutritional counselling towards respiratory health promotion.

4.2.2 Publication

Personal contribution from the doctoral candidate to the manuscript

The doctoral candidate designed and conducted the study. She also organized, coordinated and conducted the data management procedures and performed the statistical analysis. She derived conclusions from the statistical analyses, wrote the research article, and coordinated its publication in the *Respiration* Journal. The manuscript was published in May 2018.

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Associations between Dietary Patterns and Post-Bronchodilation Lung Function in the SAPALDIA Cohort

Nina Steinemann[a, b] Leticia Grize[c, d] Marco Pons[e] Thomas Rothe[f] Daiana Stolz[g] Alexander Turk[h] Christian Schindler[c, d] Christine Brombach[a] Nicole Probst-Hensch[c, d]

[a]Institute of Food and Beverage Innovation, Zurich University of Applied Sciences, Life Sciences and Facility Management, Wädenswil, Switzerland; [b]Epidemiology, Biostatistics and Prevention Institute, University of Zurich, Zurich, Switzerland; [c]Swiss Tropical and Public Health Institute, Basel, Switzerland; [d]University of Basel, Basel, Switzerland; [e]Division of Pulmonary Medicine, Regional Hospital of Lugano, Lugano, Switzerland; [f]Zürcher Höhenklinik Davos, Davos Clavadel, Switzerland; [g]Clinic of Pulmonary Medicine and Respiratory Cell Research, University Hospital Basel, Basel, Switzerland; [h]See-Spital Horgen, Horgen, Switzerland

Keywords
Dietary pattern · Factor analysis · Lung function · Food frequency questionnaire · Epidemiological studies

Abstract
Background: Chronic obstructive pulmonary disease (COPD) is not restricted to smokers. Dietary habits may contribute to the disease occurrence. Epidemiological studies point to a protective effect of fruit and vegetable intake against COPD. ***Objective:*** To investigate the associations between dietary patterns and parameters of lung function related to COPD in the Swiss Cohort Study on Air Pollution and Lung and Heart Diseases in Adults (SAPALDIA). ***Methods:*** Data were included from the second follow-up assessment of the SAPALDIA cohort in 2010–2011 using a food frequency questionnaire. Principal component factor analysis was used to derive dietary patterns, whose association with FEV1, FEV1/FVC, FEF2575, and COPD was investigated by applying multivariate regression analyses. ***Results:*** After adjustment for potential confounders, the "prudent dietary pattern" characterised by the predominant food groups vegetables, fruits, water, tea and coffee, fish, and nuts was positively associated with FEV1 (increase of 40 mL per SD, $p < 0.001$). Also for factor 3 ("high-carbohydrate diet"), we found a significant positive association with FEV1 (with an increase per SD of 36 mL, $p = 0.006$). ***Conclusions:*** The main results are consistent with a protective effect of a diet rich in fruits, vegetables, fish, and nuts against age-related chronic respiratory disease. If confirmed in prospective cohorts, our results may guide nutritional counselling towards respiratory health promotion.

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Introduction

Worldwide, the prevalence of chronic obstructive pulmonary disease (COPD) is dramatically increasing. COPD will account for the third leading cause of death by 2020, thus representing a major public health issue [1–3].

Members of the SAPALDIA Team are listed in the Appendix.

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E-Mail karger@karger.com
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Prof. Dr. N. Probst-Hensch
Swiss Tropical and Public Health Institute
Socinstrasse 57, PO Box
CH–4002 Basel (Switzerland)
E-Mail nicole.probst@unibas.ch

Cigarette smoking has been established as the predominant risk factor for COPD, but not all smokers develop COPD. Furthermore, COPD also affects many never smokers. While environmental tobacco smoking, occupational inhalants and air pollutants originating from biomass burning and traffic exhaust are established COPD risk factors [4], dietary habits may also contribute importantly to disease aetiology. Epidemiological research points to a benefit of a diet rich in antioxidants and omega-3 fatty acids for protecting from loss of lung function and from COPD symptoms [5–12]. Protective effects of fruit and vegetable intake have been shown in several cohort studies [13–19]. In their review, Boeing et al. [20] also reported a preventive effect of COPD with increasing vegetable and fruit intake. In addition, in a case-control study from Japan, a significantly lower risk of COPD was observed with increasing total vegetable intake [21].

The independent effects of individual foods on health are difficult to establish because diets are eaten in specific combinations and contexts, i.e. strong correlations can exist between nutrients, foods, and also other lifestyle aspects. In order to get a broader picture of dietary behaviour, the authors suggested to assess dietary patterns rather than focus on nutrients [15, 22–24]. Apart from hypothesis-driven approaches, the application of "data-driven approaches," i.e. exploratory approaches based on statistical dimension-reduction methods have been widely used to derive dietary patterns. In this case, dietary patterns are derived directly from the data and do not consider researchers assumptions. Principal component analysis and factor analysis are the most frequently applied dimension-reduction techniques in nutritional epidemiology [25–28].

The aim of this study was to derive dietary patterns for Swiss adults and to assess their association with lung function and COPD in the Swiss Cohort Study on Air Pollution and Lung and Heart Diseases in Adults (SAPALDIA). To focus on irreversible airway obstruction characterising COPD, we used data from post-bronchodilation measurements of lung function being used in the GOLD definition of COPD (i.e., requiring the ratio FEV1/FVC to be lower than 0.7 after bronchodilation).

Material and Methods

Study Population

The data used for the present analysis derive from the second follow-up assessment of the SAPALDIA study, the largest epidemiological cohort in Switzerland that integrates physiological assessments and bio samples. SAPALDIA was initiated in 1991 with a baseline survey (SAPALDIA 1) to investigate the relationship between air pollution and lung diseases in adults recruited as random samples from inhabitant registries (18–60 years, n = 9,651). The multi-centre cohort study includes 8 distinct urban and rural areas representing the demographic and environmental diversity of Switzerland (Aarau, Basel, Davos, Geneva, Lugano, Montana, Payerne, Wald). A first follow-up assessment of participants (SAPALDIA 2) was conducted in 2002. The methods and participation of SAPALDIA 1 and 2 have been described elsewhere [29, 30]. In SAPALDIA 3, which was conducted in 2010–2011, detailed information about dietary intake and physical activity (PA) was obtained in a random subset of participants.

Study approval was given by the central Ethics Committee of the Swiss Academy of Medical Sciences and the Cantonal Ethics Committees for each of the study areas. Written informed consent was obtained from all participants prior to the execution of any of the health examinations.

For the current analysis, 2,178 SAPALDIA 3 participants with complete data on lung function, smoking history, PA, and dietary intake were considered.

Assessment of Dietary Intake and Identification of Dietary Patterns

Dietary intake was collected using a paper form food frequency questionnaire (FFQ) designed to assess average food intake over the previous 4 weeks (www.ernaehrungserhebung.ch). The validated, 127-item, semi-quantitative paper form FFQ was handed out to SAPALDIA 3 participants after the conduct of a spirometry during an in-persons health examination. The FFQs were self-administered (detailed written instructions on how to handle the questionnaire were handed out to participants) [31].

Subjects were asked to indicate their consumption of each of the 127 food items during the past 4 weeks in terms of average frequency, portion size, and number of portions. The frequency was asked in 9 categories from "never" to "daily," and the number of portions could be specified. The amounts of food were in gram or decilitre/centilitre, and as a measurement aid for estimating portion size, 3 pictures of each food item were shown. The FFQ additionally obtained information on preparation and cooking methods (using specific types of oil, butter and/or margarine), consumption of take-out foods, and the frequency of use of dietary supplements.

To prepare for dietary pattern analysis, the 127 food items listed in the FFQ were grouped into 25 predefined food groups on the basis of similarity of type of food and nutrient composition. The classification corresponded to a similar grouping already used in the National Nutritional Survey II in the Federal Republic of Germany [32, 33]. To identify food factors, principal component factor analysis was performed on the predefined food groups. Food group consumption (originally given in g/day) was expressed as a function of body weight (g food/kg body weight per day). To achieve better interpretability, the factors were transformed using Varimax rotation. Subsequently, the number of factors retained was based on the eigenvalues and interpretability. There were 6 factors with eigenvalues >1; however, the 3 strongest factors were retained because of their clear interpretability. Their structure is summarised below in Table 1. The "predominant" food groups in factor 1 were vegetables, fruits, water, tea and coffee, fish, and nuts, in contrast to factor 2 where the dominant groups were meat, sausage, egg, fish, and alcohol. Factor 3 was characterised by sweet spreads, bread, dessert, and potatoes.

Table 1. Factor loadings estimated by factor analysis after extraction of three factors on 25 food groups

Food group	Factor loading		
	factor 1	factor 2	factor 3
Dairy products	0.0219	0.0977	0.1955
Cheese	0.1242	0.2350	0.2797
Meat	0.1005	0.7112	0.0245
Sausage	–0.2611	0.4973	0.2180
Fish	0.425	0.4269	–0.1444
Egg	0.0565	0.4595	–0.0194
Meat alternatives	0.1395	–0.1942	0.0402
Bread	0.0592	0.0769	0.6326
Cereals and grains	0.3725	0.1711	0.3331
Potato	0.1284	0.3286	0.4222
Legumes	0.1828	0.0899	–0.0564
Vegetables	0.7106	0.1761	0.0558
Fruits	0.6302	–0.1226	0.0892
Soup	0.3517	0.1188	0.0301
Sauce	0.2997	0.3631	0.2147
Dessert	0.2932	0.0525	0.4329
Nuts	0.3967	–0.1637	0.0966
Salty snacks	–0.0166	0.1788	0.0938
Composite foods	–0.1257	0.1157	0.3341
Water, tea and coffee	0.5271	–0.1110	0.1635
Soft drinks with sugar	–0.1151	0.0726	–0.0628
Soft drinks without sugar	–0.0215	0.0228	–0.1633
Alcohol	–0.2423	0.4183	–0.0780
Preparation fats and savoury spreads	0.2259	0.2196	0.3484
Sweet spreads	0.0545	–0.1028	0.6661

Factors were interpreted based on variables with a factor loading of 0.40 or more. Factor 1: vegetables, fruits, water, tea and coffee, fish, nuts → "prudent pattern." Factor 2: meat, sausage, egg, fish, alcohol → "traditional Western diet." Factor 3: sweet spreads, bread, dessert, potato → "high-carbohydrate diet."

Factor 1 seemed to represent vegetable foods and fish consumption, while factor 2 seemed to represent consumption of animal foods and alcohol. The characteristic features of factor 3 were foods rich in carbohydrates.

Assessment of Lung Function and Other Variables

In SAPALDIA 3, lung function was measured using the portable, ultrasonic EasyOne spirometer (ndd Medizintechnik AG, Zürich, Switzerland), which is widely used in epidemiological studies. In order to ensure strict quality control, field workers were trained to a standardised protocol, and the accuracy of the device was recorded and verified daily by using a 3-L syringe. Recalibrated lung function parameters were used for this analysis as previously described [34].

Spirometry was done before and after inhalation of a bronchodilator. For the present analysis, we considered lung function parameters that were assessed after the inhalation of salbutamol, focusing on the lung function parameters FEV1 (forced expiratory volume in 1 s), the ratio between FEV1 and FVC (forced vital capacity), and FEF25–75% (mean of the flow between the 25th and the 75th percentile of exhaled volume). In addition, we defined COPD as FEV1/FVC <0.7.

Other covariates considered for the present analysis were anthropometric data such as height and weight. Both were measured in the study centres, the latter by using calibrated scales (SECA 877, SECA GmbH & Co, Hamburg, Germany). In addition, several parameters were gathered in a computer-assisted interview based on a standardised questionnaire and led by trained field workers: sociodemographic variables such as educational level (low, medium, high), civil status (married, divorced, widowed, single) and employment status (employed, home, training/military/long vacation/unemployed, pension); detailed information on smoking status (never, former, current) and total amount of pack-years smoked, and the number of cigarettes per day, on exposure to environmental tobacco smoke in the last 12 months (yes/no), and on parental smoking in childhood (yes/no). Based on 4 short questions from the Swiss Health Survey questionnaire in 2012 [35] which concerned the frequency and duration of weekly PA, 2 PA variables were derived: one for the weekly number of minutes of moderate PA and the other one for the weekly time of vigorous PA.

Statistical Analyses

Data Pre-Processing

Prior to data entry, the FFQ paper forms were checked for completeness and possible errors. After scanning the FFQ paper forms, each questionnaire was checked for completeness, missing values, and structurally impossible answers (e.g., 2 boxes checked where only one was selectable). The following data management procedures were applied. If indications of frequency, portion size and number of portions were completely missing, the frequency information "never" was assigned to the respective food item. If at least one of frequency, portion size or number of portions was indicated, the following strategy was applied. Missing values of frequency or number of portions were imputed by the respective mean value for the given food item. Missing values of portion sizes were imputed by pre-set standard portion sizes.

In order to avoid bias from clearly wrongly reported food habits in the FFQ, the distribution of the total energy intake computed from the FFQ reports was considered. Upper and lower cut-offs for exceedingly high and low energy intakes, respectively, were defined at the 75th percentile plus 1.5 times the interquartile range (3,868.3 kcal) and the 25th percentile minus 1.5 times the interquartile range (242.3 kcal) [36]. Out of a total of 2,991 FFQs, 118 FFQs (3.9%) were excluded due to implausible energy intakes.

Statistical Methods

In the descriptive analyses, quantitative variables were described by their mean and standard deviation, and categorical variables by their frequency distribution. Principal component factor analysis was performed to identify dietary patterns.

In order to analyse the relationships between dietary patterns and lung function outcomes, multiple mixed linear and logistic regression models with random intercepts by study area were applied. All models contained the variables sex, age, and age squared as well as interactions between sex and the 2 age variables, and

Table 2. Characteristics of study participants in SAPALDIA 3 with food frequency questionnaire (*n* = 2,178)

Variable	All	Men	Women
Participants, *n* (%)	2,178 (100.0)	1,011 (46.4)	1,167 (53.6)
Age, years	58.6 (10.6)	58.5 (10.7)	58.7 (10.6)
Height, cm	168.8 (9.1)	175.6 (6.5)	162.8 (6.4)
Weight, kg	74.3 (15.0)	82.9 (12.3)	66.8 (13.0)
Body mass index[a]			
Underweight	28 (1.3)	2 (0.2)	26 (2.2)
Normal weight	963 (44.2)	334 (33.0)	629 (53.9)
Overweight	825 (37.9)	496 (49.1)	329 (28.2)
Obesity class I	289 (13.3)	152 (15.0)	137 (11.7)
Obesity class II	51 (2.3)	19 (1.9)	32 (2.7)
Obesity class III	22 (1.0)	8 (0.8)	14 (1.2)
Study area, *n* (%)			
Basel	310 (14.2)	147 (14.5)	163 (14.0)
Wald	391 (18.0)	188 (18.6)	203 (17.4)
Davos	238 (10.9)	113 (11.2)	125 (10.7)
Lugano	182 (8.4)	76 (7.5)	106 (9.1)
Montana	263 (12.1)	119 (11.8)	144 (12.3)
Payerne	274 (12.6)	126 (12.5)	148 (12.7)
Aarau	338 (15.5)	156 (15.4)	182 (15.6)
Geneva	182 (8.4)	86 (8.5)	96 (8.2)
Education, *n* (%)			
Low	130 (6.0)	32 (3.2)	98 (8.4)
Medium	1,452 (66.7)	622 (61.5)	830 (71.2)
High	596 (27.4)	357 (35.3)	239 (20.5)
Employment status, *n* (%)			
Employed	1,287 (59.1)	647 (64.0)	640 (54.8)
Home	138 (6.3)	11 (1.1)	127 (10.9)
Training, military, long vacation, not work	28 (1.3)	16 (1.6)	12 (1.0)
Pension	725 (33.3)	337 (33.3)	388 (33.3)
Civil status, *n* (%)			
Married	1,517 (69.7)	787 (77.8)	730 (62.6)
Divorced	268 (12.3)	98 (9.7)	170 (14.6)
Widowed	127 (5.8)	17 (1.7)	110 (9.4)
Single	266 (12.1)	109 (10.8)	157 (13.5)
Smoking status, *n* (%)			
Never	1,085 (49.8)	448 (44.3)	637 (54.6)
Former	749 (34.4)	398 (39.4)	351 (30.1)
Current	344 (15.8)	165 (16.3)	179 (15.3)
Pack years	11.7 (18.6)	14.6 (20.8)	9.1 (15.9)
Cigarettes per day	2.0 (5.9)	2.2 (6.6)	1.8 (5.2)
ETS/12 m[b], *n* (%)			
No	1,925 (88.4)	890 (88.0)	1,035 (88.7)
Yes	253 (11.6)	121 (12.0)	132 (11.3)
Parental smoking, *n* (%)			
No	993 (45.6)	447 (44.2)	546 (46.8)
Yes	1,185 (54.4)	564 (55.8)	621 (53.2)
Lung function (post-bronchodilatation)			
FEV1	3.1 (0.8)	3.6 (0.8)	2.7 (0.6)
FEV1/FVC	0.8 (0.1)	0.8 (0.1)	0.8 (0.1)
FEF2575	2.7 (1.2)	3.1 (1.3)	2.4 (1.0)
COPD[c], *n* (%)			
No	1,812 (83.2)	820 (81.1)	992 (85.0)
Yes	366 (16.8)	191 (18.9)	175 (15.0)

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Table 2 (continued)

Variable	All	Men	Women
Dietary intake			
Energy, kcal	2,038.8 (630.8)	2,172.3 (637.9)	1,923.1 (601.3)
Protein, g/day	97.6 (34.5)	106.1 (35.6)	90.2 (31.7)
Carbohydrates, g/day	268.2 (102.4)	281.7 (106.2)	256.5 (97.5)
Fat, g/day	76.2 (29.4)	81.6 (31.1)	71.5 (27.0)
Fibres, g/day	29.0 (12.3)	27.9 (11.4)	29.8 (12.9)
Physical activity			
Moderate physical activity, min/week	276.9 (303.9)	286.1 (314.5)	268.8 (294.4)
Vigorous physical activity, min/week	70.4 (91.9)	84.3 (101.5)	58.4 (80.8)

Data are presented as mean (SD) or as stated. [a] Underweight ≤18.5, normal weight = 18.5–24.9, overweight = 25.0–29.9, obesity class I = 30.0–34.9, obesity class II = 35.0–39.9, obesity class III ≥40.0. [b] Exposure to environmental tobacco smoke in the last 12 months. [c] Defined as FEV1/FVC <0.7.

those for quantitative lung function variables also included height and an interaction between sex and height. The basic model (referred to as model 1) included these basic variables and the 3 dietary factors along with a priori selected potential confounder variables (smoking status, pack-years smoked, daily number of cigarettes smoked, exposure to passive smoking in the last 12 months, parental smoking in childhood, educational level, civil status, employment status, and PA, as described in the previous section). Model 2 (referred to as "main model") was further adjusted for total energy intake, and model 3 additionally included body mass index (BMI). BMI was not included in the basic model because it may be both a confounder and an intermediate endpoint of dietary habits.

Results are expressed as mean change in the outcome per unit increment in the respective factor. As factors are z-standardised, one unit is equivalent to one standard deviation.

We conducted several sensitivity analyses. As the effects of smoking on lung function might not have been fully captured in our final model, we repeated all analyses in lifetime non-smokers. Moreover, to assess potential confounding by seasonal variations in diet and in lung function, we ran models, which additionally included the month of interview as categorical variable. Given previous findings suggesting a protective effect of omega-3 fatty acids [7] and fibre [37] on the risk of COPD, we added the 4 separate consumption variables for fatty and lean fish, and for whole grain and refined bread as additional covariates to the models to see whether associations with the 3 dietary patterns were robust to adjustment for these specific dietary items.

To address potential participation bias, additional analyses using inverse probability weighting were conducted [38]. For this purpose, the probability of being included in the present analysis was modelled using predictor variables assessed in the entire SAPALDIA 3 sample.

All statistical analyses were performed using the statistical software STATA (Release 13.1 Statistical Software; StataCorp, College Station, TX, USA).

Results

Study Population

The characteristics of the study population included in this analysis and answering an FFQ with complete data on all covariates in SAPALDIA 3 (n = 2,178) are given in Table 2. Age ranged from 37.3 to 80.8 years, with a mean of 58.6 years; 53.6% were women. Considering anthropometric data of the participants, the mean height was 168.8 cm and mean weight was 74.3 kg. Their BMI ranged from 15.9 to 54.9, with a mean of 26.0. 82.1% had a BMI between 18.5 and 30 (Table 2). Two-thirds had a medium and 27.4% a high educational level. The majority of the subjects were employed at this period (59.1%) and one-third was retired. 69.7% of the study participants were married, followed by 12.1% singles, 12.3% divorced, and 5.8% widowed persons. Concerning smoking status, half of the participants were never smokers (49.8%), one-third were former smokers and 15.8% were current smokers at the time of the assessment. Males were more likely to have smoked than females (39.4 vs. 30.1%), and to smoke more heavily (14.6 vs. 9.1 mean pack years). 88.4% of the study group did not show an exposure to passive smoking in the last 12 months, but more than half of the participants (54.4%) affirmed parental smoking in childhood. In terms of lung function parameters, the study population showed a mean FEV1 of 3.1 L, a mean FEV1/FVC of 0.8 and a mean FEF2575 of 2.7 L/s. Males had higher levels in FEV1 and FEF2575 than females (3.6 vs. 2.7 and 3.1 vs. 2.4). 16.8% of the study participants had COPD according to the FEV1/FVC <0.7 cut-off. The prevalence of COPD was higher

Table 3. Independent associations between dietary patterns and FEV1, FEV1/FVC, and FEF2575, adjusted for different covariates (n = 2,178)

	Factor 1			Factor 2			Factor 3		
	Coeff	95% CI	p value	Coeff	95% CI	p value	Coeff	95% CI	p value
FEV1, mL									
Model 1[a]	28.84	8.66 to 49.02	0.005	−10.06	−29.06 to 8.94	0.30	16.48	−2.83 to 35.79	0.09
Model 2[b]	39.65	17.36 to 61.94	<0.001	3.56	−18.89 to 26.02	0.76	35.71	10.04 to 61.38	0.006
Model 3[c]	22.52	−2.53 to 47.58	0.08	−11.17	−35.52 to 13.18	0.37	12.23	−18.93 to 43.38	0.44
FEV1/FVC, %									
Model 1	0.08	−0.22 to 0.39	0.60	−0.09	−0.38 to 0.20	0.56	−0.28	−0.57 to 0.01	0.06
Model 2	0.03	−0.31 to 0.37	0.87	−0.15	−0.49 to 0.19	0.38	−0.38	−0.76 to 0.01	0.06
Model 3	0.26	−0.12 to 0.63	0.19	0.03	−0.34 to 0.40	0.86	−0.02	−0.49 to 0.45	0.94
FEF2575, mL/s									
Model 1	28.60	−12.77 to 69.97	0.18	−7.13	−46.25 to 31.99	0.72	−19.61	−59.35 to 20.13	0.33
Model 2	30.22	−15.48 to 75.93	0.20	−5.10	−51.18 to 40.99	0.83	−16.73	−69.37 to 35.90	0.53
Model 3	39.73	−11.70 to 91.17	0.13	2.44	−47.64 to 52.52	0.92	1.63	−62.54 to 65.81	0.96

All three factors were included in the same model. The coefficients give the mean change in the outcome per unit increment in the respective factor. As factors are z-standardised, one unit is equivalent to one standard deviation. [a] Mixed linear regression models with random intercepts by study areas and adjusting for sex and interactions of sex with age, age^2 and height, for smoking status (never, former, current), pack-years smoked, daily number of cigarettes smoked, exposure to passive smoking in the last 12 months, parental smoking in childhood, educational level, civil status, employment status, and physical activity. [b] Further adjustment for total energy intake. [c] Model 2 with additional adjustment for body mass index as a categorical variable with 6 levels.

in males (18.9% vs. 15.0% in females). The mean energy and macronutrient intake was higher in males, except for fibres (29.8 g in females vs. 27.9 g in males). Male participants also tended to show a higher mean PA level than female participants (e.g., for moderate PA: 286.1 vs. 268.8 min/week).

The distributions of educational level, civil status, occupational categories, smoking categories, age, and BMI were comparable between participants included in the present analysis and SAPALDIA 3 participants not included due to incomplete data (e.g., because they were not randomly selected for answering the FFQ or did not have lung function testing (n = 2,574) (see online suppl. Table S1; for all online suppl. material, see www.karger.com/doi/10.1159/000488148). Women were over-represented in our analysis sample, and there was some heterogeneity in inclusion rates across study areas.

Dietary Patterns and Lung Function Measurements

Table 3 provides a summary of models 1–3 for the associations of lung function outcomes FEV1, FEV1/FVC, and FEF2575 with the 3 dietary factors combined. Factor 1 was positively associated with FEV1 in the models 1 and 2 (with increases per SD ranging between 29 and 40 mL, all p < 0.006). After further adjustment for BMI, the association decreased to 23 mL and was no longer significant (p = 0.08).

Associations of FEV1/FVC with factor 1 were slightly positive but clearly non-significant. Regarding the relationship with the lung function parameter FEF2575, we found consistent positive associations with factor 1 (with estimated increases in FEF2575 between 29 and 40 mL/s per SD), but none of these associations was statistically significant. In contrast to FEV1, additional adjustment for BMI even increased the association of factor 1 with FEF2575 (to 40 mL/s per SD).

Factor 3 also showed a significant positive association with FEV1 in model 2 (with an increase per SD of 36 mL, p = 0.006), whereas the associations were considerably smaller in model 1 (17 mL per SD, p = 0.09) and in model 3 (12 mL per SD, p = 0.44).

When analysing the independent relationship of factor 3 with FEV1/FVC, there was a borderline significant negative association in models 1 and 2 (−0.3 and −0.4% per SD, respectively).

Unlike in the case of FEV1, associations with factor 3 were negative across models 1 and 2 of FEF2575, without however reaching statistical significance. We found no association of factor 2 with any of the 3 lung function parameters.

Table 4. Independent associations between dietary patterns and COPD adjusted for different covariates (n = 2,178)

	COPD Gold		
	odds ratio	95% CI	p value
Factor 1			
Model 1[a]	0.98	0.86–1.13	0.82
Model 2[b]	0.97	0.84–1.13	0.70
Model 3[c]	0.90	0.77–1.06	0.21
Factor 2			
Model 1	1.03	0.91–1.17	0.61
Model 2	1.02	0.88–1.18	0.83
Model 3	0.95	0.81–1.11	0.52
Factor 3			
Model 1	1.05	0.93–1.20	0.44
Model 2	1.03	0.87–1.21	0.76
Model 3	0.90	0.74–1.10	0.31

COPD defined as FEV1/FVC <0.7. All three factors were included in the same model. [a] Mixed logistic regression models with random intercepts by study areas and adjusting for sex and interactions of sex with age, age^2, for smoking status (never, former, current), pack-years smoked, daily number of cigarettes smoked, exposure to passive smoking in the last 12 months, parental smoking in childhood, educational level, civil status, employment status, and physical activity. [b] Further adjustment for total energy intake. [c] Model 2 with additional adjustment for body mass index as a categorical variable with 6 levels.

In the subsample of never smokers, the effect estimates reported above tended to be larger (see online suppl. Table S2) and the estimated effect of factor 1 on FEV1 in model 3 was almost twice as high as in the entire sample and reached statistical significance (p = 0.02).

Significant effect estimates did not show major changes when inverse probability weighting was applied (cf. see online suppl. Table S3). Most estimates of the effects of the 3 dietary factors were comparable between men and women (cf. see online suppl. Table S4).

Dietary Patterns and COPD

Table 4 presents the results of the multiple mixed logistic regression models estimating the independent associations of the 3 dietary factors with COPD. Associations with factor 1 were consistently negative, which is in line with the corresponding coefficients for FEV1. However, none of these associations was statistically significant.

Associations between COPD and factors 2 and 3 were positive in models 1 and 2 and negative in model 3, but highly non-significant throughout.

Discussion

In the present study, we assessed the relation between dietary patterns and lung function outcomes. Three prominent food factors (dietary patterns) were derived by principal component factor analysis. Factor 1 reflected a "prudent pattern," described by the predominant food groups vegetables, fruits, water, tea and coffee, fish, and nuts. Factor 2 could reflect a rather contrasting pattern, i.e. a traditional Western pattern characterised by a high intake of meat, sausage, egg, fish, and alcohol and thus likely representing a rather "unhealthy" diet. Factor 3 was characterised by a "high-carbohydrate diet," i.e. a high intake of sweet spreads, bread, dessert, and potatoes.

Our major finding was the positive association of the "prudent pattern" (vegetables, fruits, water, tea and coffee, fish, and nuts) with FEV1. Associations with FEV1/FVC, FEF2575, and COPD were not statistically significant, but consistent with the FEV1 results.

In the case of FEV1, the statistical significance was lost, and the coefficient decreased after further adjustment for BMI. To what extent BMI is a confounder and/or a mediator of the associations between dietary habits and lung function could only be determined in a longitudinal study.

The findings are in line with other studies analysing the relationship of dietary patterns and dietary intake with lung function or COPD. Similar to our analysis, Shaheen et al. [13] showed in their cross-sectional cohort study a positive association between a prudent dietary pattern and FEV1. Our "prudent" pattern was very similar to theirs and differed only in terms of its wholemeal cereals content. Another recently published study found a lower risk of COPD with a higher intake according to a healthy diet [16]. In that prospective cohort study, associations between the risk of COPD and dietary patterns were analysed. A high Alternate Healthy Eating Index 2010 (AHEI-2010) diet score was reflecting a rather healthy diet, described by high intakes of whole grains, polyunsaturated fatty acids, nuts and long-chain omega-3 fats. In contrast to our "prudent pattern," this pattern consisted of other food groups that are rich in dietary fibres, polyunsaturated fatty acids and long-chain omega-3 fats. Moreover, a cross-sectional study by Watson et al. [39] showed a specific protective effect of fruit and vegetable consumption on COPD. Other data of a prospective study of diet and decline in lung function in a general population also suggested a beneficial effect of a prudent pattern on the FEV1 level [40]. Finally, our findings add to the general evidence of a protective effect of antioxi-

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dant intake in COPD, evidenced in part by previously reported negative associations of vitamin C with the prevalence of COPD. Cross-sectional studies have consistently shown that subjects with a high level of vitamin C intake have larger FEV1 than their counterparts [41, 42]. Oxidative stress and associated inflammation in the respiratory tract of COPD patients is well established [5].

A novel finding of our study was the positive association of factor 3 ("high-carbohydrate diet") with FEV1, which disappeared though upon BMI adjustment. Given the opposite direction of the association with FEV1 and FEF2575, in the absence of previous evidence and in the light of the inconsistency of associations with other respiratory health indicators, this finding needs to be interpreted with caution, however.

Our results were consistent in men and women, but they tended to be stronger in never smokers. This may indicate the presence of some residual confounding from imperfect control of smoking effects or a stronger effect of nutritional factors in persons who had never smoked.

The strengths of this analysis include a large sample size ($n = 2{,}178$) with rich information on lifestyle and environmental factors. Lung function data were obtained in the context of stringent spirometry protocols with well-trained field workers. Studying dietary patterns rather than single food items or nutrients has the advantage of addressing the influence of food habits in their lifestyle context. Knowledge of the effects of dietary patterns can be beneficial in designing preventive measures directed to stimulate alteration of dietary habits in specific subgroups of the population.

However, we need to address some potential limitations of these analyses. First, the dietary pattern analysis was based on a food group categorization of the 127-item FFQ into 25 food groups, which was done a priori and further evaluated with experts (see methods under assessment of dietary intake and identification of dietary patterns). Food attribution and categorization are influenced by cultural agreements and therefore differ, e.g. between European countries. Thus, despite being in accordance with cultural practice, food group categorization may be arbitrary to some extent, and this can pose limitations. Furthermore, the quality of the FFQ data is challenged by imperfect recall and difficulties in estimating portion size [43]. Despite the use of a validated FFQ, the study participants may have had difficulty recalling frequency and food portion size accurately. An additional challenge in the estimation of food intake could derive from the high level of detail in the food groups and the seasonality aspect, which could result in a tendency for over-reporting or under-reporting of specific food groups. Yet, additional adjustment for seasonality aspects did not materially alter the reported associations.

Regarding social desirability, it is well known that women may be more likely to over-report food items related to a positive health image, e.g. fruits and vegetables, whereas sweets and cakes are usually associated with a rather negative health image and thus tend to be underreported [44]. Moreover, for this analysis, dietary intake was measured only at one point in time, which introduces some random misclassification. However, this will affect intake of specific nutrients more than general dietary patterns. Also, it is well known that diet does track throughout a lifetime [45]. Despite these limitations, nutrition epidemiology presents an important research area because diet is a modifiable risk factor.

We also recognise that our study population could represent a group of people who differ from the general population in terms of health awareness, socioeconomic status and smoking behaviour. We therefore reran our models using inverse probability weighting. As all main findings could be confirmed, we think that these are unlikely affected by major selection bias.

The most important limitation is the cross-sectional study design as a result of the availability of detailed dietary information from the last SAPALDIA follow-up only, which limits our ability to infer a causal relationship between dietary intake and lung function and to differentiate between the 2 possible roles of BMI as a confounder and a mediator of this relationship.

In conclusion, our results are in line with a protective effect of a "prudent dietary pattern" against chronic respiratory disease. Apart from potential prevention benefits for cardiovascular diseases, diabetes, and cancer, a higher fruit and vegetables intake might also play a protective role in the pathogenesis of COPD through anti-inflammatory effects. For COPD prevention, smoking cessation is still the most relevant public health message. But our results point to diet as a modifiable potential risk factor of lung function decrease. Recommendations for high fruit and vegetable intake and low meat and alcohol intake may become an important pillar of respiratory disease prevention.

Appendix

Current SAPALDIA Team

Study directorate: N.M. Probst-Hensch (PI; e/g); T. Rochat (p), C. Schindler (s), N. Künzli (e/exp), J.M. Gaspoz (c).

Scientific team: J.C. Barthélémy (c), W. Berger (g), R. Bettschart (p), A. Bircher (a), C. Brombach (n), P.O. Bridevaux (p), L. Burdet

(p), D. Felber Dietrich (e), M. Frey (p), U. Frey (pd), M.W. Gerbase (p), D. Gold (e), E. de Groot (c), W. Karrer (p), F. Kronenberg (g), B. Martin (pa), A. Mehta (e), D. Miedinger (o), M. Pons (p), F. Roche (c), T. Rothe (p), P. Schmid-Grendelmeyer (a), D. Stolz (p), A. Schmidt-Trucksäss (pa), J. Schwartz (e), A. Turk (p), A. von Eckardstein (cc), E. Zemp Stutz (e). Scientific team at coordinating centers: M. Adam (e), I. Aguilera (exp), S. Brunner (s), D. Carballo (c), S.T. Caviezel (pa), I. Curjuric (e), A. Di Pascale (s), J. Dratva (e), R. Ducret (s), E. Dupuis Lozeron (s), M. Eeftens (exp), I. Eze (e), E. Fischer (g), M. Foraster (e), M. Germond (s), L. Grize (s), S. Hansen (e), A. Hensel (s), M. Imboden (g), A. Ineichen (exp), A. Jeong (g), D. Keidel (s), A. Kumar (g), N. Maire (s), A. Mehta (e), R. Meier (exp), E. Schaffner (s), T. Schikowski (e), M. Tsai (exp). a, allergology; c, cardiology; cc, clinical chemistry; e, epidemiology; exp, exposure; g, genetic and molecular biology; m, meteorology; n, nutrition; o, occupational health; p, pneumology; pa, physical activity; pd, paediatrics; s, statistics.

Local fieldworkers: Aarau: S. Brun, G. Giger, M. Sperisen, M. Stahel; Basel: C. Bürli, C. Dahler, N. Oertli, I. Harreh, F. Karrer, G. Novicic, N. Wyttenbacher; Davos: A. Saner, P. Senn, R. Winzeler; Geneva: F. Bonfils, B. Blicharz, C. Landolt, J. Rochat; Lugano: S. Boccia, E. Gehrig, M.T. Mandia, G. Solari, B. Viscardi; Montana: A.P. Bieri, C. Darioly, M. Maire; Payerne: F. Ding, P. Danieli A. Vonnez; Wald: D. Bodmer, E. Hochstrasser, R. Kunz, C. Meier, J. Rakic, U. Schafroth, A. Walder. Administrative staff: N. Bauer Ott, C. Gabriel, R. Gutknecht.

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All authors declare that they have no conflict of interest.

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Author Contributions

N.S., C.B., and N.P.H. designed the research, N.S., L.G., and N.P.H. conducted the research, N.S., L.G., and C.S. performed the statistical analysis and N.S., L.G., C.S. and N.P.H. wrote the paper. C.B., M.P., T.R., A.T., and D.S. provided guidance in drafting the manuscript. All authors read and approved the final manuscript.

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5 Discussion and Conclusions

5.1 The FFQ Validation study

The following chapter discusses the main results of the FFQ Validation study and places it in an overall context of the research questions of the thesis and emphasizes its relevance from a general public health perspective. It draws conclusions and highlights its main challenges and limitations.

The FFQ Validation study aimed at assessing the relative validity of a paper form FFQ with a 4-day FR. The validity was assessed both, at the energy and macronutrient and food group levels. Finally, data from 56 out of a total of 60 recruited participants were considered for the analysis.

One of the major findings was that the relative validity varied among intakes of energy, macronutrients and food groups. An overestimation as well as an underestimation of the FFQ compared to the 4-d FR was found, which is in line with other studies [87, 88]. Even more, the results showed that in general frequently consumed foods tended to be overestimated in the FFQ compared to the 4-d FR, in particular vegetables and fruit intake, as reported in other FFQ validation studies [50,89]. Furthermore, daily-consumed food items (e.g. bread, dairy products) were better estimated by the FFQ, which was also described in other studies [90, 91]. These food groups may represent in general more frequently consumed foods for this study population, as they reflect common dietary habits. On the contrary, rather rarely consumed foods such as soup, sauce, preparation fats and savoury spreads and meat alternatives tended to be underestimated in the FFQ when compared with the 4-d FR. In addition, these food items may include food groups that are difficult to estimate portion size and rather tended to be ignored (e.g. sauce and preparation fats and savoury spreads). Another explanation for this observation could be that information on some of the food items was collected in a predefined manner in the FFQ compared to the open-end tool of the 4-d FR, where food items were weighed right at the time of consumption. For example, preparation fats and savoury spreads may have not been reported in the FFQ, since there was only one specific question regarding this point at the end of the questionnaire.

When focusing on the correlation coefficients, our study showed that nine out of 25 food group intakes could be considered to have an acceptable validity for assessing intakes on a group level (showing correlations above 0.5, all statistically significant). The correlation coefficients for energy and macronutrient intakes showed in general similar or lower values than those observed in other studies [44, 50, 87, 89]. Protein and fibre intakes demonstrated good correlations with values of 0.55 and 0.44. The lowest degree of linear association was found for carbohydrates ($r = 0.27$), which was also considerable at the food group level for legumes ($r = 0.16$), vegetables ($r = 0.35$) and desserts ($r = 0.32$). This result could be explained due to the fact that some of the food items that contribute to carbohydrate intake were consumed less frequently than weekly or only by a limited number of persons. In agreement with this, the consumption of legumes was only reported by five persons in the 4-d FR, and several persons reported legumes intake only once a month in the FFQ.

When assessing the agreement between the two dietary assessment methods, slightly lower energy intakes on average were shown for the FFQ in comparison to the 4-d FR (50.2 kcal, Bland-Altman method). A slight tendency for larger (absolute) differences between the instruments with increasing energy intakes was also found. This result could be partly explained by a higher tendency to under-report in the FFQ for calorie-dense foods compared with the 4-d FR. Similar findings were reported in another study [91].

With regard to gender differences, the following results were found. In comparison with men, women reported a significantly higher intake of meat, fruits, sweet spreads and cheese in the FFQ compared with the 4-d FR. In response to social desirability, it is well known that women may be more likely to over-report food items related to a positive health image, e.g. fruits and vegetables, whereas sweets and cakes are usually associated with a rather negative health image and thus tend to be underreported [92]. In addition to this explanation, the high number of food items listed in the FFQ food group section " fruits" (n = 15) could also lead to an over-reporting of fruit intake. This represents a challenge for participants to estimate the overall fruit consumption, as discussed elsewhere [93]. Similar findings were observed for meat (n = 8) and cheese (n = 7) in this study. Additionally, the order of requested food items in the FFQ (e.g. meat is asked at the first position) could explain the significant differences between the two instruments.

Limitations

A main limitation of the validation study derives from the respective limitations of the applied dietary assessment tools. Despite the fact that the weighed food record (FR) is often denoted as the gold standard, it might cause a bias that has to be considered. Although it is an invasive instrument that can induce changes in dietary habits, it does not estimate longer-term dietary patterns well. The FFQ in contrast, even though aiming at measuring food intake over longer time periods, faces the challenge of recall and difficulties in estimating portion size [49]. Also the large number of listed food items within the food groups could be an additional limitation of the FFQ (e.g. from 1 for legumes to 22 for vegetables), leading to a high variety of level of detail in the different food groups. Food groups including more items may lead to a cumulative effect and a tendency for over-reporting regarding that specific food group (e.g. fruits). Conversely, food groups containing only one item (e.g. egg) may lead to an under- reporting effect due to the aggregation of foods (e.g. scrambled egg, fried egg, etc.) to the main group. This presents a challenge in the estimation of food intake.

Both instruments are time-consuming for participants. While the FFQ is only filled in once and takes about 30–45 minutes, the time investment related to the FR is higher. It is an open-end tool performed several times per day for a fixed period of time and thereby places a higher burden on daily life for weighing and recording food intake. In order to minimize the respondents' burden, the use of emerging technologies, e.g. Internet-based assessment tools presents a promising approach to tackle this challenge [94].

In addition, the short sequence of data collection between the two instruments could result in inflated correlations, because the awareness of an individual's food habits could potentially affect the reporting behavior, i.e. the reporting behavior in the dietary record could have an impact on how the FFQ is filled in.

Moreover, the seasonality aspect must be taken into account. Only a selected number of season-specific foods were reported in the 4-d FR (due to the winter season). In contrast, the FFQ consists of a fixed food list and the subjects have to estimate their intake under consideration of the respective season.

As several validation studies have to struggle with a sufficient sample size, this study was also limited to a rather small sample size (n = 56). A sample size of a minimum of 50 subjects but preferably 100 or more is recommended for validation studies [63]. Sample size post-calculations indicated that with a minimum sample size of 50, the power to detect significant correlations of 0.35, 0.40 and 0.45 would respectively be 0.74, 0.85 and 0.94 (two-tailed and alpha = 0.05).

In conclusion, the 127-food item self-administered FFQ showed good relative validity for protein and various food groups such as fruits, egg, meat, sausage, nuts, salty snacks and beverages such as water, tea and coffee. The findings are comparable with other FFQ validation studies. Therefore, the applied FFQ can be ranked as an appropriate tool to assess and characterize dietary intake and food habits of adults in epidemiological studies. However, in these studies gender differences in under- and over-reporting of specific foods should be taken into consideration when interpreting observed gender differences in associations between nutrition and health.

In general, it is essential to consider the study design, the research questions and the corresponding study population prior to planning an epidemiological study with the focus on dietary intake. Depending on these determinants, there are several tools and study designs that can be useful. To strive for good feasibility and acceptability of the performed study, emerging technologies such as computer-assisted technologies provide a broad range of feasible dietary assessment tools. To strive for the best possible assessment tool, it is also indispensable to perform a pretest with participants from the targeted study population. Good data quality only results from a profound knowledge and understanding of the study participants. Moreover, there is a rising interest for a "citizen-science approach" in medical research and public health area lately. In comparison to "classical study designs" in which study participants had merely a passive role and were contributing only in a passive way to the study, e.g. by answering predefined questions, the citizen science approach involves study participants actively at an early stage of the study and includes their knowledge and experiences in the planning and execution of a study. In this area, digital tools are notably promising to achieve higher sample sizes and reliable data due to a better feasibility and acceptability by the study participants. Therefore, it is important to consider these new trends when planning an epidemiological study with the focus on dietary intake.

5.2 The COPD study

The following chapter discusses the major results of the "main" study focusing on dietary patterns and the prevalence of COPD. It brings together the main findings in view of the overall context and emphasizes its relevance from a general public health perspective. It draws conclusions and highlights its main challenges and limitations.

In the present study, associations between dietary patterns and lung function parameters in the SAPALDIA cohort were examined. Three prominent food factors were identified by principal component factor analysis. Factor 1 reflected a rather "healthy diet", i.e. a "prudent pattern", characterized by the main food groups vegetables, fruits, water, tea and coffee, fish and nuts. In contrast, factor 2 was described by a high intake of meat, sausage, egg, fish and alcohol, representing a rather "unhealthy diet", i.e. a traditional "Western pattern". In addition, a third factor was identified, which was characterized by a "high-carbohydrate diet", i.e. a high intake of sweet spreads, bread, dessert and potatoes.

The main finding was the positive association of the "prudent pattern" (vegetables, fruits, water, tea and coffee, fish and nuts) with the lung function parameter FEV1. Associations with FEV1/FVC, FEF2575 and COPD were not statistically significant, but consistent with the FEV1 results. These results are in line with other recently published studies analyzing the relationship between dietary patterns and lung function outcomes or COPD [24, 27, 95, 96]. Thus, our results also add to the general evidence of a protective effect of antioxidant intake in COPD, evidenced in part by previously reported negative associations of vitamin C with the prevalence of COPD. Several cross-sectional studies have also consistently shown a positive effect of vitamin C intake with FEV1 levels [13, 97]. Oxidative stress and associated inflammation in the respiratory tract of COPD patients is well established [15].

An important novel finding of the present study was the positive association of factor 3 ("high-carbohydrate diet") with FEV1, which disappeared after BMI adjustment. However, this finding reveals some inconsistency due to the opposite findings for similar lung function parameters (FEV1 and FEF2575). Therefore, this result needs to be interpreted with caution and must be confirmed in future studies.

With respect to gender, no obvious differences were found. However, the results tended to be stronger in never smokers, thus potentially indicating a stronger effect of nutritional factors in persons who had never smoked, or maybe suggesting the presence of some residual confounding from imperfect control of smoking effects.

Limitations

Potential limitations that need to be addressed include the following aspects: First, the present study used the FFQ as a dietary assessment tool and therefore includes all methods-specific challenges and limitations that derived from the FFQ (see chapter 5.1. paragraph "Limitations", p. 47). Second, the dietary pattern analysis was based on a food group categorization, which was done a priori and further evaluated with experts (see chapter 3.1.4 "Data post-processing", p. 18). Food attribution and categorization strongly depend on cultural agreements and therefore differ, for example, between European countries. Hence, despite being in consensus with cultural practice, food group categorization may be arbitrary to some extent, and this can pose limitations.

In addition, food intake was measured only at one time point for this analysis, and this can result in some random misclassification. However, this will affect intake of specific nutrients more than general dietary patterns. Also, it is well known that diet does track throughout a lifetime [98].

Moreover, the potential of a major selection bias was considered as a main limitation. As it is often shown in epidemiologic studies, the study participants could represent a group of people who differ from the general population in terms of health awareness, socioeconomic status and life style behavior (e.g. smoking). A further sensitivity analysis using inverse probability weighting was performed to check for this assumption, and as all main findings could be confirmed the potential of a present selection bias was rated to be low.

An additional central limitation was the cross-sectional study design, as there was only detailed information on dietary intake in the last SAPALDIA follow-up available. This fact limits the ability to infer a causal relationship between dietary intake and lung function and to also further differentiate between the possible roles of BMI as a confounder or even a mediator of this relationship.

Despite these limitations, the field of nutritional epidemiology presents an important research area because diet is a modifiable risk factor. The investigation of dietary patterns rather than single food items or nutrients has the advantage of addressing the influence of food habits in their lifestyle context; it therefore better captures the complex nature of diet. To gain insights about the effects of dietary patterns can be valuable in designing preventive measures directed to promote changes in dietary habits in specific subgroups of the population.

For COPD prevention, smoking cessation still presents the most relevant public health message. However, the results of the present study suggest diet as a modifiable potential risk factor of lung function decrease. In addition to the nutritional guidelines for other NCDs (e.g. cardiovascular diseases, diabetes, cancer), recommendations for high fruit and vegetable intake and low meat and alcohol intake may become an important pillar of respiratory disease prevention.

For Switzerland, data on nutritional epidemiology are scarce. For many years and decades, there were no direct data of dietary intake at a national level. Their underlying calculations and estimations were based on indirect dietary assessments, such as the 6th Swiss nutrition report [99] (consumption data, no dietary intake data at population level). Very recently, the first national nutrition survey for Switzerland, called menuCH was conducted (in 2014–2017). Data from around 2'000 adults living in Switzerland was obtained. Currently, there is only one published article about dietary intake data derived from menuCH [100]. Thus, the Swiss Nutrition Strategy 2017–2024 was still developed on the basis of the 6th Swiss nutrition report [101].

With this background, the present analysis focusing on the relationship between dietary patterns and chronic obstructive pulmonary disease is novel for Switzerland. The current analysis gives a first exclusive insight into the relevant public health issue focusing on COPD and nutrition in Switzerland. Since COPD accounts for one of the most prominent public health issues and is rapidly prevalent within the next years, as reported by WHO estimated COPD to become the third leading cause of death worldwide in 2020, therefore there is an inevitable need for intervention strategies for nutrition policies, also in Switzerland more specifically targeting the reduction of risk of COPD. The results of the present study should enable to define and elaborate concrete guidelines and recommendations for action at a national level.

6 Outlook

The present paper provides findings and knowledge on relevant research questions in the field of nutritional epidemiology and public health. On one hand, it discusses current state of the art methods for dietary assessment and summarizes the pros and cons of several dietary assessment tools, and what aspects have to be considered when planning an epidemiological study. On the other hand, it reveals an explosive public health issue, namely COPD, emphasizing disease-specific underlying basic information and shows a first insight into potential associations between dietary intake and the prevalence of COPD in Switzerland.

The validation study has demonstrated that the applied FFQ can be ranked as an appropriate tool to investigate dietary intake at a population level (for adults). In Switzerland, there is a lack of potential dietary assessment tools to be used in large epidemiological studies. Even more, the landscape of nutritional epidemiology in Switzerland is sparse, and for many years and decades dietary surveys assessing the direct dietary intake were not available. Recently, the first national nutrition survey menuCH (www.menuch.ch) was conducted. The dietary assessment was set up with a mix of different assessment methods, i.e. consisting of two 24-h recalls conducted as a personal and a telephone interview, a detailed questionnaire about lifestyle behavior such as physical activity, general questions on nutritional behavior, cooking habits, and additional health style related questions, complemented with sociodemographic parameters. The first national nutrition survey delivers for the first time representative data on food behavior of adults in Switzerland. It was aimed to derive concrete recommendations and nutritional strategies on a national level, and to formulate nutrition policy for the upcoming years.

In the present study, the applied FFQ was evaluated and shown to be a qualified instrument for further investigations or follow-up surveys in nutritional assessment, such as the menuCH survey. In view of the overall results of menuCH and the proceeding research questions, it is also conceivable to use a short version of the FFQ, as it dramatically reduces respondents burden in terms of time consuming. A short version of the discussed FFQ was originally developed at the ZHAW with the aim to be implemented for future studies or dietary assessments, however it needs to be validated.

With regard to the COPD study, there are several findings and considerations to be highlighted: First of all, the study design and methodical approach with focus on dietary pattern analysis are illustrative for other epidemiological studies with related topics. When studying dietary effects or relationships with the risk of a chronic disease, it is more meaningful and current state of the art to look at dietary patterns instead of analyzing associations on a single nutrient level. Thus, the present analysis could serve as a template for further studies. This study design and methodical approach could be transferred to other studies analyzing the relationship of diet and a specific disease such as other NCDs (e.g. cardiovascular diseases). In order to elaborate national nutrition strategies and concrete recommendations, there is a need for epidemiological research as it presents a precondition for a solid data basis.

Second, the novelty of these results for Switzerland must be considered. Since there are currently no other data about the relationship between dietary patterns and COPD in Switzerland, the findings of the present study are crucial. They point out important results of a potential beneficial effect of a rather healthy diet in comparison to a rather unhealthy diet regarding the occurrence of COPD. As already discussed, the results suggest a beneficial effect of high vegetable and fruit consumption for the prevention of COPD. These findings are not only valid for the whole Swiss population, but also applicable to subgroups such as never smokers or current smokers. Our data could provide a basis for the development and elaboration of concrete action strategies for nutrition policy and recommendations at a national level, aiming for mitigating not only the individuals' harm, but also impacts of this disease on a national level. Therefore, a supportive effect for health-related policies including also the socio-economic burden could be estimated.

Third, these findings and considerations could also be adapted for the clinical and daily context. In addition to the general recommendation number one by the physicians to stop smoking, a practical manual with relevant recommendations for a healthy lifestyle, i.e. nutrition behavior and physical activity, could be handed out at a doctor's visit. It could be a conceivable option to include these practical recommendations during a normal doctor's visit, e.g. a check up visit, or also at a follow-up visit for patients with a high risk for COPD. Simple recommendations listed in a practical manual would be a suitable option. Since there is ample evidence for a protective effect of fruit and vegetable consumption one should start with these recommendations and elaborate it like the general recommendations "5 per Day". The communication of principal guidelines in nutrition might influence and provide support to individuals. By the doctor's recommendation the importance and relevance of these behavioral guidelines would be emphasized considerably. These considerations were also supported by a recently published editorial by Varraso and Shaheen in 2017 [35] .

Further recommendations and guidelines towards a healthy diet and lung function could include the topics fiber intake, moderate alcohol consumption and a reduction of meat consumption, in particular red meat and processed meat consumption, as recent literature suggests a potential relationship between these food groups and the risk of COPD [36] . However, these considerations must be investigated thoroughly in future in order to have a solid basis for the development of further dietary recommendations in the context of lung function and COPD.

7 Summary

Worldwide, the prevalence of chronic obstructive pulmonary disease (COPD) is dramatically increasing. COPD will account for the third leading cause of death by 2020, thus representing a major public health issue. COPD is not restricted to smokers and dietary habits may contribute to the disease occurrence. Epidemiological research points to a benefit of a diet rich in antioxidants and omega-3 fatty acids for protecting from loss of lung function and from COPD symptoms, and protective effects of fruit and vegetable intake have been shown in several cohort studies. Recently, in order to get a broader picture of dietary intake, the assessment of dietary patterns is a state – of – the art method, rather than focussing only on nutrients.

The aims of the current study were to derive and analyze dietary patterns for Swiss adults and to assess their association with lung function and COPD in the Swiss Cohort Study on Air Pollution and Lung and Heart Diseases in Adults (SAPALDIA). Furthermore, associations between dietary patterns and COPD with gender and lifestyle factors, such as smoking and physical activity were also investigated. Dietary intake was collected using a paper form food frequency questionnaire (FFQ) designed to assess average food intake over the previous 4 weeks (www.ernaehrungserhebung.ch). In order to apply a robust tool, which will be able to compile data in a valid and reproducible manner, the FFQ had to be validated first. The FFQ Validation study therefore presented the "precondition study" for the main research questions in the context of food patterns and COPD in the SAPALDIA cohort. The study aimed at assessing the relative validity of a paper form FFQ with a 4-day FR. The validity was assessed both, at the energy and macronutrient and food group levels. Finally, data from 56 out of a total of 60 recruited participants were considered for the analysis.

In conclusion, the 127-food item self-administered FFQ showed good relative validity for protein and various, commonly consumed food groups such as fruits, egg, meat, sausage, nuts, salty snacks and beverages such as water, tea and coffee. The applied FFQ was shown to be an appropriate tool for assessing and characterizing dietary intake and food habits of adults in epidemiological studies.

For the main analysis, 2178 SAPALDIA participants with complete data on lung function, smoking history, physical activity and dietary intake were considered. The validated, 127-item, semi-quantitative paper form FFQ was handed out to the study participants and filled in self-administered. To derive dietary patterns, principal component factor analysis (PCF) was performed on 25 predefined food groups on the basis of similarity of type of food and nutrient composition.

Three prominent food factors were identified: Factor 1 reflected a rather "healthy diet", i.e. a "prudent pattern", characterized by the main food groups vegetables, fruits, water, tea and coffee, fish and nuts. In contrast, factor 2 was described by a high intake of meat, sausage, egg, fish and alcohol, representing a rather "unhealthy diet", i.e. a traditional "Western pattern". In addition, a third factor was identified, which was characterized by a "high-carbohydrate diet", i.e. a high intake of sweet spreads, bread, dessert and potatoes.

In order to analyze the relationships between dietary patterns and lung function outcomes and COPD, multiple mixed linear and logistic regression models were applied. Three different models with increasing adjustment for potential confounder variables were applied, i.e. for sex, age, height, smoking status, exposure to passive smoking, educational level, civil status, employment status, total energy intake, body mass index, and physical activity.

The main finding was the positive association of the "prudent pattern" (vegetables, fruits, water, tea and coffee, fish and nuts) with the lung function parameter FEV1. Associations with FEV1/FVC, FEF2575 and COPD were consistent with the FEV1 results. These results are in line with current literature on dietary patterns and lung function outcomes or COPD.

Thus, our results also add to the general evidence of a protective effect of antioxidant intake in COPD, evidenced in part by previously reported negative associations of vitamin C with the prevalence of COPD.

A novel finding of the present study was the positive association of factor 3 ("high-carbohydrate diet") with FEV1, which disappeared after BMI adjustment. However, this finding reveals some inconsistency due to the opposite findings for similar lung function parameters (FEV1 and FEF2575). Therefore, this result needs to be interpreted with caution and must be confirmed in future studies.

For COPD prevention, smoking cessation still presents the most relevant public health message. However, the results of the present study suggest diet as a modifiable potential risk factor of lung function decrease. The investigation of dietary patterns rather than single food items or nutrients has the advantage of addressing the influence of food habits in their lifestyle context; it therefore better captures the complex nature of diet. In addition to the nutritional guidelines for other NCDs (e.g. cardiovascular diseases, diabetes, cancer), recommendations for high fruit and vegetable intake and low meat and alcohol intake may become an important pillar of respiratory disease prevention.

Thus, the present analysis could serve as a template for further studies. This study design and methodical approach could be transferred to other studies analyzing the relationship of diet and a specific disease such as other NCDs (e.g. cardiovascular diseases). In order to elaborate national nutrition strategies and concrete recommendations, there is a need for epidemiological research as it presents a precondition for a solid data basis.

In addition, the novelty of these results for Switzerland must be considered. Since there are currently no other data about the relationship between dietary patterns and COPD in Switzerland, the findings of the present study are crucial. They point out important results of a potential beneficial effect of a rather healthy diet in comparison to a rather unhealthy diet regarding the occurrence of COPD.

These findings are not only valid for the whole Swiss population, but also applicable to subgroups such as never smokers or current smokers. Our data could provide a basis for the development and elaboration of concrete action strategies for nutrition policy and recommendations at a national level, aiming for mitigating not only the individuals' harm, but also impacts of this disease on a national level. Therefore, a supportive effect for health-related policies including also the socio-economic burden could be estimated.

Zusammenfassung

Die Prävalenz der chronisch obstruktiven Lungenkrankheit COPD nimmt weltweit drastisch zu. So wird COPD im Jahre 2020 die dritthäufigste Todesursache ausmachen und damit ein erhebliches gesundheitspolitisches Thema darstellen. COPD betrifft nicht nur Raucher, und auch Ernährungsgewohnheiten können zum Auftreten dieser Krankheit beitragen. Epidemiologische Studien deuten auf einen Nutzen einer Ernährung reich an Antioxidantien und omega-3 Fettsäuren auf die Lungenfunktion sowie gegen COPD Symptome, und protektive Effekte eines erhöhten Früchte- und Gemüseverzehrs wurden in mehreren Kohorten Studien bestätigt. Um ein umfassenderes Bild der Nahrungsaufnahme zu erhalten zählt gemäss neuestem Stand der Forschung die Analyse von Ernährungsmustern zur Methode der ersten Wahl, eher als der herkömmliche Fokus auf einzelner Nährstoffe.

Die Ziele der vorliegenden Studie waren die Ableitung und Analyse von Ernährungsmustern für Schweizer Erwachsene und die Untersuchung möglicher Zusammenhänge dieser Ernährungsmuster mit Lungenfunktionsparametern und dem Auftreten von COPD in der SAPALDIA (Swiss Cohort Study on Air Pollution and Lung and Heart Diseases in Adults) Studie. Ausserdem wurden die Assoziationen zwischen den Ernährungsmustern und COPD auf das Geschlecht und andere Lebensstilfaktoren wie zum Beispiel Rauchen oder körperliche Aktivität geprüft. Die Nahrungszufuhr wurde mittels einer Papierversion eines Food Frequency Questionnaires (FFQ) erhoben, welcher für die Einschätzung der üblichen Nahrungsmittelzufuhr der letzten 4 Wochen konzipiert wurde (www.ernaehrungserhebung.ch). Für den Einsatz eines robusten und validen Instruments, welches die Daten möglichst konsistent erfassen sollte, musste der FFQ zuerst validiert werden. Die FFQ Validierungsstudie ist somit die Vorläuferstudie, um die zentralen Forschungsfragen im Kontext der Ernährungsmuster und COPD in der SAPALDIA Studie zu untersuchen. Die Validierungsstudie verfolgte das Ziel, die relative Validität eines FFQ auf Papier im Vergleich zu einem 4-Tages Ernährungsprotokoll zu bewerten, sowohl für Energie und Mikronährstoffe als auch auf der Lebensmittelgruppenebene. Schliesslich wurden 56 von insgesamt 60 Datensätzen für die Analyse berücksichtigt. Zusammenfassend zeigte der selbst ausgefüllte FFQ mit 127 Lebensmitteln eine gute relative Validität für Protein und verschiedene, häufig konsumierte Lebensmittelgruppen wie Früchte, Eier, Fleisch, Wurst, Nüsse, salzige Snacks und Getränke wie Wasser, Tee und Kaffee. Der verwendete FFQ erwies sich als geeignetes Instrument für die Einschätzung und Charakterisierung der Nahrungszufuhr und Ernährungsgewohnheiten von Erwachsenen in epidemiologischen Studien.

Für die Hauptanalyse wurden 2178 SAPALDIA Teilnehmer mit kompletten Daten von Lungenfunktionsparametern, Rauchgewohnheiten, körperlicher Aktivität und Nahrungszufuhr berücksichtigt. Der validierte, semi-quantitative FFQ mit 127 Lebensmitteln wurde den Studienteilnehmern auf Papier ausgehändigt und selbstständig ausgefüllt. Für die Ableitung der Ernährungsmuster wurde eine Faktorenanalyse (principal component factor analysis) von 25 vordefinierten Lebensmittelgruppen durchgeführt. Die Komposition dieser 25 Lebensmittelgruppen wurde aufgrund der Ähnlichkeit des Lebensmittels sowie der Nährstoffzusammensetzung festgelegt. Drei prominente Ernährungsfaktoren wurden identifiziert: Faktor 1 reflektierte eine eher „gesunde Ernährungsweise“ oder ein „prudent pattern“, charakterisiert durch die primären Lebensmittelgruppen Gemüse, Früchte, Wasser, Tee und Kaffee, Fisch und Nüsse. Im Gegensatz dazu wurde der Faktor 2 als eher „ungesunde Ernährungsweise“ oder auch traditionelles „Western pattern“ durch einen hohen Konsum von Fleisch, Wurst, Eier, Fisch und Alkohol charakterisiert. Zusätzlich wurde ein dritter Faktor identifiziert, welcher eher als „kohlenhydratreiche Ernährungsweise“ beschrieben wurde, d.h. durch einen hohen Verzehr von süssem Aufstrich, Brot, Dessert und Kartoffeln.

Für die Analyse möglicher Zusammenhänge von Ernährungsmustern und Lungenfunktionsparametern sowie COPD wurden multiple lineare und logistische Regressionsmodelle angewandt. Drei verschiedene Modelle mit zunehmender Adjustierung für potentielle Störfaktoren (Confounder-Variablen) wurden eingesetzt (Geschlecht, Alter, Grösse, Rauchgewohnheiten, Exposition gegenüber Passivrauchen, Bildungsstufe, Zivilstand, Beschäftigungsstatus, totale Energiezufuhr, Body Mass Index (BMI) und körperliche Aktivität). Das Hauptergebnis war die positive Assoziation des “prudent patterns” (Gemüse, Früchte, Wasser, Tee und Kaffee, Fisch und Nüsse) mit dem Lungenfunktionsparameter FEV1. Die Assoziationen mit FEV1/FVC, FEF2575 und COPD waren konsistent mit denjenigen von FEV1. Diese Resultate stehen im Einklang mit der aktuellen Literatur zum Thema Ernährungsmuster und Lungenfunktionsparameter oder COPD. Unsere Resultate unterstreichen somit auch die allgemeine Evidenz eines protektiven Effekts von Antioxidantien bei COPD, welche bislang durch eine negative Assoziation von Vitamin C mit der Prävalenz von COPD gezeigt wurde. Ein neuartiges Ergebnis der vorliegenden Studie war die positive Assoziation von Faktor 3 („kohlenhydratreiche Ernährungsweise“) mit FEV1, welche jedoch nach Adjustierung für den BMI nicht mehr vorlag. Dieses Resultat sollte allerdings mit Vorsicht interpretiert und in zukünftigen Studien bestätigt werden, da ein ähnlicher Lungenfunktionsparameter FEF2575 ein entgegengesetztes Ergebnis zeigte.

Für die Prävention von COPD stellt die Raucherentwöhnung nach wie vor die relevanteste Botschaft im Bereich der öffentlichen Gesundheit dar. Die Ergebnisse der vorliegenden Studie deuten jedoch auf die Ernährung als veränderbaren potenziellen Risikofaktor für die Abnahme der Lungenfunktion hin. Die Untersuchung von Ernährungsmustern anstelle der Analyse einzelner Nahrungsmittel oder Nährstoffe hat den Vorteil, dass der Einfluss von Ernährungsgewohnheiten in ihrem Lebensstilkontext ermittelt werden kann; damit wird die komplexe Natur der Ernährung besser eingefangen. Neben den Ernährungsrichtlinien für andere NCDs (z.B. Herz-Kreislauf-Erkrankungen, Diabetes, Krebs) können Empfehlungen für einen hohen Obst- und Gemüsekonsum sowie einen niedrigen Fleisch- und Alkoholkonsum zu einem wichtigen Pfeiler der Prävention von Atemwegserkrankungen werden.

Die vorliegende Analyse könnte somit als Vorlage für weitere Studien dienen. Dieses Studiendesign und der methodische Ansatz könnten auf andere Studien übertragen werden, in denen der Zusammenhang von Ernährung und einer bestimmten Krankheit wie andere NCDs (z.B. Herz-Kreislauf-Erkrankungen) analysiert werden soll. Für die Ausarbeitung nationaler Ernährungsstrategien und konkreter Empfehlungen ist eine epidemiologische Forschung erforderlich, da sie eine Voraussetzung für eine solide Datenbasis darstellt. Darüber hinaus muss die Neuartigkeit dieser Ergebnisse für die Schweiz berücksichtigt werden. Da es in der Schweiz bislang keine Daten über den Zusammenhang zwischen Ernährungsgewohnheiten und COPD gab, sind die Ergebnisse der vorliegenden Studie zentral, da sie auf eine mögliche positive Wirkung einer eher gesunden Ernährungsweise im Vergleich zu einer eher ungesunden Ernährungsweise hinsichtlich des Auftretens von COPD hinweisen.

Diese Ergebnisse gelten nicht nur für die gesamte Schweizer Bevölkerung, sondern auch für Subgruppen wie Nichtraucher oder aktuelle Raucher. Unsere Daten könnten eine Grundlage für die Entwicklung und Ausarbeitung konkreter ernährungspolitischer Handlungsstrategien und -empfehlungen auf nationaler Ebene bilden, um nicht nur das Leid des Einzelnen, sondern auch die Auswirkungen dieser Krankheit auf nationaler Ebene abzuschwächen. Daher könnte ein unterstützender Effekt für die gesundheitspolitischen Maßnahmen, einschließlich der sozioökonomischen Belastung, abgeschätzt werden.

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9 Further Publications

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Appendix

A) The 127-itemed, semi-quantitative paper form FFQ (German version)

Bar Code

FRAGEBOGEN ZUR ERNÄHRUNG

Milch / Milchprodukte

Vollmilch

erfasst den Milchkonsum, auch für Müesli, Cornflakes etc.
Ohne Ovomaltine/Schokolade, Tee, Kaffee oder Saucen

Häufigkeit

☐ täglich
☐ 1-2 mal pro Woche ☐ 3-4 mal pro Woche ☐ 5-6 mal pro Woche
☐ 1 mal pro Monat ☐ 2 mal pro Monat ☐ 3 mal pro Monat
☐ seltener ☐ nie

Anzahl Portionen

0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Portionsgrösse


☐ 1 dl


☐ 2 dl


☐ 3 dl

Teilentrahmte Milch

erfasst den Milchkonsum, auch für Müesli, Cornflakes etc.
Ohne Ovomaltine/Schokolade, Tee, Kaffee oder Saucen

Häufigkeit

☐ täglich
☐ 1-2 mal pro Woche ☐ 3-4 mal pro Woche ☐ 5-6 mal pro Woche
☐ 1 mal pro Monat ☐ 2 mal pro Monat ☐ 3 mal pro Monat
☐ seltener ☐ nie

Anzahl Portionen

0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Portionsgrösse


☐ 1 dl


☐ 2 dl


☐ 3 dl

49640

Ovomaltine / Schokolade

Häufigkeit

☐ täglich
☐ 1-2 mal pro Woche ☐ 3-4 mal pro Woche ☐ 5-6 mal pro Woche
☐ 1 mal pro Monat ☐ 2 mal pro Monat ☐ 3 mal pro Monat
☐ seltener ☐ nie

Anzahl Portionen

0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Portionsgrösse


☐ 1 dl


☐ 2 dl


☐ 3 dl

Reibkäse

Häufigkeit

☐ täglich
☐ 1-2 mal pro Woche ☐ 3-4 mal pro Woche ☐ 5-6 mal pro Woche
☐ 1 mal pro Monat ☐ 2 mal pro Monat ☐ 3 mal pro Monat
☐ seltener ☐ nie

Anzahl Portionen

0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Portionsgrösse


☐ 5 g


☐ 10 g


☐ 15 g

Raclettekäse

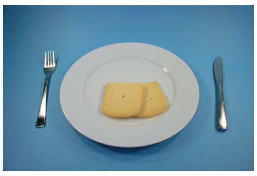
Häufigkeit

☐ täglich
☐ 1-2 mal pro Woche ☐ 3-4 mal pro Woche ☐ 5-6 mal pro Woche
☐ 1 mal pro Monat ☐ 2 mal pro Monat ☐ 3 mal pro Monat
☐ seltener ☐ nie

Anzahl Portionen

0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Portionsgrösse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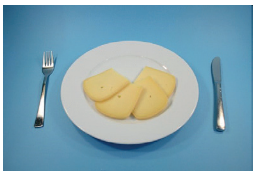
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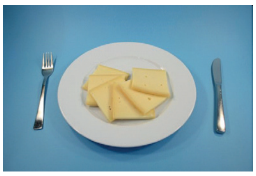
☐ 240 g

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Hartkäse

Zum Hartkäse werden z.B. Greyerzer und Emmentaler gezählt.

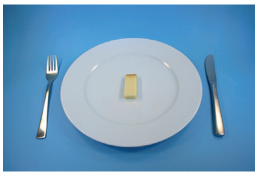
Häufigkeit

☐ täglich
☐ 1-2 mal pro Woche ☐ 3-4 mal pro Woche ☐ 5-6 mal pro Woche
☐ 1 mal pro Monat ☐ 2 mal pro Monat ☐ 3 mal pro Monat
☐ seltener ☐ nie

Anzahl Portionen

0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Portionsgrösse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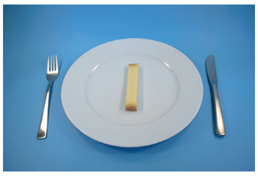
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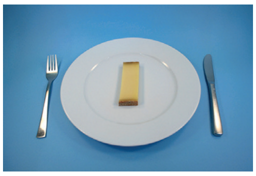

☐ 45 g

Halbhartkäse

Zum Halbhartkäse werden z.B. Appenzeller und Tilsiter gezählt.

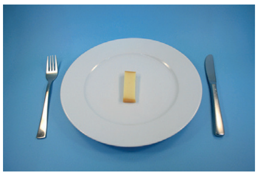
Häufigkeit

☐ täglich
☐ 1-2 mal pro Woche ☐ 3-4 mal pro Woche ☐ 5-6 mal pro Woche
☐ 1 mal pro Monat ☐ 2 mal pro Monat ☐ 3 mal pro Monat
☐ seltener ☐ nie

Anzahl Portionen

0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Portionsgrösse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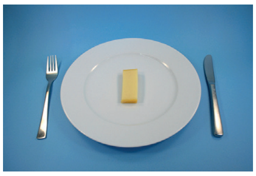
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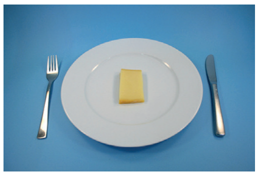

☐ 45 g

Weichkäse

Zum Weichkäse werden z.B. Camembert, Tomme und Brie gezählt.

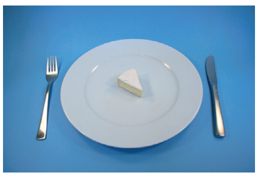
Häufigkeit

☐ täglich
☐ 1-2 mal pro Woche ☐ 3-4 mal pro Woche ☐ 5-6 mal pro Woche
☐ 1 mal pro Monat ☐ 2 mal pro Monat ☐ 3 mal pro Monat
☐ seltener ☐ nie

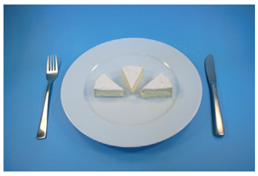
Anzahl Portionen

0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Portionsgrösse


☐ 30 g


☐ 60 g


☐ 90 g

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Frischkäse

Zum Frischkäse werden neben Hüttenkäse und Quark auch Mozzarella gezählt.

Häufigkeit

☐ täglich
☐ 1-2 mal pro Woche ☐ 3-4 mal pro Woche ☐ 5-6 mal pro Woche
☐ 1 mal pro Monat ☐ 2 mal pro Monat ☐ 3 mal pro Monat
☐ seltener ☐ nie

Anzahl Portionen

0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Portionsgrösse


☐ 50 g


☐ 100 g


☐ 150 g

Käse fettreduziert

alle Sorten

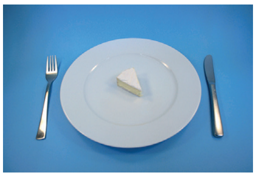
Häufigkeit

☐ täglich
☐ 1-2 mal pro Woche ☐ 3-4 mal pro Woche ☐ 5-6 mal pro Woche
☐ 1 mal pro Monat ☐ 2 mal pro Monat ☐ 3 mal pro Monat
☐ seltener ☐ nie

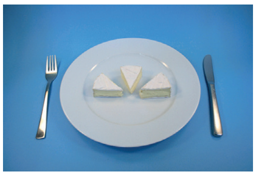
Anzahl Portionen

0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Portionsgrösse


☐ 30 g


☐ 60 g


☐ 90 g

Frucht- und Aromajoghurt

beinhaltet auch Frucht- und Aromajoghurt im Birchermüesli

Häufigkeit

☐ täglich
☐ 1-2 mal pro Woche ☐ 3-4 mal pro Woche ☐ 5-6 mal pro Woche
☐ 1 mal pro Monat ☐ 2 mal pro Monat ☐ 3 mal pro Monat
☐ seltener ☐ nie

Anzahl Portionen

0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Portionsgrösse


☐ 125 g


☐ 180 g


☐ 250 g

49640

Joghurt nature

beinhaltet auch Joghurt nature im Birchermüesli

Häufigkeit

☐ täglich
☐ 1-2 mal pro Woche ☐ 3-4 mal pro Woche ☐ 5-6 mal pro Woche
☐ 1 mal pro Monat ☐ 2 mal pro Monat ☐ 3 mal pro Monat
☐ seltener ☐ nie

Anzahl Portionen

0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Portionsgrösse


☐ 125 g


☐ 180 g

Frucht- und Aromajoghurt light

beinhaltet auch Joghurt light im Birchermüesli

Häufigkeit

☐ täglich
☐ 1-2 mal pro Woche ☐ 3-4 mal pro Woche ☐ 5-6 mal pro Woche
☐ 1 mal pro Monat ☐ 2 mal pro Monat ☐ 3 mal pro Monat
☐ seltener ☐ nie

Anzahl Portionen

0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Portionsgrösse


☐ 125 g


☐ 180 g

49640

Fleisch / Wurst

Kalbfleisch

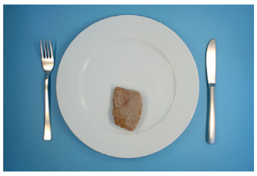
Häufigkeit

☐ täglich
☐ 1-2 mal pro Woche ☐ 3-4 mal pro Woche ☐ 5-6 mal pro Woche
☐ 1 mal pro Monat ☐ 2 mal pro Monat ☐ 3 mal pro Monat
☐ seltener ☐ nie

Anzahl Portionen

0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Portionsgrösse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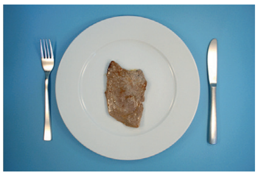
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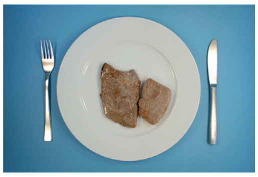

☐ 180 g

Rindfleisch

Häufigkeit

☐ täglich
☐ 1-2 mal pro Woche ☐ 3-4 mal pro Woche ☐ 5-6 mal pro Woche
☐ 1 mal pro Monat ☐ 2 mal pro Monat ☐ 3 mal pro Monat
☐ seltener ☐ nie

Anzahl Portionen

0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Portionsgrösse


☐ 60 g


☐ 120 g


☐ 180 g

Schweinefleisch

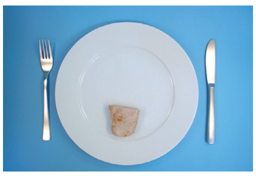
Häufigkeit

☐ täglich
☐ 1-2 mal pro Woche ☐ 3-4 mal pro Woche ☐ 5-6 mal pro Woche
☐ 1 mal pro Monat ☐ 2 mal pro Monat ☐ 3 mal pro Monat
☐ seltener ☐ nie

Anzahl Portionen

0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Portionsgrösse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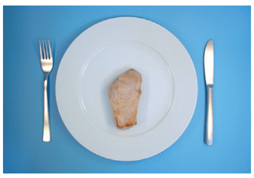
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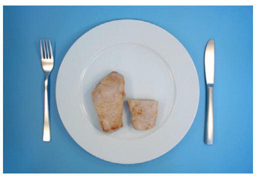

☐ 180 g

49640

Lammfleisch

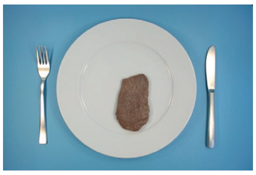
Häufigkeit

☐ täglich
☐ 1-2 mal pro Woche ☐ 3-4 mal pro Woche ☐ 5-6 mal pro Woche
☐ 1 mal pro Monat ☐ 2 mal pro Monat ☐ 3 mal pro Monat
☐ seltener ☐ nie

Anzahl Portionen

0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Portionsgrösse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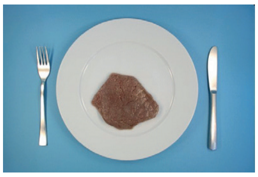
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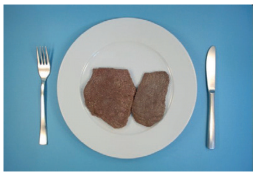

☐ 180 g

Geflügel

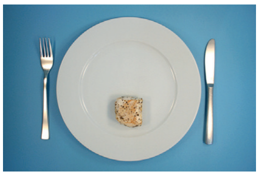
Häufigkeit

☐ täglich
☐ 1-2 mal pro Woche ☐ 3-4 mal pro Woche ☐ 5-6 mal pro Woche
☐ 1 mal pro Monat ☐ 2 mal pro Monat ☐ 3 mal pro Monat
☐ seltener ☐ nie

Anzahl Portionen

0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Portionsgrösse


☐ 60 g


☐ 120 g


☐ 180 g

Leber

Häufigkeit

☐ täglich
☐ 1-2 mal pro Woche ☐ 3-4 mal pro Woche ☐ 5-6 mal pro Woche
☐ 1 mal pro Monat ☐ 2 mal pro Monat ☐ 3 mal pro Monat
☐ seltener ☐ nie

Anzahl Portionen

0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Portionsgrösse


☐ 60 g


☐ 120 g


☐ 180 g

49640

Trockenfleisch

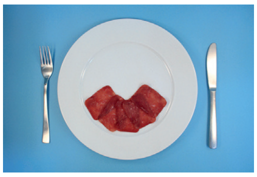
Häufigkeit

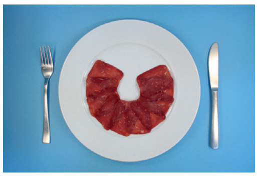
☐ täglich
☐ 1-2 mal pro Woche ☐ 3-4 mal pro Woche ☐ 5-6 mal pro Woche
☐ 1 mal pro Monat ☐ 2 mal pro Monat ☐ 3 mal pro Monat
☐ seltener ☐ nie

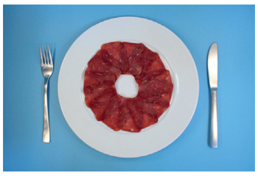
Anzahl Portionen

0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Portionsgrösse


☐ 15 g


☐ 30 g


☐ 45 g

Schinken

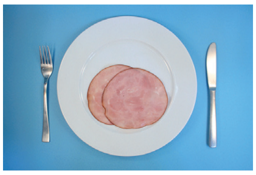
Häufigkeit

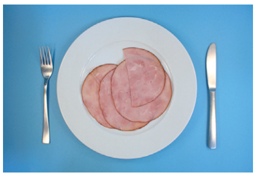
☐ täglich
☐ 1-2 mal pro Woche ☐ 3-4 mal pro Woche ☐ 5-6 mal pro Woche
☐ 1 mal pro Monat ☐ 2 mal pro Monat ☐ 3 mal pro Monat
☐ seltener ☐ nie

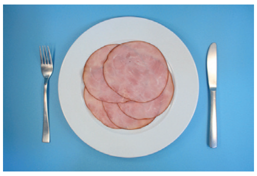
Anzahl Portionen

0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Portionsgrösse


☐ 25 g


☐ 50 g


☐ 75 g

Salami

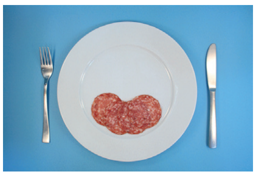
Häufigkeit

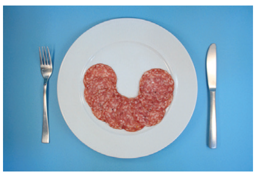
☐ täglich
☐ 1-2 mal pro Woche ☐ 3-4 mal pro Woche ☐ 5-6 mal pro Woche
☐ 1 mal pro Monat ☐ 2 mal pro Monat ☐ 3 mal pro Monat
☐ seltener ☐ nie

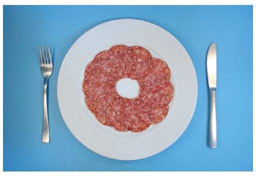
Anzahl Portionen

0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Portionsgrösse


☐ 15 g


☐ 30 g


☐ 45 g

49640

Aufschnitt

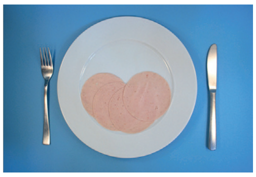
Häufigkeit

☐ täglich
☐ 1-2 mal pro Woche ☐ 3-4 mal pro Woche ☐ 5-6 mal pro Woche
☐ 1 mal pro Monat ☐ 2 mal pro Monat ☐ 3 mal pro Monat
☐ seltener ☐ nie

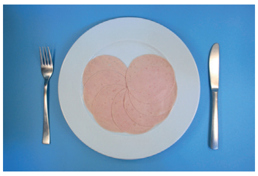
Anzahl Portionen

0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

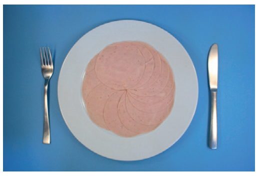
Portionsgrösse



☐ 25 g



☐ 50 g



☐ 75 g

Wurst

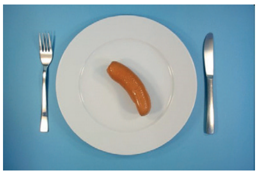
Häufigkeit

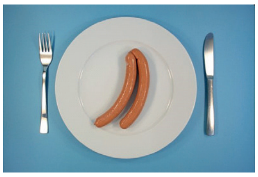
☐ täglich
☐ 1-2 mal pro Woche ☐ 3-4 mal pro Woche ☐ 5-6 mal pro Woche
☐ 1 mal pro Monat ☐ 2 mal pro Monat ☐ 3 mal pro Monat
☐ seltener ☐ nie

Anzahl Portionen

0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Portionsgrösse





☐ 120 g

49640

Fisch und vegetarische Produkte

Fisch mager

z.B. Forelle, Dorsch, Egli, Flunder, Seezunge

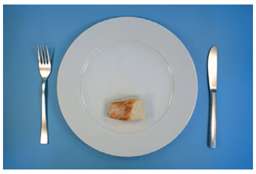
Häufigkeit

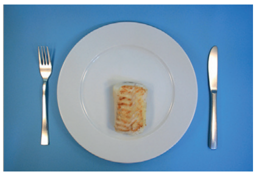
☐ täglich
☐ 1-2 mal pro Woche ☐ 3-4 mal pro Woche ☐ 5-6 mal pro Woche
☐ 1 mal pro Monat ☐ 2 mal pro Monat ☐ 3 mal pro Monat
☐ seltener ☐ nie

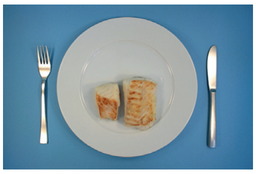
Anzahl Portionen

0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Portionsgrösse


☐ 60 g


☐ 120 g


☐ 180 g

Fisch fettreich

Zu den fettreichen Fischen gehören Lachs, Thunfisch, Makrele, Hering und Aal

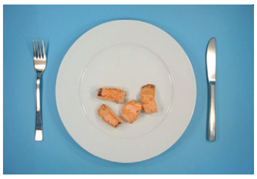
Häufigkeit

☐ täglich
☐ 1-2 mal pro Woche ☐ 3-4 mal pro Woche ☐ 5-6 mal pro Woche
☐ 1 mal pro Monat ☐ 2 mal pro Monat ☐ 3 mal pro Monat
☐ seltener ☐ nie

Anzahl Portionen

0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Portionsgrösse


☐ 60 g


☐ 120 g


☐ 180 g

Fischstäbchen

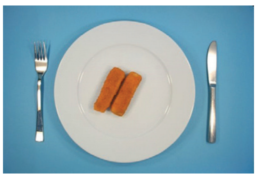
Häufigkeit

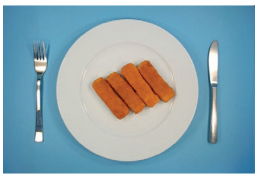
☐ täglich
☐ 1-2 mal pro Woche ☐ 3-4 mal pro Woche ☐ 5-6 mal pro Woche
☐ 1 mal pro Monat ☐ 2 mal pro Monat ☐ 3 mal pro Monat
☐ seltener ☐ nie

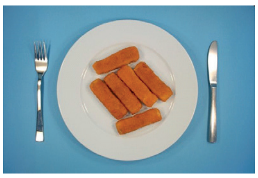
Anzahl Portionen

0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Portionsgrösse


☐ 60 g


☐ 120 g


☐ 180 g

49640

Fischkonserven

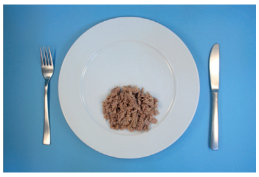
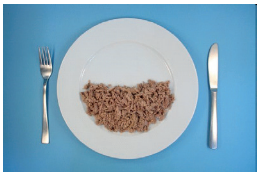
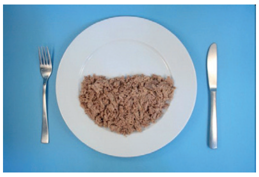
Häufigkeit

☐ täglich
☐ 1-2 mal pro Woche ☐ 3-4 mal pro Woche ☐ 5-6 mal pro Woche
☐ 1 mal pro Monat ☐ 2 mal pro Monat ☐ 3 mal pro Monat
☐ seltener ☐ nie

Anzahl Portionen

0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Portionsgrösse

☐ 50 g ☐ 100 g ☐ 150 g

Ei

beinhaltet Rühr-, Spiegel- und Frühstückseier, keine versteckten Eier

Häufigkeit

☐ täglich
☐ 1-2 mal pro Woche ☐ 3-4 mal pro Woche ☐ 5-6 mal pro Woche
☐ 1 mal pro Monat ☐ 2 mal pro Monat ☐ 3 mal pro Monat
☐ seltener ☐ nie

Anzahl Portionen

0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Portionsgrösse

☐ 1 Ei ☐ 2 Eier ☐ 3 Eier

Fleischersatz

in diese Kategorie gehören neben Tofu und Cornatur auch andere Fleischersatzprodukte

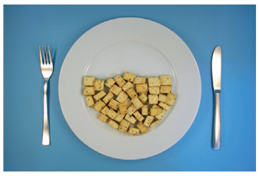
Häufigkeit

☐ täglich
☐ 1-2 mal pro Woche ☐ 3-4 mal pro Woche ☐ 5-6 mal pro Woche
☐ 1 mal pro Monat ☐ 2 mal pro Monat ☐ 3 mal pro Monat
☐ seltener ☐ nie

Anzahl Portionen

0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Portionsgrösse

☐ 60 g ☐ 120 g ☐ 180 g

49640

Sojamilch

Häufigkeit

☐ täglich
☐ 1-2 mal pro Woche ☐ 3-4 mal pro Woche ☐ 5-6 mal pro Woche
☐ 1 mal pro Monat ☐ 2 mal pro Monat ☐ 3 mal pro Monat
☐ seltener ☐ nie

Anzahl Portionen

0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Portionsgrösse

☐ 1 dl

☐ 2 dl

☐ 3 dl

Sojajoghurt

Häufigkeit

☐ täglich
☐ 1-2 mal pro Woche ☐ 3-4 mal pro Woche ☐ 5-6 mal pro Woche
☐ 1 mal pro Monat ☐ 2 mal pro Monat ☐ 3 mal pro Monat
☐ seltener ☐ nie

Anzahl Portionen

0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Portionsgrösse

☐ 125 g

49640

Brot und Brotaufstrich

Sandwich

Alle Arten von Brotsorten und Sandwichbelägen

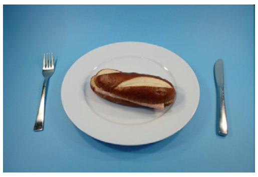
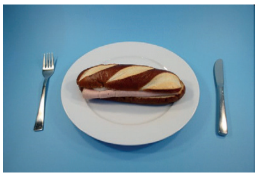
Häufigkeit

☐ täglich
☐ 1-2 mal pro Woche ☐ 3-4 mal pro Woche ☐ 5-6 mal pro Woche
☐ 1 mal pro Monat ☐ 2 mal pro Monat ☐ 3 mal pro Monat
☐ seltener ☐ nie

Anzahl Portionen

0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Portionsgrösse


☐ 80 g ☐ 160 g ☐ 220 g

Weissbrot

Hinweis: Es werden alle Brotsorten einzeln abgefragt.

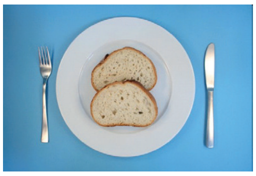
Häufigkeit

☐ täglich
☐ 1-2 mal pro Woche ☐ 3-4 mal pro Woche ☐ 5-6 mal pro Woche
☐ 1 mal pro Monat ☐ 2 mal pro Monat ☐ 3 mal pro Monat
☐ seltener ☐ nie

Anzahl Portionen

0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Portionsgrösse



☐ 50 g ☐ 100 g ☐ 150 g

49640

Ruchbrot

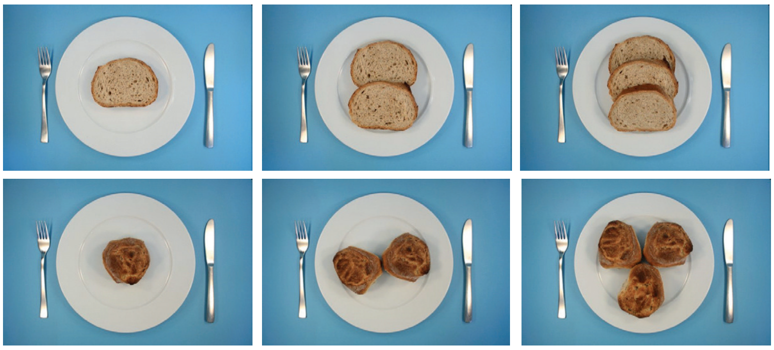
Häufigkeit

☐ täglich
☐ 1-2 mal pro Woche ☐ 3-4 mal pro Woche ☐ 5-6 mal pro Woche
☐ 1 mal pro Monat ☐ 2 mal pro Monat ☐ 3 mal pro Monat
☐ seltener ☐ nie

Anzahl Portionen

0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Portionsgrösse



☐ 50 g ☐ 100 g ☐ 150 g

Vollkornbrot

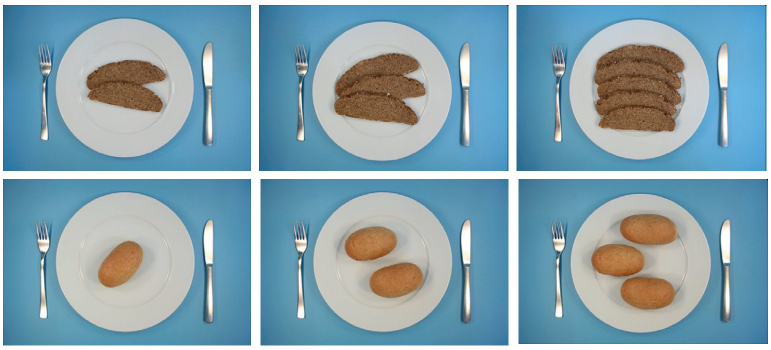
Häufigkeit

☐ täglich
☐ 1-2 mal pro Woche ☐ 3-4 mal pro Woche ☐ 5-6 mal pro Woche
☐ 1 mal pro Monat ☐ 2 mal pro Monat ☐ 3 mal pro Monat
☐ seltener ☐ nie

Anzahl Portionen

0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Portionsgrösse



☐ 50 g ☐ 100 g ☐ 150 g

49640

Butterzopf

Häufigkeit

☐ täglich
☐ 1-2 mal pro Woche ☐ 3-4 mal pro Woche ☐ 5-6 mal pro Woche
☐ 1 mal pro Monat ☐ 2 mal pro Monat ☐ 3 mal pro Monat
☐ seltener ☐ nie

Anzahl Portionen

0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Portionsgrösse


☐ 50 g


☐ 75 g


☐ 100 g

Gipfeli

Butter-, Laugen- und Vollkorngipfeli

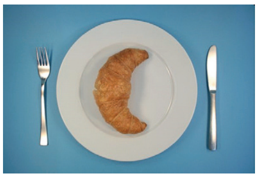
Häufigkeit

☐ täglich
☐ 1-2 mal pro Woche ☐ 3-4 mal pro Woche ☐ 5-6 mal pro Woche
☐ 1 mal pro Monat ☐ 2 mal pro Monat ☐ 3 mal pro Monat
☐ seltener ☐ nie

Anzahl Portionen

0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Portionsgrösse


☐ 45 g


☐ 90 g

Knäckebrot

Zu dieser Kategorie gehören z.B. auch Zwieback und Dar Vida

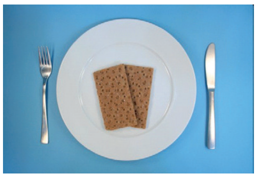
Häufigkeit

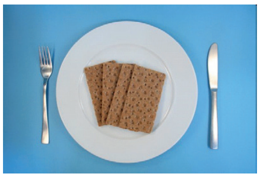
☐ täglich
☐ 1-2 mal pro Woche ☐ 3-4 mal pro Woche ☐ 5-6 mal pro Woche
☐ 1 mal pro Monat ☐ 2 mal pro Monat ☐ 3 mal pro Monat
☐ seltener ☐ nie

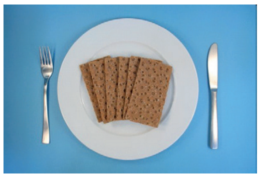
Anzahl Portionen

0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Portionsgrösse


☐ 20 g


☐ 40 g


☐ 60 g

49640

Butter / Margarine
als Brotaufstrich

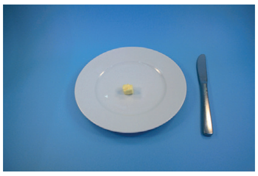
Häufigkeit

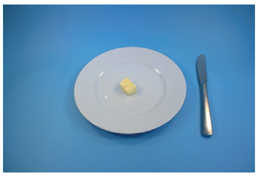
☐ täglich		
☐ 1-2 mal pro Woche	☐ 3-4 mal pro Woche	☐ 5-6 mal pro Woche
☐ 1 mal pro Monat	☐ 2 mal pro Monat	☐ 3 mal pro Monat
☐ seltener	☐ nie	

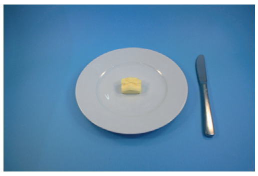
Anzahl Portionen

0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Portionsgrösse


☐ 5 g


☐ 10 g


☐ 20 g

Butter /Margarine fettreduziert
als Brotaufstrich

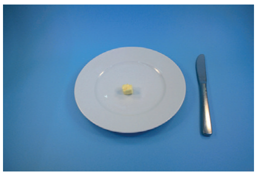
Häufigkeit

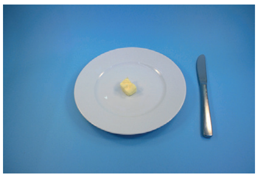
☐ täglich		
☐ 1-2 mal pro Woche	☐ 3-4 mal pro Woche	☐ 5-6 mal pro Woche
☐ 1 mal pro Monat	☐ 2 mal pro Monat	☐ 3 mal pro Monat
☐ seltener	☐ nie	

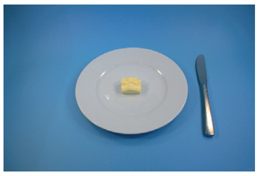
Anzahl Portionen

0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Portionsgrösse


☐ 5 g


☐ 10 g


☐ 20 g

49640

Konfitüre ohne Zucker

Häufigkeit

☐ täglich
☐ 1-2 mal pro Woche ☐ 3-4 mal pro Woche ☐ 5-6 mal pro Woche
☐ 1 mal pro Monat ☐ 2 mal pro Monat ☐ 3 mal pro Monat
☐ seltener ☐ nie

Anzahl Portionen

0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Portionsgrösse

☐ 12.5 g

☐ 37.5 g

☐ 25 g

Konfitüre

Häufigkeit

☐ täglich
☐ 1-2 mal pro Woche ☐ 3-4 mal pro Woche ☐ 5-6 mal pro Woche
☐ 1 mal pro Monat ☐ 2 mal pro Monat ☐ 3 mal pro Monat
☐ seltener ☐ nie

Anzahl Portionen

0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Portionsgrösse

☐ 12.5 g

☐ 37.5 g

☐ 25 g

49640

Honig

Häufigkeit

☐ täglich
☐ 1-2 mal pro Woche ☐ 3-4 mal pro Woche ☐ 5-6 mal pro Woche
☐ 1 mal pro Monat ☐ 2 mal pro Monat ☐ 3 mal pro Monat
☐ seltener ☐ nie

Anzahl Portionen

0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Portionsgrösse


☐ 12.5 g


☐ 25 g


☐ 37.5 g

Haselnuss-Schokolade-Brotaufstrich

Häufigkeit

☐ täglich
☐ 1-2 mal pro Woche ☐ 3-4 mal pro Woche ☐ 5-6 mal pro Woche
☐ 1 mal pro Monat ☐ 2 mal pro Monat ☐ 3 mal pro Monat
☐ seltener ☐ nie

Anzahl Portionen

0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Portionsgrösse


☐ 12.5 g


☐ 25 g


☐ 37.5 g

49640

Getreideprodukte / Kartoffeln / Hülsenfrüchte

Hülsenfrüchte

z.B. Linsen, Kichererbsen, rote und weisse Bohnen

Häufigkeit

☐ täglich
☐ 1-2 mal pro Woche ☐ 3-4 mal pro Woche ☐ 5-6 mal pro Woche
☐ 1 mal pro Monat ☐ 2 mal pro Monat ☐ 3 mal pro Monat
☐ seltener ☐ nie

Anzahl Portionen

0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Portionsgrösse

☐ 30 g

☐ 60 g

☐ 90 g

Rösti

Häufigkeit

☐ täglich
☐ 1-2 mal pro Woche ☐ 3-4 mal pro Woche ☐ 5-6 mal pro Woche
☐ 1 mal pro Monat ☐ 2 mal pro Monat ☐ 3 mal pro Monat
☐ seltener ☐ nie

Anzahl Portionen

0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Portionsgrösse

☐ 75 g

☐ 150 g

☐ 225 g

Pommes Frites

Zu dieser Kategorie zählen auch Ofen Frites

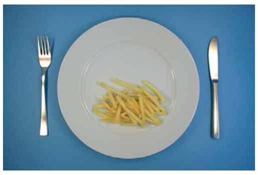
Häufigkeit

☐ täglich
☐ 1-2 mal pro Woche ☐ 3-4 mal pro Woche ☐ 5-6 mal pro Woche
☐ 1 mal pro Monat ☐ 2 mal pro Monat ☐ 3 mal pro Monat
☐ seltener ☐ nie

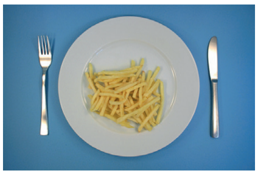
Anzahl Portionen

0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

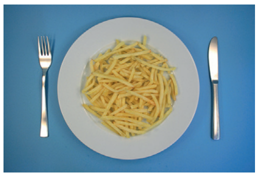
Portionsgrösse



☐ 45 g



☐ 90 g



☐ 135 g

49640

Kartoffeln

Zu dieser Kategorie gehören auch Kartoffelstock und Bratkartoffeln

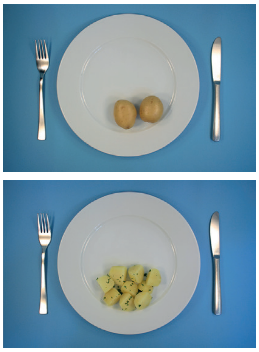
Häufigkeit

☐ täglich
☐ 1-2 mal pro Woche ☐ 3-4 mal pro Woche ☐ 5-6 mal pro Woche
☐ 1 mal pro Monat ☐ 2 mal pro Monat ☐ 3 mal pro Monat
☐ seltener ☐ nie

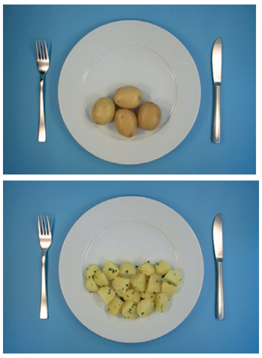
Anzahl Portionen

0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

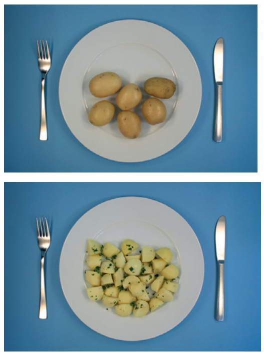
Portionsgrösse



☐ 90 g



☐ 180 g



☐ 270 g

Reis

Die Bilder entsprechen der gekochten Menge, die jeweilige Grammangabe dem Rohgewicht.

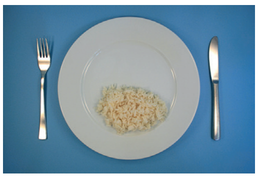
Häufigkeit

☐ täglich
☐ 1-2 mal pro Woche ☐ 3-4 mal pro Woche ☐ 5-6 mal pro Woche
☐ 1 mal pro Monat ☐ 2 mal pro Monat ☐ 3 mal pro Monat
☐ seltener ☐ nie

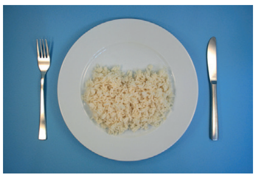
Anzahl Portionen

0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

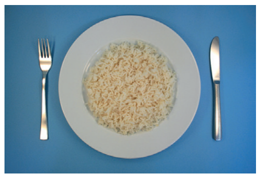
Portionsgrösse



☐ 30 g (roh)



☐ 60 g (roh)



☐ 90 g (roh)

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Vollkornreis

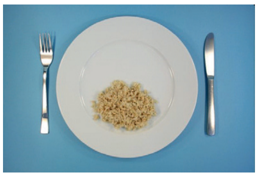
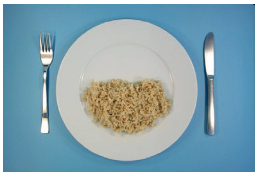
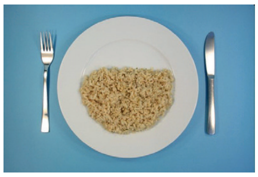
Die Bilder entsprechen der gekochten Menge, die jeweilige Grammangabe dem Rohgewicht.

Häufigkeit
☐ täglich
☐ 1-2 mal pro Woche ☐ 3-4 mal pro Woche ☐ 5-6 mal pro Woche
☐ 1 mal pro Monat ☐ 2 mal pro Monat ☐ 3 mal pro Monat
☐ seltener ☐ nie

Anzahl Portionen

0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Portionsgrösse

☐ 30 g (roh) ☐ 60 g (roh) ☐ 90 g (roh)

Teigwaren

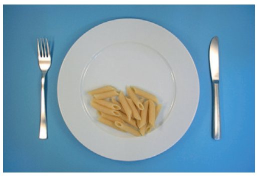
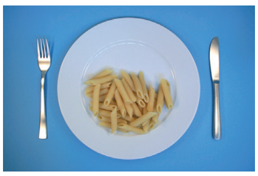
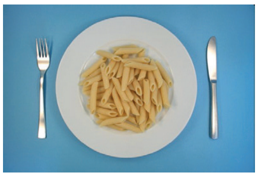
Die Bilder entsprechen der gekochten Menge, die jeweilige Grammangabe dem Rohgewicht.

Häufigkeit
☐ täglich
☐ 1-2 mal pro Woche ☐ 3-4 mal pro Woche ☐ 5-6 mal pro Woche
☐ 1 mal pro Monat ☐ 2 mal pro Monat ☐ 3 mal pro Monat
☐ seltener ☐ nie

Anzahl Portionen

0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Portionsgrösse

☐ 30 g (roh) ☐ 60 g (roh) ☐ 90 g (roh)

Vollkornteigwaren

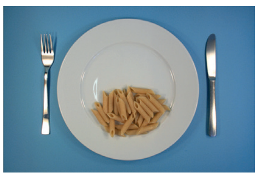
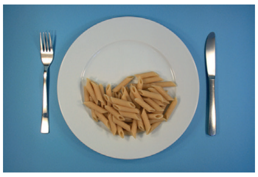
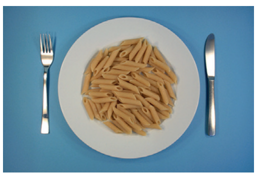
Die Bilder entsprechen der gekochten Menge, die jeweilige Grammangabe dem Rohgewicht.

Häufigkeit
☐ täglich
☐ 1-2 mal pro Woche ☐ 3-4 mal pro Woche ☐ 5-6 mal pro Woche
☐ 1 mal pro Monat ☐ 2 mal pro Monat ☐ 3 mal pro Monat
☐ seltener ☐ nie

Anzahl Portionen

0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Portionsgrösse

☐ 30 g (roh) ☐ 60 g (roh) ☐ 90 g (roh)

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Gefüllte Teigwaren

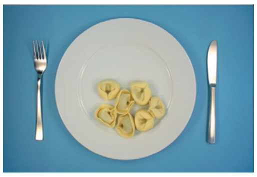
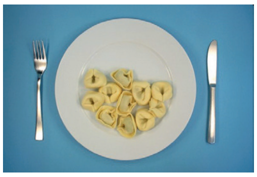
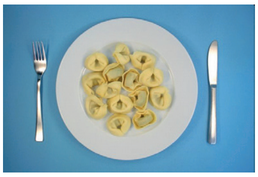
Die Bilder und Grammangabe entsprechen der gekochten Menge.

Häufigkeit
☐ täglich
☐ 1-2 mal pro Woche ☐ 3-4 mal pro Woche ☐ 5-6 mal pro Woche
☐ 1 mal pro Monat ☐ 2 mal pro Monat ☐ 3 mal pro Monat
☐ seltener ☐ nie

Anzahl Portionen

0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Portionsgrösse

☐ 60 g (gekocht) ☐ 120 g (gekocht) ☐ 180 g (gekocht)

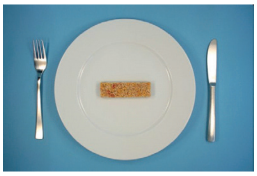
Getreideriegel

Häufigkeit
☐ täglich
☐ 1-2 mal pro Woche ☐ 3-4 mal pro Woche ☐ 5-6 mal pro Woche
☐ 1 mal pro Monat ☐ 2 mal pro Monat ☐ 3 mal pro Monat
☐ seltener ☐ nie

Anzahl Portionen

0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Portionsgrösse



☐ 20 g

49640

Müeslimischung / Cornflakes

in diese Kategorie gehören auch Getreideflocken und Frühstückscerealien

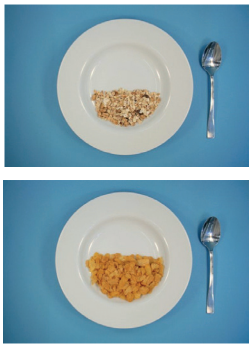
Häufigkeit

☐ täglich
☐ 1-2 mal pro Woche ☐ 3-4 mal pro Woche ☐ 5-6 mal pro Woche
☐ 1 mal pro Monat ☐ 2 mal pro Monat ☐ 3 mal pro Monat
☐ seltener ☐ nie

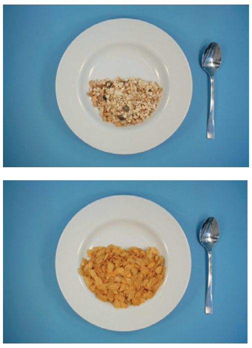
Anzahl Portionen

0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

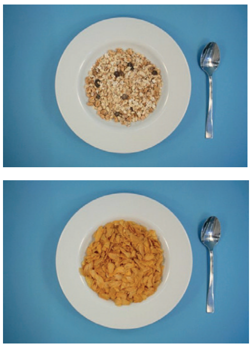
Portionsgrösse



☐ 20 g



☐ 40 g



☐ 60 g

Polenta (Griess)

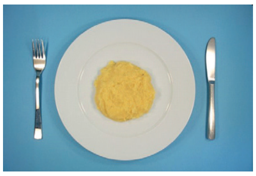
Häufigkeit

☐ täglich
☐ 1-2 mal pro Woche ☐ 3-4 mal pro Woche ☐ 5-6 mal pro Woche
☐ 1 mal pro Monat ☐ 2 mal pro Monat ☐ 3 mal pro Monat
☐ seltener ☐ nie

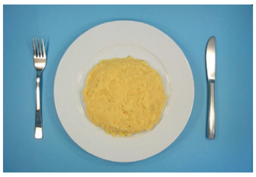
Anzahl Portionen

0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

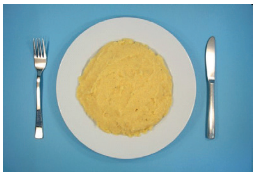
Portionsgrösse



☐ 30 g (roh)



☐ 60 g (roh)



☐ 90 g (roh)

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Gemüse

Tomate

ohne Tomatensauce

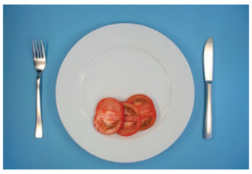
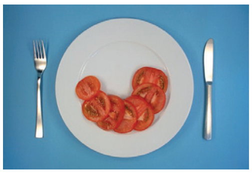
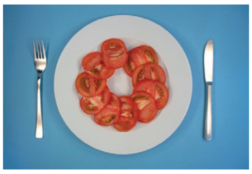
Häufigkeit

☐ täglich
☐ 1-2 mal pro Woche ☐ 3-4 mal pro Woche ☐ 5-6 mal pro Woche
☐ 1 mal pro Monat ☐ 2 mal pro Monat ☐ 3 mal pro Monat
☐ seltener ☐ nie

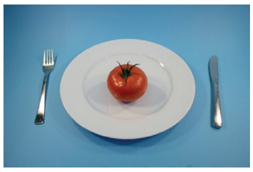
Anzahl Portionen

0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Portionsgrösse

☐ 60 g ☐ 120 g



☐ 180 g

Karotte

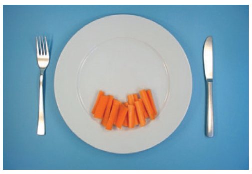
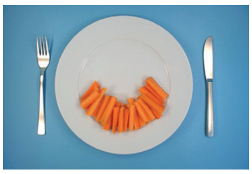
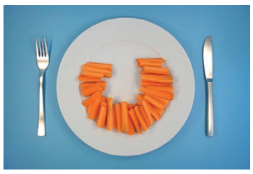
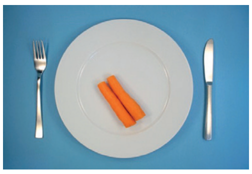
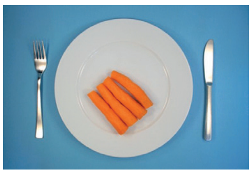
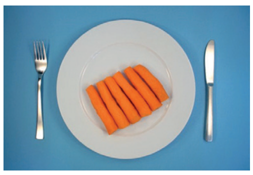
Häufigkeit

☐ täglich
☐ 1-2 mal pro Woche ☐ 3-4 mal pro Woche ☐ 5-6 mal pro Woche
☐ 1 mal pro Monat ☐ 2 mal pro Monat ☐ 3 mal pro Monat
☐ seltener ☐ nie

Anzahl Portionen

0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Portionsgrösse

☐ 60 g ☐ 120 g ☐ 180 g

49640

Gurke

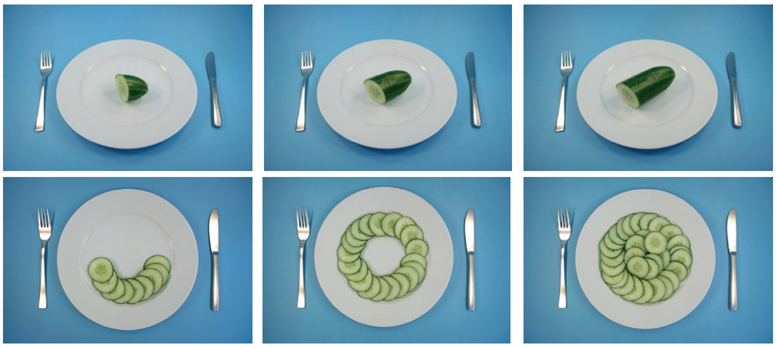
Häufigkeit

☐ täglich
☐ 1-2 mal pro Woche ☐ 3-4 mal pro Woche ☐ 5-6 mal pro Woche
☐ 1 mal pro Monat ☐ 2 mal pro Monat ☐ 3 mal pro Monat
☐ seltener ☐ nie

Anzahl Portionen

0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Portionsgrösse



☐ 60 g ☐ 120 g ☐ 180 g

Zwiebel

Zwiebeln in kalten und warmen Gerichten

Häufigkeit

☐ täglich
☐ 1-2 mal pro Woche ☐ 3-4 mal pro Woche ☐ 5-6 mal pro Woche
☐ 1 mal pro Monat ☐ 2 mal pro Monat ☐ 3 mal pro Monat
☐ seltener ☐ nie

Anzahl Portionen

0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Portionsgrösse

☐ 30 g ☐ 60 g ☐ 90 g

49640

Zucchetti

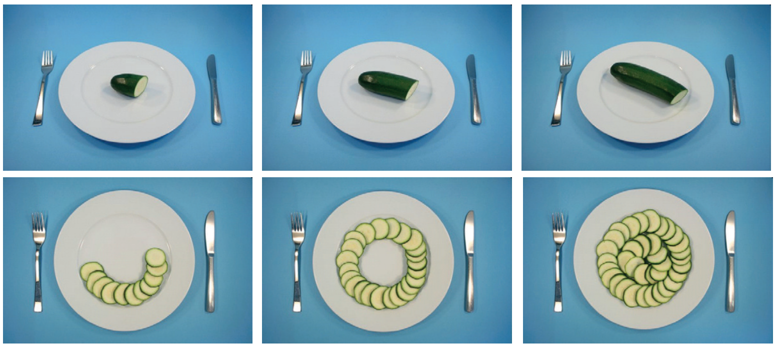
Häufigkeit

☐ täglich
☐ 1-2 mal pro Woche ☐ 3-4 mal pro Woche ☐ 5-6 mal pro Woche
☐ 1 mal pro Monat ☐ 2 mal pro Monat ☐ 3 mal pro Monat
☐ seltener ☐ nie

Anzahl Portionen

0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Portionsgrösse



☐ 60 g ☐ 120 g ☐ 180 g

Mischgemüse

Häufigkeit

☐ täglich
☐ 1-2 mal pro Woche ☐ 3-4 mal pro Woche ☐ 5-6 mal pro Woche
☐ 1 mal pro Monat ☐ 2 mal pro Monat ☐ 3 mal pro Monat
☐ seltener ☐ nie

Anzahl Portionen

0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Portionsgrösse

☐ 60 g ☐ 120 g ☐ 180 g

49640

Gemüsekonserven

In diese Kategorie gehören neben Mais auch andere Gemüse aus der Dose wie z.B. Pilze oder Spargeln.

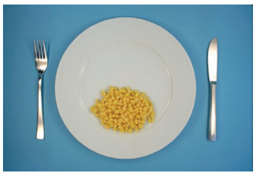
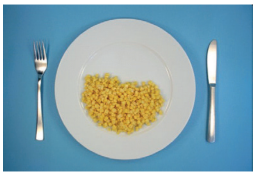
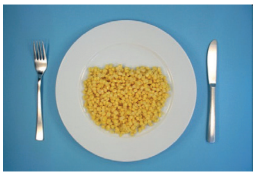
Häufigkeit

☐ täglich
☐ 1-2 mal pro Woche ☐ 3-4 mal pro Woche ☐ 5-6 mal pro Woche
☐ 1 mal pro Monat ☐ 2 mal pro Monat ☐ 3 mal pro Monat
☐ seltener ☐ nie

Anzahl Portionen

0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Portionsgrösse

☐ 60 g ☐ 120 g ☐ 180 g

Blattsalat

Alle Blattsalate wie z.B. Eisberg, Endivie, Kopfsalat oder Zuckerhut.

Häufigkeit

☐ täglich
☐ 1-2 mal pro Woche ☐ 3-4 mal pro Woche ☐ 5-6 mal pro Woche
☐ 1 mal pro Monat ☐ 2 mal pro Monat ☐ 3 mal pro Monat
☐ seltener ☐ nie

Anzahl Portionen

0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Portionsgrösse



☐ 30 g ☐ 60 g ☐ 90 g

Peperoni

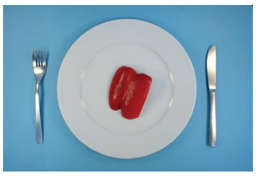
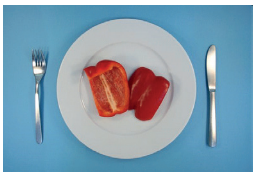
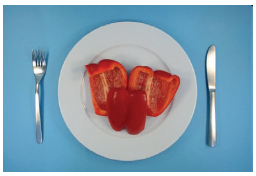
Häufigkeit

☐ täglich
☐ 1-2 mal pro Woche ☐ 3-4 mal pro Woche ☐ 5-6 mal pro Woche
☐ 1 mal pro Monat ☐ 2 mal pro Monat ☐ 3 mal pro Monat
☐ seltener ☐ nie

Anzahl Portionen

0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Portionsgrösse

☐ 60 g ☐ 120 g ☐ 180 g

49640

Pilze

Häufigkeit
☐ täglich
☐ 1-2 mal pro Woche ☐ 3-4 mal pro Woche ☐ 5-6 mal pro Woche
☐ 1 mal pro Monat ☐ 2 mal pro Monat ☐ 3 mal pro Monat
☐ seltener ☐ nie

Anzahl Portionen

0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Portionsgrösse


☐ 30 g


☐ 60 g


☐ 90 g

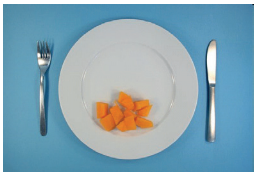
Kürbis

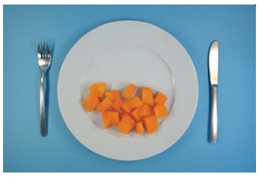
Häufigkeit
☐ täglich
☐ 1-2 mal pro Woche ☐ 3-4 mal pro Woche ☐ 5-6 mal pro Woche
☐ 1 mal pro Monat ☐ 2 mal pro Monat ☐ 3 mal pro Monat
☐ seltener ☐ nie

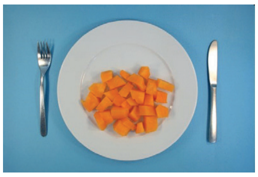
Anzahl Portionen

0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Portionsgrösse


☐ 60 g


☐ 120 g


☐ 180 g

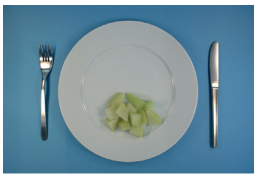
Kohlrabi

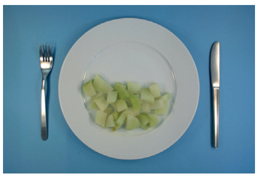
Häufigkeit
☐ täglich
☐ 1-2 mal pro Woche ☐ 3-4 mal pro Woche ☐ 5-6 mal pro Woche
☐ 1 mal pro Monat ☐ 2 mal pro Monat ☐ 3 mal pro Monat
☐ seltener ☐ nie

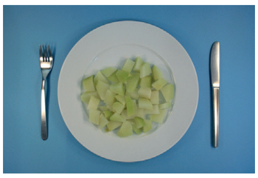
Anzahl Portionen

0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Portionsgrösse


☐ 60 g


☐ 120 g


☐ 180 g

49640

Aubergine

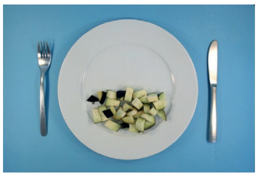
Häufigkeit

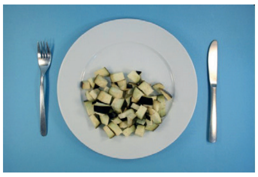
☐ täglich
☐ 1-2 mal pro Woche ☐ 3-4 mal pro Woche ☐ 5-6 mal pro Woche
☐ 1 mal pro Monat ☐ 2 mal pro Monat ☐ 3 mal pro Monat
☐ seltener ☐ nie

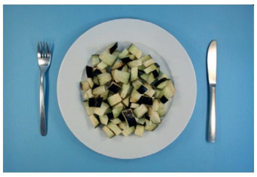
Anzahl Portionen

0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Portionsgrösse


☐ 60 g


☐ 120 g


☐ 180 g

Bohnen grün

Häufigkeit

☐ täglich
☐ 1-2 mal pro Woche ☐ 3-4 mal pro Woche ☐ 5-6 mal pro Woche
☐ 1 mal pro Monat ☐ 2 mal pro Monat ☐ 3 mal pro Monat
☐ seltener ☐ nie

Anzahl Portionen

0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Portionsgrösse


☐ 60 g


☐ 120 g


☐ 180 g

Spargel

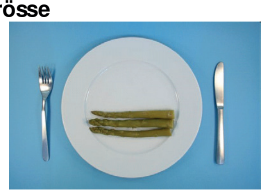
Häufigkeit

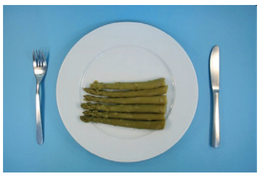
☐ täglich
☐ 1-2 mal pro Woche ☐ 3-4 mal pro Woche ☐ 5-6 mal pro Woche
☐ 1 mal pro Monat ☐ 2 mal pro Monat ☐ 3 mal pro Monat
☐ seltener ☐ nie

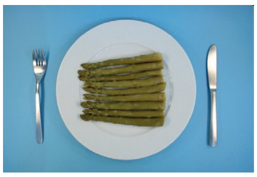
Anzahl Portionen

0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Portionsgrösse


☐ 60 g


☐ 120 g


☐ 180 g

49640

Kohlgemüse (Rotkohl, Weisskohl, Wirz)

Häufigkeit

☐ täglich
☐ 1-2 mal pro Woche ☐ 3-4 mal pro Woche ☐ 5-6 mal pro Woche
☐ 1 mal pro Monat ☐ 2 mal pro Monat ☐ 3 mal pro Monat
☐ seltener ☐ nie

Anzahl Portionen

0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Portionsgrösse


☐ 60 g


☐ 120 g


☐ 180 g

Sellerie

Häufigkeit

☐ täglich
☐ 1-2 mal pro Woche ☐ 3-4 mal pro Woche ☐ 5-6 mal pro Woche
☐ 1 mal pro Monat ☐ 2 mal pro Monat ☐ 3 mal pro Monat
☐ seltener ☐ nie

Anzahl Portionen

0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Portionsgrösse


☐ 60 g


☐ 120 g


☐ 180 g

Broccoli

Häufigkeit

☐ täglich
☐ 1-2 mal pro Woche ☐ 3-4 mal pro Woche ☐ 5-6 mal pro Woche
☐ 1 mal pro Monat ☐ 2 mal pro Monat ☐ 3 mal pro Monat
☐ seltener ☐ nie

Anzahl Portionen

0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Portionsgrösse


☐ 60 g


☐ 120 g


☐ 180 g

49640

Lauch

Häufigkeit

☐ täglich
☐ 1-2 mal pro Woche ☐ 3-4 mal pro Woche ☐ 5-6 mal pro Woche
☐ 1 mal pro Monat ☐ 2 mal pro Monat ☐ 3 mal pro Monat
☐ seltener ☐ nie

Anzahl Portionen

0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Portionsgrösse


☐ 60 g


☐ 120 g


☐ 180 g

Blumenkoh

Häufigkeit

☐ täglich
☐ 1-2 mal pro Woche ☐ 3-4 mal pro Woche ☐ 5-6 mal pro Woche
☐ 1 mal pro Monat ☐ 2 mal pro Monat ☐ 3 mal pro Monat
☐ seltener ☐ nie

Anzahl Portionen

0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Portionsgrösse


☐ 60 g


☐ 120 g


☐ 180 g

49640

Früchte

Apfel

Häufigkeit

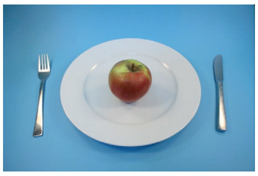
☐ täglich
☐ 1-2 mal pro Woche ☐ 3-4 mal pro Woche ☐ 5-6 mal pro Woche
☐ 1 mal pro Monat ☐ 2 mal pro Monat ☐ 3 mal pro Monat
☐ seltener ☐ nie

Anzahl Portionen

0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Portionsgrösse

☐ 120 g



☐ 180 g

Banane

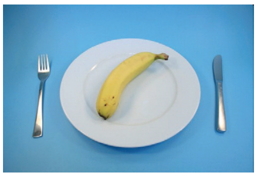
Häufigkeit

☐ täglich
☐ 1-2 mal pro Woche ☐ 3-4 mal pro Woche ☐ 5-6 mal pro Woche
☐ 1 mal pro Monat ☐ 2 mal pro Monat ☐ 3 mal pro Monat
☐ seltener ☐ nie

Anzahl Portionen

0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Portionsgrösse



☐ 160 g

Orange

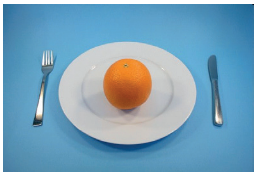
Häufigkeit

☐ täglich
☐ 1-2 mal pro Woche ☐ 3-4 mal pro Woche ☐ 5-6 mal pro Woche
☐ 1 mal pro Monat ☐ 2 mal pro Monat ☐ 3 mal pro Monat
☐ seltener ☐ nie

Anzahl Portionen

0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Portionsgrösse



☐ 180 g

49640

Mandarine / Clementine

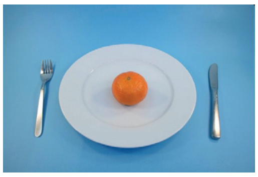
Häufigkeit

☐ täglich		
☐ 1-2 mal pro Woche	☐ 3-4 mal pro Woche	☐ 5-6 mal pro Woche
☐ 1 mal pro Monat	☐ 2 mal pro Monat	☐ 3 mal pro Monat
☐ seltener	☐ nie	

Anzahl Portionen

0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Portionsgrösse



☐ 70 g

Trauben

Häufigkeit

☐ täglich		
☐ 1-2 mal pro Woche	☐ 3-4 mal pro Woche	☐ 5-6 mal pro Woche
☐ 1 mal pro Monat	☐ 2 mal pro Monat	☐ 3 mal pro Monat
☐ seltener	☐ nie	

Anzahl Portionen

0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Portionsgrösse

☐ 60 g

☐ 120 g

☐ 180 g

Beeren

Alle Arten von Beeren

Häufigkeit

☐ täglich		
☐ 1-2 mal pro Woche	☐ 3-4 mal pro Woche	☐ 5-6 mal pro Woche
☐ 1 mal pro Monat	☐ 2 mal pro Monat	☐ 3 mal pro Monat
☐ seltener	☐ nie	

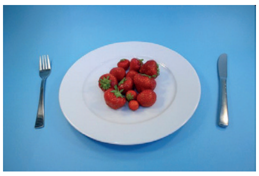
Anzahl Portionen

0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Portionsgrösse

☐ 60 g

☐ 120 g



☐ 180 g

49640

Kiwi

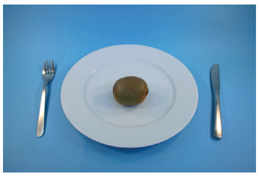
Häufigkeit

☐ täglich
☐ 1-2 mal pro Woche ☐ 3-4 mal pro Woche ☐ 5-6 mal pro Woche
☐ 1 mal pro Monat ☐ 2 mal pro Monat ☐ 3 mal pro Monat
☐ seltener ☐ nie

Anzahl Portionen

0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Portionsgrösse



☐ 80 g

Fruchtkonserven

Beinhaltet neben Apfelmus auch andere Fruchtkonserven wie z.B. Ananas, Aprikosen oder Fruchtcocktail.

Häufigkeit

☐ täglich
☐ 1-2 mal pro Woche ☐ 3-4 mal pro Woche ☐ 5-6 mal pro Woche
☐ 1 mal pro Monat ☐ 2 mal pro Monat ☐ 3 mal pro Monat
☐ seltener ☐ nie

Anzahl Portionen

0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Portionsgrösse

☐ 60 g

☐ 120 g

☐ 180 g

Fruchtkonserven ungezuckert

Zu dieser Kategorie gehören neben Produkten mit Süssstoffen auch Früchte im eigenen Saft.

Häufigkeit

☐ täglich
☐ 1-2 mal pro Woche ☐ 3-4 mal pro Woche ☐ 5-6 mal pro Woche
☐ 1 mal pro Monat ☐ 2 mal pro Monat ☐ 3 mal pro Monat
☐ seltener ☐ nie

Anzahl Portionen

0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Portionsgrösse

☐ 60 g

☐ 120 g

☐ 180 g

49640

Trockenfrüchte

Alle Sorten

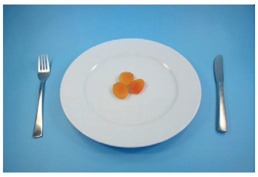
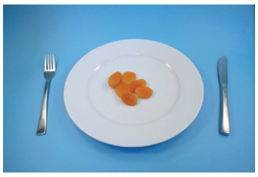
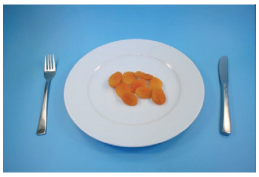
Häufigkeit

☐ täglich
☐ 1-2 mal pro Woche ☐ 3-4 mal pro Woche ☐ 5-6 mal pro Woche
☐ 1 mal pro Monat ☐ 2 mal pro Monat ☐ 3 mal pro Monat
☐ seltener ☐ nie

Anzahl Portionen

0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Portionsgrösse

☐ 20 g ☐ 40 g ☐ 60 g

Exotische Früchte (z.B. Ananas, Mango)

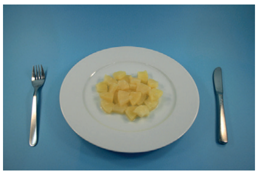
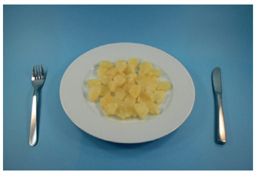
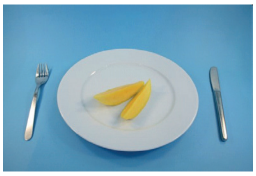
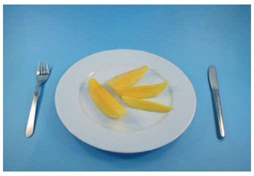
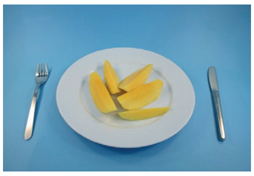
Häufigkeit

☐ täglich
☐ 1-2 mal pro Woche ☐ 3-4 mal pro Woche ☐ 5-6 mal pro Woche
☐ 1 mal pro Monat ☐ 2 mal pro Monat ☐ 3 mal pro Monat
☐ seltener ☐ nie

Anzahl Portionen

0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Portionsgrösse

☐ 60 g ☐ 120 g ☐ 180 g

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Birne

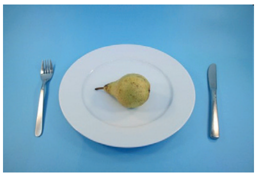
Häufigkeit

☐ täglich
☐ 1-2 mal pro Woche ☐ 3-4 mal pro Woche ☐ 5-6 mal pro Woche
☐ 1 mal pro Monat ☐ 2 mal pro Monat ☐ 3 mal pro Monat
☐ seltener ☐ nie

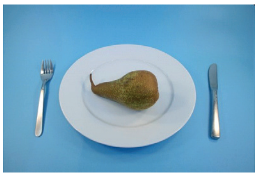
Anzahl Portionen

0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Portionsgrösse



☐ 120 g



☐ 180 g

Steinobst (z.B. Pfirsich, Aprikose)

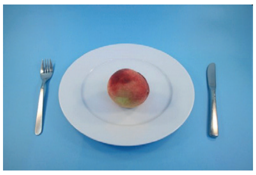
Häufigkeit

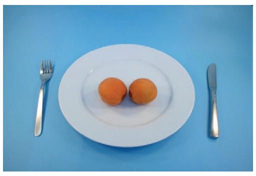
☐ täglich
☐ 1-2 mal pro Woche ☐ 3-4 mal pro Woche ☐ 5-6 mal pro Woche
☐ 1 mal pro Monat ☐ 2 mal pro Monat ☐ 3 mal pro Monat
☐ seltener ☐ nie

Anzahl Portionen

0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Portionsgrösse





☐ 130 g

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Melone

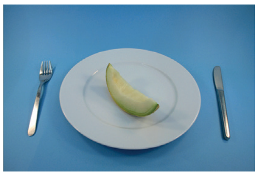
Häufigkeit

☐ täglich		
☐ 1-2 mal pro Woche	☐ 3-4 mal pro Woche	☐ 5-6 mal pro Woche
☐ 1 mal pro Monat	☐ 2 mal pro Monat	☐ 3 mal pro Monat
☐ seltener	☐ nie	

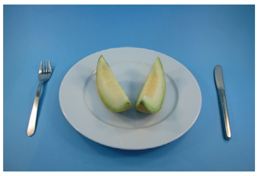
Anzahl Portionen

0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

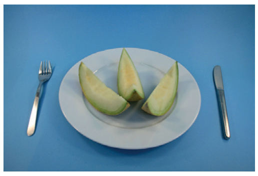
Portionsgrösse



☐ 60 g



☐ 120 g



☐ 180 g

Saucen / Suppen

Suppe

Selbst hergestellte, Beutel- und Instantsuppen

Häufigkeit

☐ täglich		
☐ 1-2 mal pro Woche	☐ 3-4 mal pro Woche	☐ 5-6 mal pro Woche
☐ 1 mal pro Monat	☐ 2 mal pro Monat	☐ 3 mal pro Monat
☐ seltener	☐ nie	

Anzahl Portionen

0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Portionsgrösse

☐ 1 dl

☐ 2 dl

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Mayonnaise

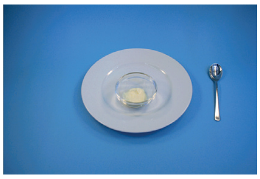
Häufigkeit

☐ täglich
☐ 1-2 mal pro Woche ☐ 3-4 mal pro Woche ☐ 5-6 mal pro Woche
☐ 1 mal pro Monat ☐ 2 mal pro Monat ☐ 3 mal pro Monat
☐ seltener ☐ nie

Anzahl Portionen

0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Portionsgrösse



☐ 10 g

☐ 20 g

☐ 30 g

Ketchup

Häufigkeit

☐ täglich
☐ 1-2 mal pro Woche ☐ 3-4 mal pro Woche ☐ 5-6 mal pro Woche
☐ 1 mal pro Monat ☐ 2 mal pro Monat ☐ 3 mal pro Monat
☐ seltener ☐ nie

Anzahl Portionen

0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Portionsgrösse

☐ 10 g

☐ 20 g

☐ 30 g

Salatsauce

Alle Sorten.

Häufigkeit

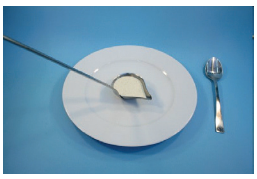
☐ täglich
☐ 1-2 mal pro Woche ☐ 3-4 mal pro Woche ☐ 5-6 mal pro Woche
☐ 1 mal pro Monat ☐ 2 mal pro Monat ☐ 3 mal pro Monat
☐ seltener ☐ nie

Anzahl Portionen

0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Portionsgrösse

☐ 20 ml



☐ 40 ml

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Tomatensauce

Die Mengenangaben beziehen sich nur auf die Tomatensauce

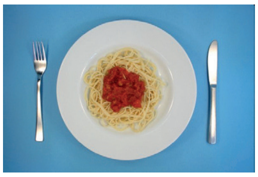
Häufigkeit

- ☐ täglich
- ☐ 1-2 mal pro Woche ☐ 3-4 mal pro Woche ☐ 5-6 mal pro Woche
- ☐ 1 mal pro Monat ☐ 2 mal pro Monat ☐ 3 mal pro Monat
- ☐ seltener ☐ nie

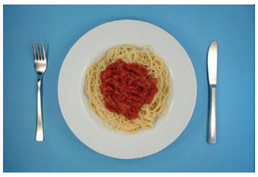
Anzahl Portionen

0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

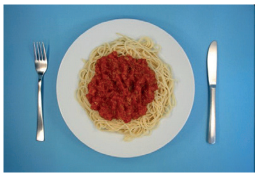
Portionsgrösse



☐ 50 g



☐ 100 g



☐ 150 g

Bratensauce

z.B. Bratensauce oder Jägersauce

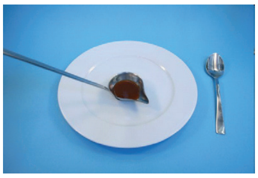
Häufigkeit

- ☐ täglich
- ☐ 1-2 mal pro Woche ☐ 3-4 mal pro Woche ☐ 5-6 mal pro Woche
- ☐ 1 mal pro Monat ☐ 2 mal pro Monat ☐ 3 mal pro Monat
- ☐ seltener ☐ nie

Anzahl Portionen

0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Portionsgrösse



☐ 20 ml

☐ 40 ml

Weisse Sauce

z.B. Béchamelsauce, Sauce Hollandaise.

Häufigkeit

- ☐ täglich
- ☐ 1-2 mal pro Woche ☐ 3-4 mal pro Woche ☐ 5-6 mal pro Woche
- ☐ 1 mal pro Monat ☐ 2 mal pro Monat ☐ 3 mal pro Monat
- ☐ seltener ☐ nie

Anzahl Portionen

0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Portionsgrösse

☐ 20 ml

☐ 40 ml

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Snacks / Süsses

Glace

Alle Arten und Formen von Glace

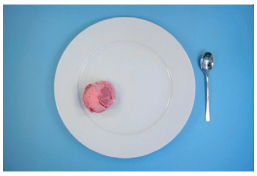
Häufigkeit

☐ täglich
☐ 1-2 mal pro Woche ☐ 3-4 mal pro Woche ☐ 5-6 mal pro Woche
☐ 1 mal pro Monat ☐ 2 mal pro Monat ☐ 3 mal pro Monat
☐ seltener ☐ nie

Anzahl Portionen

0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Portionsgrösse


☐ 50 g


☐ 100 g


☐ 150 g

Glace fettreduziert, energievermindert

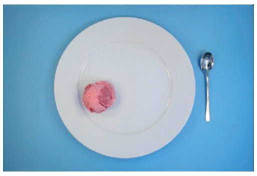
Häufigkeit

☐ täglich
☐ 1-2 mal pro Woche ☐ 3-4 mal pro Woche ☐ 5-6 mal pro Woche
☐ 1 mal pro Monat ☐ 2 mal pro Monat ☐ 3 mal pro Monat
☐ seltener ☐ nie

Anzahl Portionen

0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Portionsgrösse


☐ 50 g


☐ 100 g


☐ 150 g

Creme / Pudding

Pudding, Flan und Cremen in allen Geschmacksrichtungen

Häufigkeit

☐ täglich
☐ 1-2 mal pro Woche ☐ 3-4 mal pro Woche ☐ 5-6 mal pro Woche
☐ 1 mal pro Monat ☐ 2 mal pro Monat ☐ 3 mal pro Monat
☐ seltener ☐ nie

Anzahl Portionen

0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Portionsgrösse


☐ 75 g


☐ 150 g


☐ 225 g

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Guetzli

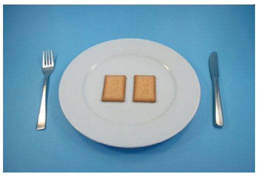
Häufigkeit

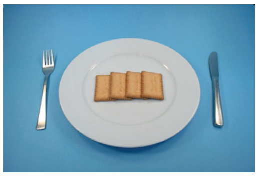
☐ täglich
☐ 1-2 mal pro Woche ☐ 3-4 mal pro Woche ☐ 5-6 mal pro Woche
☐ 1 mal pro Monat ☐ 2 mal pro Monat ☐ 3 mal pro Monat
☐ seltener ☐ nie

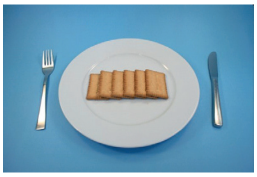
Anzahl Portionen

0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Portionsgrösse


☐ 15 g


☐ 30 g


☐ 45 g

Fruchtwähe

Häufigkeit

☐ täglich
☐ 1-2 mal pro Woche ☐ 3-4 mal pro Woche ☐ 5-6 mal pro Woche
☐ 1 mal pro Monat ☐ 2 mal pro Monat ☐ 3 mal pro Monat
☐ seltener ☐ nie

Anzahl Portionen

0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Portionsgrösse


☐ 220 g

Kuchen

Kuchen, Cakes oder Torten

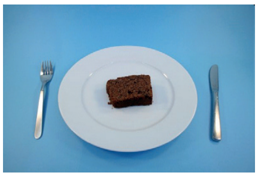
Häufigkeit

☐ täglich
☐ 1-2 mal pro Woche ☐ 3-4 mal pro Woche ☐ 5-6 mal pro Woche
☐ 1 mal pro Monat ☐ 2 mal pro Monat ☐ 3 mal pro Monat
☐ seltener ☐ nie

Anzahl Portionen

0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Portionsgrösse


☐ 50 g


☐ 120 g

49640

Süssgebäck

Süsses Gebäck wie Mandel- oder Nussgipfel

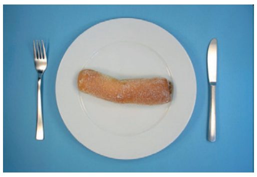
Häufigkeit

☐ täglich
☐ 1-2 mal pro Woche ☐ 3-4 mal pro Woche ☐ 5-6 mal pro Woche
☐ 1 mal pro Monat ☐ 2 mal pro Monat ☐ 3 mal pro Monat
☐ seltener ☐ nie

Anzahl Portionen

0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Portionsgrösse



☐ 110 g

Schokolade

Alle Arten und Formen von Schokolade

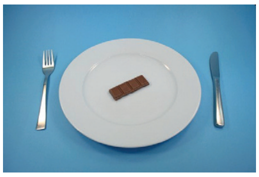
Häufigkeit

☐ täglich
☐ 1-2 mal pro Woche ☐ 3-4 mal pro Woche ☐ 5-6 mal pro Woche
☐ 1 mal pro Monat ☐ 2 mal pro Monat ☐ 3 mal pro Monat
☐ seltener ☐ nie

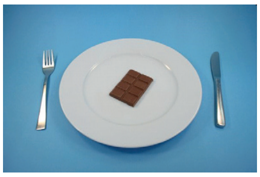
Anzahl Portionen

0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

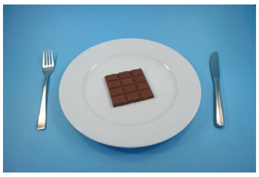
Portionsgrösse



☐ 17 g



☐ 34 g



☐ 50 g

Nüsse

Alle Nüsse und Nussmischungen

Häufigkeit

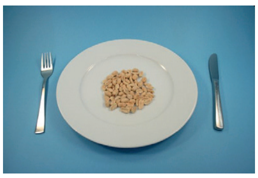
☐ täglich
☐ 1-2 mal pro Woche ☐ 3-4 mal pro Woche ☐ 5-6 mal pro Woche
☐ 1 mal pro Monat ☐ 2 mal pro Monat ☐ 3 mal pro Monat
☐ seltener ☐ nie

Anzahl Portionen

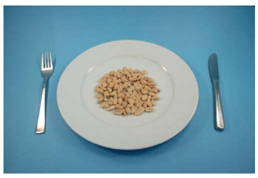
0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Portionsgrösse

☐ 15 g



☐ 30 g



☐ 45 g

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Pommes Chips

Häufigkeit

☐ täglich
☐ 1-2 mal pro Woche ☐ 3-4 mal pro Woche ☐ 5-6 mal pro Woche
☐ 1 mal pro Monat ☐ 2 mal pro Monat ☐ 3 mal pro Monat
☐ seltener ☐ nie

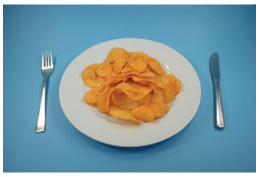
Anzahl Portionen

0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Portionsgrösse


☐ 15 g


☐ 30 g


☐ 45 g

Zusammengesetzte Speisen

Kebab

Häufigkeit

☐ täglich
☐ 1-2 mal pro Woche ☐ 3-4 mal pro Woche ☐ 5-6 mal pro Woche
☐ 1 mal pro Monat ☐ 2 mal pro Monat ☐ 3 mal pro Monat
☐ seltener ☐ nie

Anzahl Portionen

0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Portionsgrösse


☐ 330 g

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Hamburger

Häufigkeit

☐ täglich
☐ 1-2 mal pro Woche ☐ 3-4 mal pro Woche ☐ 5-6 mal pro Woche
☐ 1 mal pro Monat ☐ 2 mal pro Monat ☐ 3 mal pro Monat
☐ seltener ☐ nie

Anzahl Portionen

0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Portionsgrösse

☐ 130 g

Pizza

Häufigkeit

☐ täglich
☐ 1-2 mal pro Woche ☐ 3-4 mal pro Woche ☐ 5-6 mal pro Woche
☐ 1 mal pro Monat ☐ 2 mal pro Monat ☐ 3 mal pro Monat
☐ seltener ☐ nie

Anzahl Portionen

0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Portionsgrösse

☐ 160 g

☐ 320 g

Lasagne

Lasagne mit Fleisch

Häufigkeit

☐ täglich
☐ 1-2 mal pro Woche ☐ 3-4 mal pro Woche ☐ 5-6 mal pro Woche
☐ 1 mal pro Monat ☐ 2 mal pro Monat ☐ 3 mal pro Monat
☐ seltener ☐ nie

Anzahl Portionen

0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Portionsgrösse

☐ 150 g

☐ 300 g

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Getränke

Wasser

Mineralwasser mit und ohne Kohlensäure, Hahnenwasser

Häufigkeit

☐ täglich
☐ 1-2 mal pro Woche ☐ 3-4 mal pro Woche ☐ 5-6 mal pro Woche
☐ 1 mal pro Monat ☐ 2 mal pro Monat ☐ 3 mal pro Monat
☐ seltener ☐ nie

Anzahl Portionen

0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Portionsgrösse

  

☐ 1 dl ☐ 2 dl ☐ 3 dl

Tee

Schwarz-, Grün- und Kräutertee

Häufigkeit

☐ täglich
☐ 1-2 mal pro Woche ☐ 3-4 mal pro Woche ☐ 5-6 mal pro Woche
☐ 1 mal pro Monat ☐ 2 mal pro Monat ☐ 3 mal pro Monat
☐ seltener ☐ nie

Anzahl Portionen

0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Portionsgrösse

 

☐ 1.5 dl ☐ 3 dl

Wie trinken Sie Ihren Tee?	**Anzahl Portionen des Zusatzes**			
☐ Ohne Zucker oder mit Süssstoffen				
☐ Mit Würfelzucker	1 ☐	2 ☐	3 ☐	4 ☐
☐ Mit TL Zucker	1 ☐	2 ☐	3 ☐	4 ☐
☐ Ohne Kafferähmli oder Milch				
☐ Mit Kafferähmli	1 ☐	2 ☐	3 ☐	
☐ Mit Milch (dl)	0.25 ☐	0.5 ☐	0.75 ☐	1 ☐

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Kaffee

Häufigkeit

☐ täglich
☐ 1-2 mal pro Woche ☐ 3-4 mal pro Woche ☐ 5-6 mal pro Woche
☐ 1 mal pro Monat ☐ 2 mal pro Monat ☐ 3 mal pro Monat
☐ seltener ☐ nie

Anzahl Portionen

0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Portionsgrösse


☐ 50 ml g


☐ 150 ml

Wie trinken Sie Ihren Kaffe?

Anzahl Portionen des Zusatzes

☐ Ohne Zucker oder mit Süssstoffen

☐ Mit Würfelzucker	1 ☐	2 ☐	3 ☐	4 ☐
☐ Mit TL Zucker	1 ☐	2 ☐	3 ☐	4 ☐

☐ Ohne Kafferähmli oder Milch

☐ Mit Kafferähmli	1 ☐	2 ☐	3 ☐	
☐ Mit Milch (dl)	0.25 ☐	0.5 ☐	0.75 ☐	1 ☐

Fruchtsaft

Alle Sorten

Häufigkeit

☐ täglich
☐ 1-2 mal pro Woche ☐ 3-4 mal pro Woche ☐ 5-6 mal pro Woche
☐ 1 mal pro Monat ☐ 2 mal pro Monat ☐ 3 mal pro Monat
☐ seltener ☐ nie

Anzahl Portionen

0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Portionsgrösse


☐ 1 dl


☐ 2 dl


☐ 3 dl

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Gemüsesaft
Alle Sorten

Häufigkeit
☐ täglich
☐ 1-2 mal pro Woche ☐ 3-4 mal pro Woche ☐ 5-6 mal pro Woche
☐ 1 mal pro Monat ☐ 2 mal pro Monat ☐ 3 mal pro Monat
☐ seltener ☐ nie

Anzahl Portionen

0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Portionsgrösse


☐ 1 dl


☐ 2 dl


☐ 3 dl

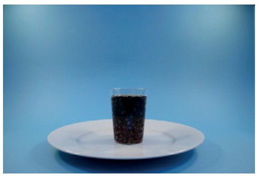
Softdrinks
z.B. Coca-Cola, Eistee, Limonaden etc.

Häufigkeit
☐ täglich
☐ 1-2 mal pro Woche ☐ 3-4 mal pro Woche ☐ 5-6 mal pro Woche
☐ 1 mal pro Monat ☐ 2 mal pro Monat ☐ 3 mal pro Monat
☐ seltener ☐ nie

Anzahl Portionen

0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Portionsgrösse


☐ 1 dl


☐ 2 dl


☐ 3 dl

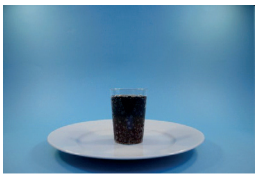
Softdrinks ohne Zucker
z.B. Coca-Cola Light, Limonaden ohne Zucker etc.

Häufigkeit
☐ täglich
☐ 1-2 mal pro Woche ☐ 3-4 mal pro Woche ☐ 5-6 mal pro Woche
☐ 1 mal pro Monat ☐ 2 mal pro Monat ☐ 3 mal pro Monat
☐ seltener ☐ nie

Anzahl Portionen

0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Portionsgrösse


☐ 1 dl


☐ 2 dl


☐ 3 dl

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Bier

Häufigkeit

☐ täglich
☐ 1-2 mal pro Woche ☐ 3-4 mal pro Woche ☐ 5-6 mal pro Woche
☐ 1 mal pro Monat ☐ 2 mal pro Monat ☐ 3 mal pro Monat
☐ seltener ☐ nie

Anzahl Portionen

0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Portionsgrösse

☐ 3 dl

Wein

Rot-, Rosé- und Weisswein.

Häufigkeit

☐ täglich
☐ 1-2 mal pro Woche ☐ 3-4 mal pro Woche ☐ 5-6 mal pro Woche
☐ 1 mal pro Monat ☐ 2 mal pro Monat ☐ 3 mal pro Monat
☐ seltener ☐ nie

Anzahl Portionen

0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Portionsgrösse

☐ 1 dl

Spirituosen

Hochprozentige alkoholische Getränke wie z.B. Kirsch, Grappa oder Whisky

Häufigkeit

☐ täglich
☐ 1-2 mal pro Woche ☐ 3-4 mal pro Woche ☐ 5-6 mal pro Woche
☐ 1 mal pro Monat ☐ 2 mal pro Monat ☐ 3 mal pro Monat
☐ seltener ☐ nie

Anzahl Portionen

0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Portionsgrösse

☐ 2 cl

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Zubereitung

Rahm

zum Kochen und für Desserts

Häufigkeit

☐ täglich
☐ 1-2 mal pro Woche ☐ 3-4 mal pro Woche ☐ 5-6 mal pro Woche
☐ 1 mal pro Monat ☐ 2 mal pro Monat ☐ 3 mal pro Monat
☐ seltener ☐ nie

Anzahl Portionen

0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Portionsgrösse


☐ 0.5 dl


☐ 1 dl


☐ 2 dl

Butter / Margarine

Butter oder Margarine zum Abschmecken von Gemüse, Teigwaren, Reis etc.

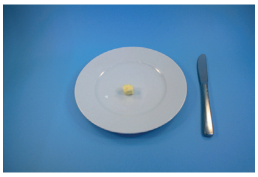
Häufigkeit

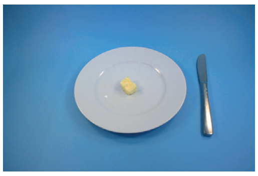
☐ täglich
☐ 1-2 mal pro Woche ☐ 3-4 mal pro Woche ☐ 5-6 mal pro Woche
☐ 1 mal pro Monat ☐ 2 mal pro Monat ☐ 3 mal pro Monat
☐ seltener ☐ nie

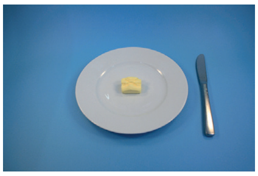
Anzahl Portionen

0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Portionsgrösse


☐ 5 g


☐ 10 g


☐ 15 g

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Fett und Öl

nur für die warme Küche, ohne Salatsauce

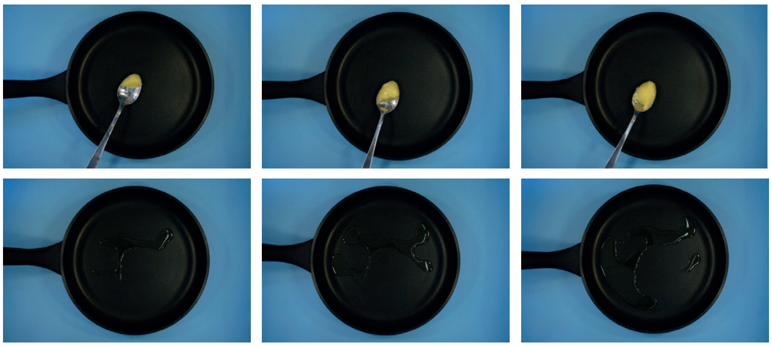
Häufigkeit

☐ täglich
☐ 1-2 mal pro Woche ☐ 3-4 mal pro Woche ☐ 5-6 mal pro Woche
☐ 1 mal pro Monat ☐ 2 mal pro Monat ☐ 3 mal pro Monat
☐ seltener ☐ nie

Anzahl Portionen

0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Portionsgrösse



☐ 5 g ☐ 10 g ☐ 15 g

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ZUSATZFRAGEN ZUR ERNÄHRUNG

Wie oft essen Sie pro Woche auswärts (Restaurant, Kantine, Take away)?

Mittags:	nie ☐	1 mal ☐	2 mal ☐	3 mal ☐	4 mal ☐	5 mal ☐	6 mal ☐	7 mal ☐
Abends:	nie ☐	1 mal ☐	2 mal ☐	3 mal ☐	4 mal ☐	5 mal ☐	6 mal ☐	7 mal ☐

Wie oft essen Sie pro Woche die folgenden Mahlzeiten?

Frühstück:	nie ☐	1 mal ☐	2 mal ☐	3 mal ☐	4 mal ☐	5 mal ☐	6 mal ☐	7 mal ☐
Znüni / Zwischen-verpflegung:	nie ☐	1 mal ☐	2 mal ☐	3 mal ☐	4 mal ☐	5 mal ☐	6 mal ☐	7 mal ☐
Mittagessen:	nie ☐	1 mal ☐	2 mal ☐	3 mal ☐	4 mal ☐	5 mal ☐	6 mal ☐	7 mal ☐
Zvieri / Zwischen-verpflegung:	nie ☐	1 mal ☐	2 mal ☐	3 mal ☐	4 mal ☐	5 mal ☐	6 mal ☐	7 mal ☐
Nachtessen:	nie ☐	1 mal ☐	2 mal ☐	3 mal ☐	4 mal ☐	5 mal ☐	6 mal ☐	7 mal ☐
Spätimbiss:	nie ☐	1 mal ☐	2 mal ☐	3 mal ☐	4 mal ☐	5 mal ☐	6 mal ☐	7 mal ☐

Nehmen Sie ein Vitamin- Mineralstoffpräparat

☐ nie
☐ Selten
☐ Pro Monat 1 mal
☐ Pro Monat 2 mal
☐ Pro Monat 3 mal
☐ Pro Monat 1-2 mal
☐ Pro Monat 3-4 mal
☐ Pro Monat 5-7 mal

Wie oft kaufen Sie die folgenden Lebensmittel(-gruppen) als Bioprodukte? (Wenn Sie selbst einkaufen oder eine andere Person für Sie einkauft?)

Brot und Backwaren:

☐ (fast) immer
☐ häufig
☐ selten
☐ nie
☐ esse/trinke ich nicht

Getreide- und Getreideprodukte (z.B. Müsli, Teigwaren):

☐ (fast) immer
☐ häufig
☐ selten
☐ nie
☐ esse/trinke ich nicht

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Früchte:

- ☐ (fast) immer
- ☐ häufig
- ☐ selten
- ☐ nie
- ☐ esse/trinke ich nicht

Gemüse:

- ☐ (fast) immer
- ☐ häufig
- ☐ selten
- ☐ nie
- ☐ esse/trinke ich nicht

Milch- und Milchprodukte (inkl. Käse, Joghurt):

- ☐ (fast) immer
- ☐ häufig
- ☐ selten
- ☐ nie
- ☐ esse/trinke ich nicht

Fleisch und Wurstwaren :

- ☐ (fast) immer
- ☐ häufig
- ☐ selten
- ☐ nie
- ☐ esse/trinke ich nicht

Fisch:

- ☐ (fast) immer
- ☐ häufig
- ☐ selten
- ☐ nie
- ☐ esse/trinke ich nicht

Eier:

- ☐ (fast) immer
- ☐ häufig
- ☐ selten
- ☐ nie
- ☐ esse/trinke ich nicht

Welches Öl verwenden Sie hauptsächlich für die kalte Küche (z.B. Zubereitung von Salatsaucen)?

- ☐ Rapsöl
- ☐ Olivenöl
- ☐ Sonnenblumenöl
- ☐ Distelöl
- ☐ Maiskeimöl
- ☐ Traubenkernöl
- ☐ Anderes

Welches Öl verwenden Sie hauptsächlich für warme Küche (z.B. zum Braten)?

- ☐ Bratbutter
- ☐ Sonnenblumenöl
- ☐ Erdnussöl
- ☐ Olivenöl
- ☐ Rapsöl
- ☐ Kokosfett
- ☐ Anderes

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Wie oft salzen Sie Ihre Speisen am Tisch nach?

- ☐ Nie (0 von 10 Mahlzeiten)
- ☐ Gelegentlich (1 bis 5 von 10 Mahlzeiten)
- ☐ Meistens (6 bis 9 von 10 Mahlzeiten)
- ☐ Immer (10 von 10 Mahlzeiten)

Gibt es Speisen, die Sie regelmässig konsumieren, die im Fragebogen nicht vorgekommen sind? Wenn ja, welche?

VIELEN DANK FÜR IHRE MITARBEIT !!

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B) I: The categorization of the 127-itemed FFQ into 25 food groups

Nummer	Kategorie Name	n	Lebensmittel	Kommentare
G01	Milch/Milchgetränke/ Joghurt	6	Vollmilch Teilentrahmte Milch Ovomaltine/Schokolade Joghurt nature Frucht- und Aromajoghurt Frucht- und Aromajoghurt light	Fettstufe bei der Datenanalyse in Betracht ziehen
G02	Käse inkl. Frischkäse	7	Reibkäse Raclettekäse Hartkäse Halbhartkäse Weichkäse Frischkäse Käse fettreduziert	Dito G01
G03	Fleisch	8	Kalbfleisch Rindfleisch Schweinefleisch Lammfleisch Geflügel Leber Trockenfleisch Schinken	Fleischart bei Datenanalyse berücksichtigen (rot vs. weiss)
G04	Wurst/Aufschnitt	3	Salami Aufschnitt Wurst	
G05	Fisch	4	Fisch mager Fisch fettreich Fischstäbchen Fischkonserven	Fettstufe beachten!
G06	Ei	1	Ei (e.g. Rührei, Spiegelei, keine versteckten Eier)	

Nummer	Kategorie Name	n	Lebensmittel	Kommentare
G07	Fleischersatz	3	Fleischersatz (e.g. Tofu und Quorn) Sojamilch Sojajoghurt	
G08	Brot	6	Weissbrot Ruchbrot Vollkornbrot Butterzopf Gipfeli Knäckebrot	Mahlgrad beachten (weiss vs. VK)
G09	Getreide	7	Reis Vollkornreis Teigwaren Vollkornteigwaren Gefüllte Teigwaren Polenta Müeslimischung, Cornflakes	Mahlgrad beachten (weiss vs. VK)
G10	Kartoffeln	3	Kartoffeln (aller Art) Pommes Frites „Röschti“	Fettstufe beachten!
G11	Hülsenfrüchte	1	Hülsenfrüchte	

Nummer	Kategorie Name	n	Lebensmittel	Kommentare
G12	Gemüse	22	Tomate Karotte Gurke Zwiebel Zucchetti Mischgemüse Gemüsekonserven Blattsalat Fenchel Peperoni Pilze Kürbis Kohlrabi Aubergine Bohnen grün Spargel Kohlgemüse (Rotkohl, Wirz etc.) Sellerie Broccoli Lauch Blumenkohl Gemüsesaft	Cave: Saison!!
G13	Früchte	15	Apfel Banane Orange Mandarine/Clementine Trauben Beeren Kiwi Fruchtkonserven Fruchtkonserven ungezuckert Trockenfrüchte Exotische Früchte (e.g Mango, Ananas) Birne Steinobst (e.g. Pfirsich, Aprikose) Melone Fruchtsaft	Cave: Saison!!

Nummer	Kategorie Name	n	Lebensmittel	Kommentare
G14	Suppen	1	Suppe	
G15	Saucen	6	Mayonnaise Ketchup Salatsauce Tomatensauce Bratensauce Weisse Sauce	
G16	Süssspeisen/Dessert	10	Glacé Glacé fettreduziert, energievermindert Creme/Pudding Guetzli Fruchtwähe Kuchen Süssgebäck Schokolade Schokoriegel Getreideriegel	
G17	Nüsse	1	Nüsse	
G18	Salzige Snacks	1	Pommes chips	
G19	Zusammengesetzte Speisen	5	Kebap Hamburger Pizza Lasagne Sandwich	
G20	Wasser/Tee/Kaffee	3	Wasser Tee Kaffee	
G21	Soft Drinks mit Zucker	1	Softdrinks mit Zucker	
G22	Soft Drinks ohne Zucker	1	Softdrinks o/Zucker	

Nummer	Kategorie Name	n	Lebensmittel	Kommentare
G23	Alkohol	3	Bier Wein Spirituosen	
G24	Zubereitung/Brotaufstrich (Fette/Öle)	5	Rahm Butter/Margarine Fett und Öl Butter/Margarine (Brotaufstrich) Butter/Margarine fettred. (Brotaufstrich)	
G25	Brotaufstrich süss	4	Konfitüre Honig Konfitüre o/Zucker Haselnuss-Schokolade-Brotaufstrich	

II: Overview of the Categorization of the food items in the FFQ

ID	Name (n)	ID	Name (n)
G01	Milch/Milchgetränke/Joghurt (6)	G14	Suppen (1)
G02	Käse inkl. Frischkäse (7)	G15	Saucen (6)
G03	Fleisch (8)	G16	Süssspeisen/Dessert (10)
G04	Wurst/Aufschnitt (3)	G17	Nüsse (1)
G05	Fisch (4)	G18	Salzige Snacks (1)
G06	Ei (1)	G19	Zusammengesetzte Speisen (5)
G07	Fleischersatz (3)	G20	Wasser/Tee/Kaffee (3)
G08	Brot (6)	G21	Soft Drinks mit Zucker (1)
G09	Getreide (7)	G22	Soft Drinks ohne Zucker (1)
G10	Kartoffeln (3)	G23	Alkohol (3)
G11	Hülsenfrüchte (1)	G24	Zubereitung/Brotaufstrich (Fette/Öle) (5)
G12	Gemüse (22)	G25	Brotaufstrich süss (4)
G13	Früchte (15)		

C) Factor analysis: factor loadings after extraction of three factors on 25 food groups

	Factor loading		
	Factor 1	Factor 2	Factor 3
Food group			
Dairy products	0.0219	0.0977	0.1955
Cheese	0.1242	0.235	0.2797
Meat	0.1005	0.7112	0.0245
Sausage	–0.2611	0.4973	0.218
Fish	0.425	0.4269	–0.1444
Egg	0.0565	0.4595	–0.0194
Meat alternatives	0.1395	–0.1942	0.0402
Bread	0.0592	0.0769	0.6326
Cereals and grains	0.3725	0.1711	0.3331
Potato	0.1284	0.3286	0.4222
Legumes	0.1828	0.0899	–0.0564
Vegetables	0.7106	0.1761	0.0558
Fruits	0.6302	–0.1226	0.0892
Soup	0.3517	0.1188	0.0301
Sauce	0.2997	0.3631	0.2147
Dessert	0.2932	0.0525	0.4329
Nuts	0.3967	–0.1637	0.0966
Salty snacks	–0.0166	0.1788	0.0938
Composite foods	–0.1257	0.1157	0.3341

	Factor loading		
	Factor 1	Factor 2	Factor 3
Food group			
Water, tea and coffee	0.5271	–0.111	0.1635
Soft drinks with sugar	–0.1151	0.0726	–0.0628
Soft drinks without sugar	–0.0215	0.0228	–0.1633
Alcohol	–0.2423	0.4183	–0.078
Preparation fats and savoury spreads	0.2259	0.2196	0.3484
Sweet spreads	0.0545	–0.1028	0.6661

Factors were interpreted based on variables with a factor loading of 0.40 or more.
Factor 1: Vegetables, fruits, water, tea and coffee, fish, nuts => “prudent pattern”
Factor 2: Meat, sausage, egg, fish, alcohol => “traditional Western diet”
Factor 3: Sweet spreads, bread, dessert, potato => “high-carbohydrate diet”