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# **The marginal monetary costs of a healthier diet for Dutch consumers**

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## **Abstract**

The last ten years, the prices of food products are increasing more and more, especially the prices of healthier products. This causes consumers to pay more for a healthy diet. However, not everyone has more to spend and it is necessary to create an understanding of the marginal cost of a healthy diet. Therefore, the aim of this research is to estimate the marginal monetary costs of more healthy diets for different types of Dutch households. A calculation model was created that calculates the nutritional values and costs of the current standard diet and four improved healthier diets. The various output models showed that one of the improved diets was more expensive and three of the improved diets had approximately the same price as the current diet. This suggests that consumers do not necessarily have to pay more for a healthier diet. Further research should focus on transforming this calculation model into an optimization model, using linear programming, to maximize or minimize the outcomes of a linear function under various constraints, such as limits on the amount of calories or fats etc.

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## ***1. Background information***

In the Netherlands, healthy eating is an important part of people's life. It is beneficial to have a healthy diet, as this has many advantages (Neuhouser, 2019). Fruit and vegetables reduce the chance on diseases, such as diabetes type 2, cardiometabolic diseases, and different types of cancer. LDL-cholesterol will be lower by consuming nuts and legumes. Low LDL cholesterol leads to a lower incidence of coronary heart disease (Rosenbaum, 2011). Specific norms are set for men and women of all ages that indicate how much of vitamins, minerals, proteins, carbohydrates, fibre, and fats someone needs to maintain a healthy lifestyle. Similarly, as there are minimum levels of nutrients that have a positive effect on the body, there are also upper limits for substances that have a negative effect, such as salt and saturated fat. A too high salt intake increases blood pressure and too much saturated fat increases cholesterol levels. The risk of cardiovascular disease events increases with increasing blood pressure and cholesterol levels (Martikainen et al., 2011).

In this chapter, the definition of a healthy diet is explained in more detail. Next to this, studies on current eating patterns are discussed, both international and Dutch. Moreover, food prices and the costs of healthy and unhealthy diets are reviewed and lastly, a conceptual model is developed which shows the relationship between different variables in this research.

### ***1.1 Healthy foods***

There is an enormous amount of literature on healthy diets. For example, a search of 'healthy' AND 'diet' in search engine Web of Science results in 299 articles published in 2022. Several institutes are engaged in healthy diets and their benefits, and therefore this information from such institutes can be used. The United Nations Food Systems Summit (UNFSS) is an important event for all stakeholders working in the field of agriculture, food and nutrition to change food systems to make progress on the Sustainable Development Goals (SDGs). For the UNFSS, a healthy diet is defined as follows: 'A healthy diet is health-promoting and disease-preventing. It provides adequacy without excess of nutrients and health-promoting substances from nutritious foods and avoids the consumption of health-harming substances' (Scientific Group of the UN Food Systems Summit, 2021). The nutritional elements in food can be distinguished into two main categories: macronutrients and micronutrients (Rijksinstituut voor Volksgezondheid en Milieu, n.d.). Macronutrients are carbohydrates, proteins, and fats. The body needs these in huge amounts. The exact intake depends on age, sex, weight class and physical activity levels. Micronutrients are vitamins and minerals. The body needs these in a minor amounts than the macronutrients. Their primary role is to regulate physiological processes, which is why deficiencies are dangerous. The Dutch Voedingscentrum has set up guidelines for a healthy diet, which are represented by the Wheel of five. The Wheel of Five is an educational model created to give a clear overview of foods that are beneficial for someone's health, which should then be part of a healthy dietary pattern. It is structured into five boxes which all represent a different food group. These five food groups will now be described. A healthy dietary pattern contains enough fruit and vegetables. It is recommended to eat at least 250 grams of vegetables and 2 portions of fruit per day, which equals 200 grams of fruit. Moreover, the advice is to eat different kinds of fruit and vegetables. One type of them does not

contain all nutrients that are needed, so varying fruit and vegetables is important (Voedingscentrum, n.d.-g). In the next category the advice is to eat whole wheat or brown bread (4-5 slices women, 6-8 slices man) and 4-5 ladles of whole wheat cereal products or 4-5 potatoes (Voedingscentrum, n.d.-f). A general advice is to eat more plant-based products and less meat. Eat once a week legumes, once a week fish, and a maximum of 500 grams of meat per week, of which maximum 300 grams of red meat. Moreover, eat 2 to 3 eggs a week, no more dairy than needed, and every day 25 grams of unsalted nuts (Voedingscentrum, n.d.-i). Then in the next category of oils and fats, it is recommended to ingest every day certain amount of unsaturated fats (40 grams women, 65 grams man) (Voedingscentrum, n.d.-h). When moving on to the drinks, the advice is to drink 1.5-2 litres a day. These drinks consist of water, black and green tea, herbal tea, coffee, or dairy drinks (Voedingscentrum, n.d.-j). However, for many people it is almost impossible to eat and drink only healthy products that are in the Wheel of Five. Therefore, it says that it is tolerated to eat or drink 3-5 times a day something small and maximum 3 times a week something big. For example, something small is a little cookie, ice cream, portion ketchup, or jam on bread, and something big is a croissant, a piece of cake, crisps, soft drinks, or pizza (Voedingscentrum, n.d.-e). Next to Voedingscentrum, the Health Council of the Netherlands also has set specific guidelines for healthy nutrition. These recommendations are largely similar in terms of which food groups to eat, only the amount that should be eaten is generally a bit lower (Gezondheidsraad, 2015). This might be the case because these guidelines are published in 2015 and this is already some time ago. In the meantime, more and more research has been done on healthy foods.

These recommendations are about products and food groups rather than a specific amount of particular nutrients. Therefore, the elements of a healthy diet were established by using dietary reference intakes. Reference intakes are legally defined guideline values for a balanced diet (Voedingscentrum, n.d.-d). It indicates how much energy and nutrients an average adult needs per day or what maximum still fits within a healthy diet. In table 5 the daily reference intakes are stated for adults.

*Table 5: Reference intakes of various nutrients assuming an average adult.*

	Female		Male		Average	
	Day	Week	Day	Week	Day	Week
Energy (kcal)	2000	14000	2500	17500	2250	15750
Total fat (g)	70	490	87,5	612,5	78,75	551,25
Of which saturated fat (g)	20	140	25	175	22,5	157,5
Of which unsaturated fat (g)	50	350	62,5	437,5	56,25	393,75
Carbohydrates (g)	260	1820	325	2275	292,5	2047,5
Of which sugars (g)	90	630	112,5	787,5	101,25	708,75
Proteins (g)	50	350	62,5	437,5	56,25	393,75
Fibre (g)	25	175	30	210	27,5	192,5
Salt (g)	6	42	7,5	52,5	6,75	47,25

Next to this, the Health Council created an overview of the energy requirements of different age groups with an associated physical activity level (PAL) (Gezondheidsraad, 2022). This PAL-value indicated how active someone is. The higher the PAL-value, the more active a person is, and the more energy a person needs. A PAL-value of 1.4 represented a slightly active activity pattern, 1.6 a moderately active, 1.8 an active, and 2.0 a very active. This is shown in table 6.

*Table 6: Energy requirement of different age groups with a specific level of physical activity*

		PAL = 1.4 (kcal)	PAL = 1.6 (kcal)	PAL = 1.8 (kcal)	PAL = 2.0 (kcal)
19-30 years	Day	2255	2580	2905	3220
	Week	15785	18060	20335	22540
31-50 years	Day	2130	2432,5	2737,5	3042,5
	Week	14910	17027,5	19162,5	21297,5
51-70 years	Day	2040	2330	2620	2915
	Week	14280	16310	18340	20405
71-79 years	Day	1935	2210	2490	2760
	Week	13545	15470	17430	19320

Moreover, there was an advice on the proportion of nutrients. The recommendation was to eat 40-70% of carbohydrates, 10-30% of proteins, and 20-30% of fats (Voedingscentrum, n.d.-c). The most commonly used proportion is 50% of carbohydrates, 30% of proteins, and 20% of fats. To compare these percentages with the total energy requirement, 1 gram of carbohydrates is 4 kcal, 1 gram of protein is 4 kcal, and 1 gram of fat is 9 kcal (Gezondheidsraad, 2022).

### *1.2 Current eating patterns*

A lot of research was already conducted on eating patterns in many parts of the world. For example, in Japan a cross-sectional study was conducted to describe eating patterns (Murakami et al., 2022). Moreover, in Australia the relationship between eating pattern and blood pressure and hypertension prevalence was studied (Leech et al., 2019). In the United States a systematic review was undertaken of dietary patterns and their sustainability (Reinhardt et al., 2020). In India, a systematic review was performed to explore dietary patterns and the relationship with diseases (Green et al., 2016). Next to this, the Mediterranean dietary pattern had been studied to examine its association with depression (Altun et al., 2019). Between 2012 and 2016, the eating patterns of Dutch consumers was studied. This Dutch National Food Consumption Survey 2012-2016 provided insights in the consumption of food and drinks in the Netherlands (van Rossum, 2020). Food consumption data was obtained using two 24h dietary recall days and reported in Globodiet software. There were 18 main food groups, and these consisted of several subgroups. The total population consisted of 4313 men and women aged 1-79 years. This was further divided into age groups of 1-18 years, 19-30 years, 31-50 years, 51-70 years, and 71-79 years. Next to age and gender, the influence of education, region, urbanisation, and BMI were also investigated. Level of education was categorized into low, intermediate, or high, the degree of urbanisation into hardly urbanized, moderately urbanized, and highly urbanized, and the weight status into underweight, normal weight, overweight, and obese. Moreover,

eating occasion and place of consumption were considered. This study was used as reference to investigate the eating patterns of Dutch consumers in this research.

This study showed that there was a moderate improvement in the Dutch diet since the previous study in 2007-2010. Dutch consumers ate more fruit and vegetables and less meat and drink less sugar-containing drinks. The intake of carbohydrates, proteins, and unsaturated fat satisfied the criteria, but the intake of alcohol, salt, total fat, and saturated fat was high, and the intake of fibre was low. Most Dutch people did not adhere to the Dutch dietary Guidelines for a healthy diet, so there is still much to achieve (van Rossum, 2020). There is already a new study done, the Dutch National Food Consumption Survey 2019-2021, but publications are not yet available.

### *1.3 Economic costs*

‘Oh, healthy food is so expensive!’ This is a claim that one regularly hears these days. A number of news articles have appeared around the cost of healthy food (NOS, 2021; Veerbeek, 2022). These state indeed that healthy food is more expensive than unhealthy food and that it will become more and more in the future. But why? Do people really have to spend much more money to eat healthy, or it is all not as bad as mentioned?

Almost one in three Dutch people eat less healthy since healthy products have become more expensive and high inflation plays a role (Capelleveen, 2022). On the short term, living unhealthy is cheaper than living healthy, but on the longer term the burden is large (AD, 2022). In the last ten years, the prices of healthier foods increased on average by 21 percent, while unhealthier foods became on average 15 percent more expensive. In 2019, the average consumer spent 12.8% of their expenses on food and beverages for home consumption. This translates to an average of €7,18 euros per capita per day (Centraal Bureau voor de Statistiek, 2021).

Several studies have evaluated the association between nutritional quality of diets and their costs. Dietary costs are a higher barrier for having a high quality diet for people in low socioeconomic groups than in high socioeconomic groups (Mackenbach et al., 2019; Rao et al., 2013). Next to this, several studies show that healthy foods are often harder to access and more expensive than unhealthy foods. For example, the research of Zorbas et al. (2018) shows that several environmental and social factors were frequently influencing or even barriers to healthy eating, such as habits, knowledge and skills, food price and diet affordability, food availability, convenience and time, geography, and seasonality. Moreover, the systematic review of Chen et al. (2020) indicates that the consumption of ultra-processed foods is associated with a higher risk of several health outcomes and these foods are consumed more and more. They contain more fat, sugar, and salt and have low-cost compared to non- or minimally-processed foods. To conclude, these studies show that there is a positive association between nutritional quality and costs.

In 2022, already a systematic literature review of methods was performed to assess the cost of healthy and unhealthy diets (Russell et al., 2022). The aim of the review was to summarise food environment costing methodologies. It concluded a total of 100 food pricing studies, most of which come from the USA and Australia. These studies used different instruments to measure

food prices. The majority of studies used mainly a food basket instrument (n = 30). A food basket is a set of various food items with their price that are included in someone's diet. When these food items are nutritious and expressed in sufficient quantities, they can meet people's calorie needs and represent a nutritionally optimal diet (Cochrane & D'Souza, 2015). In this way it can monitor the availability and affordability of healthy eating. Another instrument that was frequently (n = 15) used in food pricing studies is the Nutrition Environment Measures Survey for Stores (NEMS-S). This instrument compares products in the same category classified 'healthy' or 'unhealthy' based on the Dietary Guidelines for Americans. It focusses on availability, price, and quality of food products. With this information the relative affordability can be calculated. Thirdly, a few studies (n = 4) used the Healthy Diets Australian Standardised Affordability and Price (ASAP) ((Lee et al., 2020; Lee et al., 2021; Love et al., 2018; Zorbas et al., 2021). With this instrument the costs can be compared between the 'recommended' Australian diet and the 'current' Australian diet. Results in all these four studies show that recommended healthier diets are less expensive than current diets. However, it is still unaffordable for low-income households and people in remote areas with limited healthy food supply. A limitation of these studies is that a reference household of two parents and two children is used, and that food is shared equally among household members.

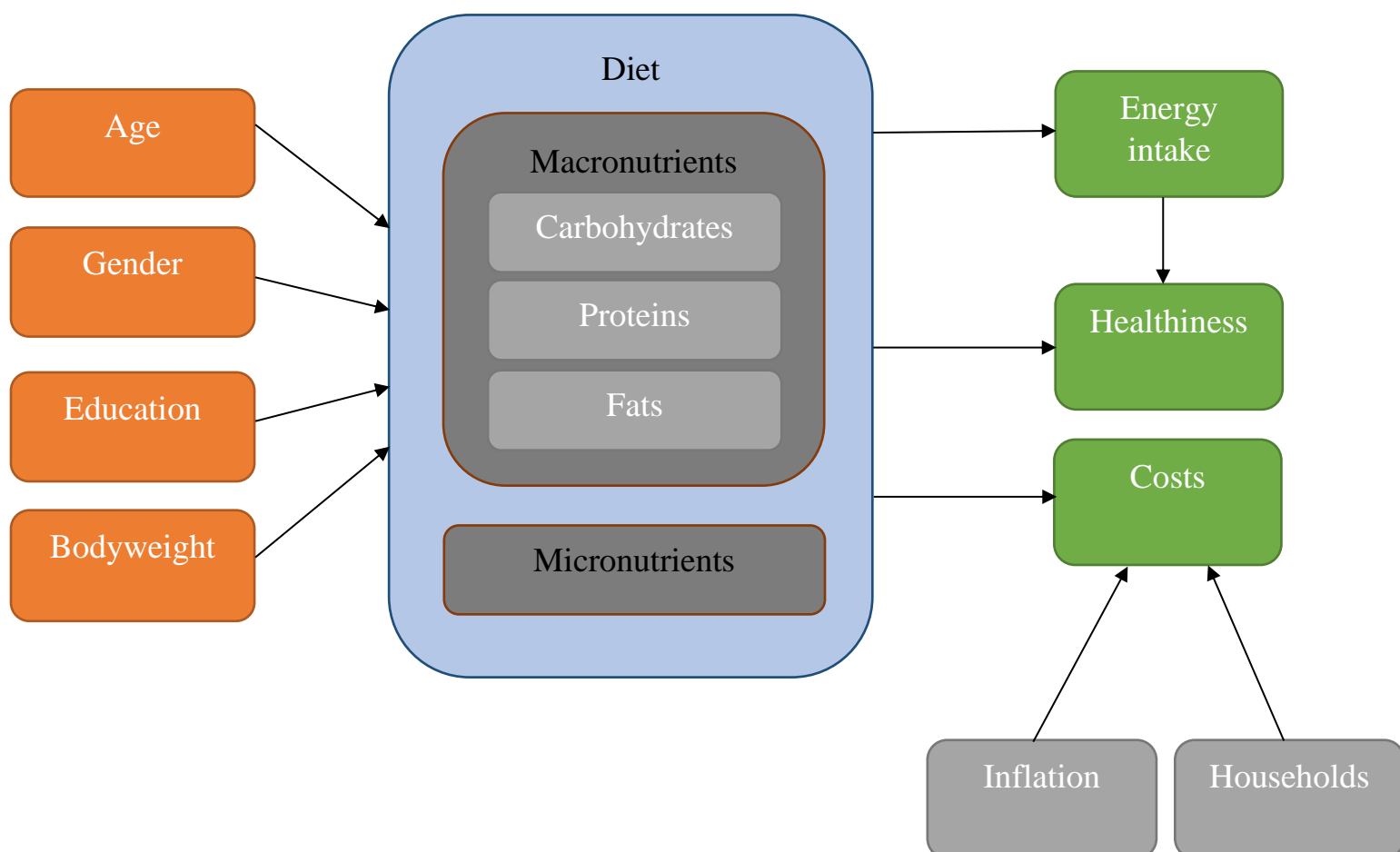
In addition to studies conducted outside Europe, studies were also performed in the Netherlands. In the research of Vellinga et al. (2022) the nutritional quality, environmental impact and food costs of ultra-processed foods and drinks (UPFD) were compared with unprocessed or minimally processed foods and drinks (MPFD). The data used for this study was derived from the Dutch National Food Consumption Survey 2012-2016 (van Rossum, 2020). To define the degree of food processing, the NOVA food classification system was used. This classification distinguishes four categories: unprocessed or minimally processed foods, processed culinary ingredients, processed foods, and ultra-processed foods (Monteiro et al., 2019). The environmental impact of foods was assessed for Greenhouse gas (GHG) emissions and blue water use, which data was taken from the Dutch Life Cycle Assessment (LCA) food database. Blue water is referred to as irrigation water used during cultivation. The food costs were estimated by using the Dutch food cost database. Descriptive statistics were practiced typifying the nutritional and environmental aspects and costs for foods and drinks. The results showed that UPFD were less healthy because of their high energy, saturated fat, sugar, and sodium content. However, they were associated with higher GHG emissions but lower blue water use and were cheaper than unprocessed or minimally processed foods. This suggests that MPFD are more healthy, but also more expensive. In the end, there is not directly a win-win of nutritional quality, environmental impacts, and food costs.

As this paragraph showed, studies are conducted on the environmental impact and healthiness of diets, and the costs of healthy or unhealthy foods. Next to this, it is also investigated how current diets can be made healthier and more sustainable and meet environmental requirements (Broekema et al., 2020; Paris et al., 2022). However, in scientific literature, there is no research on comparing the costs of healthy and unhealthy diets in the Netherlands or the increase in costs associated with a healthier diet. Moreover, for consumers, it is important what a change in diet will cost them: the marginal costs of a healthier diet, rather than the change in prices.



### 1.4 Conceptual model

Based on the literature on healthy diets and costs thereof, a conceptual model was developed. It shows the relationship between different variables which are included in this research. Age, gender, education, and bodyweight are all factors that have an influence on someone's diet, as can be read in results of the Dutch National Food Consumption Survey 2012-2016 (van Rossum, 2020). A diet is constituted of macronutrients and micronutrients. The three macronutrients are carbohydrates, proteins, and fats. The diet with macro- and micronutrients has a certain energy intake and healthiness. Energy intake is related to healthiness. In general, products high in energy are less healthy. Moreover, someone's diet determines the price that needs to be paid for it. Given the literature, my hypothesis is that a healthier diet is associated with high marginal monetary costs for Dutch consumers. Inflation and household type can play a role in the price of a diet. When all products become more expensive, then the price of any diet, of course, increases too. A less healthy diet and more inflation might lead to the same price as a healthier diet and less inflation. In addition, in different household types, costs per person may differ. My hypothesis is that the costs per person in a more persons household are lower than in a one-person household.



## ***2. Research aim***

The aim of this research is to estimate the marginal monetary costs of more healthy diets for different types of Dutch households.

In order to achieve this objective, the following research questions were answered.

- What are the current standard diets, reflecting different groups and households, in the Netherlands?
- What are the costs related to these current diets?
- How does household size affect the price of someone's diet?
- How can the current diets be made healthier?
- What are the marginal costs of these more healthy diets?

### ***3. Materials and method***

#### *3.1 Model overview*

A calculation model is developed to determine the marginal costs of a healthier diet for people in the Netherlands. It estimates the costs and nutritional values of the diet of different subgroups of the total population. Subgroups were created with regard to age, gender, education, and weight. The model first calculates the costs and nutritional values for the standard diets, and then for changing the diet towards a more healthy diet. The diet is categorized into eating moment: breakfast, lunch, dinner, drinks, and in-between snacks. Each day of the week and per eating moment of the day it can be decided if (a portion of) a certain product is eaten or not. For each product a total amount of grams consumed per week is estimated, with related nutritional intake and costs. The model developed for this research and the calculations performed were carried out using Excel. A one-person household and a four persons household were included.

A food basket instrument was used, which in this case was a set of 48 food items with their price that were included in the diet. The selection of products was based on the eating moments with typical products for Dutch consumers. Breakfast consisted of 8 products, lunch of 10 products (of which 6 were also listed under breakfast), dinner of 23 products, drinks of 8 products, and in-between snacks of 6. Breakfast included bread with 4 spreads and yoghurt with cereals. The 4 spreads were jam and chocolate sprinkles, as these are the most eaten sweet spread among Dutch people, and cheese and meat (Zoetwaren, n.d.). Lunch also consisted of bread with these spreads, added with eggs, crackers, and soup. Then, dinner was made up of potatoes or pasta or rice with vegetables and meat. 10 types of vegetables were included, as these were the most eaten vegetables in the Netherlands and variation in the diet is important (Voedingscentrum, n.d.-b). Five types of meats were included, because Dutch people eat meat on average 5-6 days in the week, and one type of fish was included (Vlees en vleesvervangers, n.d.). The drinks consisted of coffee, tea or water, milk as dairy drink, fruit juice and cola as soft drinks, and wine or beer as alcoholic drinks. In-between snacks included 3 types of fruit, these belong to the most eaten types in the Netherlands, and unsalted nuts, cookies, and crisps (Voedingscentrum, n.d.-a).

So, the input of this model was a list of 48 food products with several characteristics (Table 1). The following product characteristics were included: portion size, calories, fat, of which saturated, of which unsaturated, carbohydrates, of which sugars, proteins, fibre, and salt. Next to this, nutriscore and price per gram product were noted. The price per gram is derived from the data in table 2, price per product divided by package size. These data were collected from the Albert Heijn website. The price of the products was determined on 24-02-2023. All products were from the Albert Heijn private label, except coffee and beer as these were not available. Coffee was from the brand Douwe Egberts and beer from Heineken. Table 2 presents an overview of all products with their package price and package size. By choosing the products regarding packaging size, a one-person household was taken into account, which means products are bought in small quantities. In a four persons household bigger package sizes were taken into account as these products were shared with more people.

Code	Product	Portion size	Unit of portion size	Calories per portion (kcal)	Fats per portion (g)	Saturated per portion (g)	Unsaturated per portion (g)	Carbohydrates per portion (g)	Sugar per portion (g)	Proteins per portion (g)	Fibre per portion (g)	Salt per portion (g)	Nutri score	Price per gram (€)
1	bread	35	g (slice)	81,2	0,63	0,14	0,455	14,35	0,42	3,5	2,1	0,315	A	0,002714
2	yoghurt	200	ml	118	6	3,8	2,4	7,8	7,8	8	0	0,2	A	0,00198
31	breakfast cereals	40	g	166,4	4	0,64	3,4	27,2	7,2	3,96	2,8	0	A	0,00229
32	crackers	15	g	55,65	0,72	0,075	0,585	9,6	0,27	1,65	2,1	0,1095	A	0,003707
3	apple	135	g (piece)	81	0,27	0	0	17,6	13,5	0,27	2,7	0	A	0,00209
4	banana	165	g (piece)	150,15	0,495	0,165	0,33	33	26,4	1,815	3,135	0	A	0,00219
5	orange	170	g (piece)	81,6	1,7	0,34	1,36	13,43	13,09	1,19	3,4	0	A	0,00219
33	nuts	25	g	167	15,25	1,725	13,25	1,525	0,75	5	1,775	0	A	0,01295
34	egg	55	g (M)	74,8	5,225	1,65	2,695	0,275	0,11	6,6	0	0,209	A	0,005121
35	butter	5	g	17,65	1,95	0,55	1,4	0,03	0	0	0	0,015	C	0,00238
36	oil	15	ml	122,85	13,65	2,1	11,55	0	0	0	0	0	C	0,00958
37	cooking butter	15	ml	94,5	10,5	1,02	9,45	0	0	0	0	0,135	C	0,002787
38	jam	15	g	36,75	0,03	0	0,03	9	8,25	0,06	0,15	0,0045	D	0,002778
39	chocolate sprinkles	20	g	91,4	3,4	1,96	1,36	13,4	13	1,36	0,9	0,03	E	0,007
6	meats on bread	10	g	28,7	2,5	0,91	1,6	0,16	0,07	1,4	0	0,235	E	0,017308
7	cheese	32	g	120	9,92	6,72	3,008	0	0	7,68	0	0,64	D	0,017632
8	soup	300	ml	147	3,3	1,2	1,8	22,8	12,3	5,1	2,1	2,19	B	0,0033
40	potato	200	g	176	0	0	0	38	2	4	3,6	0	A	0,00169
9	tomato	250	g	52,5	1	0,25	0,5	7,25	7,25	1,75	3,25	0	A	0,00398
10	cucumber	250	g	32,5	1	0,25	0,75	3,25	3,25	1,75	1,5	0	A	0,003475
11	pepper	135	g	32,4	0,135	0	0,135	5,13	5,13	1,08	2,835	0	A	0,010296

12	lettuce	250	g	37,5	0,75	0	0,75	4,25	4,25	2,25	2,75	0,125	A	0,0095
13	spinach	200	g	52	1,2	0,2	0,8	1,8	0	6,4	4	0,06	A	0,00895
14	broccoli	250	g	67,5	1,75	0,25	1,5	2	1,25	7,25	7,75	0,075	A	0,01095
15	cauliflower	250	g	62,5	0,5	0	0,5	7,25	6	4,75	5,5	0,075	A	0,01095
16	carrot	250	g	87,5	0,75	0,25	0,25	14,25	7,75	1,5	8,25	0,25	A	0,00312
41	onion	30	g	10,5	0,03	0	0,03	1,95	1,5	0,3	0,6	0	A	0,0033
17	green beans (legumes)	200	g	67,5	0,5	0,25	0,25	5	2,5	6,25	8,75	0	A	0,00498
42	pasta	80	g	285,6	1,04	0,24	0,8	57,6	2,56	10,4	2,16	0	A	0,00198
43	rice	75	g	265,5	0,75	0,3	0,525	60	0	4,35	0,825	0	B	0,003225
18	minced meat	100	g	228	16	6,7	7,5	0,9	0	20	0	0,2	C	0,008633
19	chicken fillet	100	g	114	1,2	0,5	0,7	0	0	25	1,6	0,1	A	0,0153
20	cordon bleu cheese ham	138	g	420,9	27,6	11,178	13,8	19,32	0,966	23,46	0,966	1,794	D	0,010145
21	sausage	100	g	257	19	7,2	9,9	1,4	0,06	20	0,07	1,45	D	0,00995
22	chicken schnitzel	103	g	247,2	14,42	2,987	10,3	17,51	1,133	11,33	1,133	1,3184	C	0,015073
23	salmon fillet	140	g	308	22,4	3,5	19,6	0	0	26,6	0	0,28	A	0,036188
24	pastasauce	100	g	39	0,1	0	0,1	7	5,2	2	1,1	0,8	A	0,006225
25	dessert	150	g	265,5	9,9	7,05	2,85	34,5	31,5	7,8	3,3	0,15	C	0,00545
44	cookie	39	g	177,84	8,19	4,68	3,42	24,18	13,26	1,365	0,975	0,273	E	0,005214
45	crisps	40	g	219,6	14	1,4	12,4	20,4	0,2	2,2	1,6	0,48	C	0,00516
46	coffee	250	ml	2	0	0	0	0,2	0,2	0,5	0	0,01	B	0,01716
47	tea	250	ml	2,5	0	0	0	0,2	0	0	0	0	B	0,01125
48	water	250	ml	0	0	0	0	0	0	0	0	0	A	1,5E-06
26	milk	250	ml	117,5	3,75	2,75	1	11,75	11,75	9	0	0,325	B	0,00145
27	fruit juice	250	ml	100	0	0	0	21,75	21,75	1,75	0,5	0	C	0,00145
28	cola	250	ml	100	0	0	0	24,5	24,25	0	0	0	E	0,000593
29	wine	125	ml	83,75	0	0	0	0,75	0,75	0,125	0	0	-	0,005987
30	beer	300	ml	126	0	0	0	9,6	0	0	0	0	-	0,0028

Table 1: the products with their specific characteristics expressed in grams per portion of product.

Table 2: the Albert Heijn products with their price and package size (small).

Product	Albert Heijn product	Package price (€)	Package size (g, ml)
bread	AH Nederlands rond volkoren heel	2,09	770
yoghurt	AH Volle yoghurt	0,99	500
breakfast cereals	AH Krokante muesli naturel	2,29	1000
crackers	AH Knackebrod volkoren	1,39	375
apple	AH Elstar appels los	2,09	1000
banana	AH Bananen los	2,19	1000
orange	AH Handsinaasappel los	2,19	1000
nuts	AH Notenmix ongebrand	2,59	200
egg	AH witte vrije uitloopeieren M	1,69	330
butter	AH Halvarine lekker op brood	1,19	500
oil	AH Olijfolie traditioneel	4,79	500
cooking butter	AH Basis vloeibaar	2,09	750
jam	AH Extra jam aardbeien	1,25	450
chocolate sprinkles	AH Hagelslag melk	1,75	250
meats on bread	AH Grillworst	2,25	130
cheese	AH Goudse jong belegen 48+ plakken	3,35	190
soup	AH Rijkgevulde tomatensoep	0,99	300
potato	AH Vastkokend 1kg	1,69	1000
tomato (fruiting)	AH Tomaten los	1,99	500
cucumber (fruiting)	AH Komkommer	1,39	400
pepper (fruiting)	AH Paprika rood	1,39	135
lettuce (leafy)	AH Fijngesneden Ijsbergsla	0,95	100
spinach (leafy)	AH Spinazie kleinverpakking	1,79	200
broccoli (cabbage)	AH Bloemkool broccoli kleinverpakking	2,19	200
cauliflower (cabbage)	AH Bloemkool broccoli kleinverpakking	2,19	200
carrot (other)	AH Winterpeen	0,39	125
onion (other)	AH Gele uien	0,99	300
green beans (legumes)	AH Sperziebonen los	2,49	500
pasta	AH Penne	0,99	500
rice	AH Witte snelkook rijst	1,29	400
minced meat	AH Half-om-half gehakt	2,59	300
chicken fillet	AH Scharrel kipfilet 2 stuks	4,59	300
cordon bleu cheese ham	AH Gehakt cordon bleu kaas en ham	2,79	275
sausage	AH Braadworst	1,99	200
chicken schnitzel	AH Scharrel kipschnitzel	3,09	205
salmon fillet	AH Zalmfilet	5,79	160
pastasauce	AH Pastasaus traditionale	2,49	400
dessert	AH Chocolade mousse puur	1,09	200
cookie	AH Roomboter stroopwafels	2,44	468

crisps	AH Chips naturel	1,29	250
coffee	Douwe Egberts Aroma Rood snelfiltermaling	4,29	250
tea	AH Zwarte thee earl grey	0,45	40
water	Kraanwater	(0,3)	(200000)
milk	AH Halfvolle melk	1,45	1000
fruit juice	AH Sinaasappelsap	1,45	1000
cola	AH Cola regular	0,89	1500
wine	AH Chardonnay	4,49	750
beer	Heineken Premium pilsener	0,84	300

### 3.2 Calculations

A calculation model is developed in excel. The output of this model was a diet consisting of 48 products with their nutritional value and costs. The model calculated the amount of nutrients (g) that will be eaten in a week and the related costs in euros per week. The report on the Dutch National Food Consumption Survey 2012-2016 was used to determine the input of this model. The results of this survey in terms of dietary intake were included as input data to determine the quantities per product. The mean consumption of food groups in grams per day was included. This was done for the total population and groups of age, gender, education, and BMI. The main and sub food groups from the report were classified into 48 products. The costs of the diets were based on cost accounting theory. The total cost was a sum of the cost of all fresh products added together and all long-life products added together. In this study, the following parameters were used:

- Product:  $i$
- Days of the week:  $j = 1 - 7$
- Portion size: PS
- Quantity eaten in grams:  $Q^w$ .
- Quantity eaten in units:  $Q^u$
- Calories: Cal
- Fat: F
- Saturated fat:  $F_s$
- Unsaturated fat:  $F_u$
- Carbohydrates: Car
- Sugars: Su
- Proteins: Pro
- Fibre: Fi
- Salt: Sa
- Nutriscore: N
- Price per small product:  $P^s$
- Price per large product:  $P^l$
- Costs: C
- Costs of fresh products:  $C^f$
- Costs of long-life products:  $C^l$
- Amount of sales units: S
- Package size small:  $Pas^s$

- Package size large:  $Pas^L$

### 3.2.1 One-person household

For a one-person household the following calculations were made.

The input consisted of portions of each food product, which had to be converted to grams. For instance, one portion of bread is one slice of 35 grams (Table 1). So, the total amount of product  $i$  eaten in a week (in g) is calculated as the sum of the times of consumption ( $Q^U$ ) on each day  $j$  of the week times the portion size (PS):

$$Q_i^W = \sum_{j=1}^7 Q_{ij}^U * PS_i \quad [1]$$

The total amount of calories of product  $i$  eaten in a week is the amount of calories of product  $i$  per portion (Cal) divided by the portion size (PS) times total grams of product  $i$  eaten ( $Q^W$ ):

$$Q_i^{Cal} = \frac{Cal_i}{PS_i} * Q_i^W \quad [2]$$

Similarly, the quantity of the macronutrients fat ( $Q^F$ ), saturated fat ( $Q^{Fs}$ ), unsaturated fat ( $Q^{Fu}$ ), carbohydrates ( $Q^{Car}$ ), sugars ( $Q^{Su}$ ), protein ( $Q^{Pro}$ ), micronutrients fibre ( $Q^{Fi}$ ) and salt ( $Q^{Sa}$ ) were calculated with input values  $F$ ,  $Fs$ ,  $Fu$ ,  $Car$ ,  $Su$ ,  $Pro$ ,  $Fi$ , and  $Sa$ .

The expenditures for a product depend on whether the product is a fresh product or a long-life product. A fresh product is defined as one that cannot be stored for more than a week after opening the product. The fresh products are products 1 to 30 (table 1). The costs of fresh products are the costs of the total package, because what is left must be thrown away. To calculate the expenditures for fresh products, the amount of packages of a product that is needed should be known. The amount of packages that is needed, so the amount of sales units ( $S$ ) is calculated as the total amount of product  $i$  (in g) divided by the package size, rounded up:

$$S_i = ROUNDUP \left( \left( \frac{Q_i^W}{Pas_i^S} \right), 0 \right) \quad [3]$$

The total costs of all fresh products ( $C^F$ ) are the amount of sales units times the price, calculated for every fresh product ( $i=1-30$ ):

$$C^F = \sum_{i=1}^{30} S_i * P_i^S \quad [4]$$

A long-life product is defined as one that can be stored for more than a week after opening the product. The costs of long-life products are the costs of the part that is actually eaten, as the part of the product that is not eaten can be stored for the next week. The long-life products are products 31 to 48 (table 1).

The total costs of all long-life products ( $C^L$ ) are the price of product  $i$  divided by package size times total amount of product  $i$ , calculated for every long-life product ( $i=31-48$ ):

$$C^L = \sum_{i=31}^{48} \frac{P_i^S}{Pas_i^S} * Q_i^W \quad [5]$$

The total costs of the whole diet are the sum of the costs of fresh products and long-life products:



$$C = C^F + C^L \quad [6]$$

### 3.2.2 Four persons household

Similarly, by using the formulas above the costs of a four persons household can be calculated.

The total grams eaten of a product is that of a one-person household [1] times four:

$$Q_i^W = (\sum_{j=1}^7 Q_{ij}^U * PS_i) * 4 \quad [7]$$

The amount of packages needed is the total gram of four persons divided by the package size, rounded up and to zero decimals. This is the same as [3], with the total gram eaten calculated in [7] and a large package size:

$$S_i = ROUNDUP\left(\left(\frac{Q_i^W}{Pas_i^L}\right); 0\right) \quad [8]$$

The cost of each of the fresh products is the price of the product times the amount of packages needed. This is the same as [4], with the price of a large package:

$$C^F = \sum_{i=1}^{30} S_i * P_i^L \quad [9]$$

The cost of a long-life product is the price of a product divided by the package size times total gram eaten of four persons. This is the same as [5], with a large package size with associated product price, and total grams calculated in [7]:

$$C^L = \sum_{i=31}^{48} \frac{P_i^L}{Pas_i^L} * Q_i^W \quad [10]$$

The total costs of this four persons household is the sum of the costs of fresh products and long-life products, the same as in [6] so [9] + [10]:

$$C = C^F + C^L \quad [11]$$

### 3.3 Assumptions

All products were from the Albert Heijn private label. A-brand products were not considered, but consumers might consume these as well. In general, private label products are cheaper than A-brand products. However, consumers can also buy products on markets or in budget supermarkets such as Lidl, which products are often cheaper than private labels. Therefore, the price of private label products is expected to be in between these alternatives. Moreover, for a lot of products there were a lot of varieties available. For example bread, there are many different types of bread and every person will choose another one. The most commonly eaten bread in the Netherlands is whole wheat bread, so in this research the private AH label whole wheat bread was selected. The same holds for vegetables, the most commonly consumed vegetables per type were/have been included, but of course there are many more. Another assumption is that in one-person households consumers choose the smallest package sizes, but they also might buy bigger package sizes as these are in the end cheaper per portion size. This

leads to a further assumption; every fresh product that is not fully consumed, is thrown away. In reality people might consume the rest of the product another day of the week, but then variety in the diet is lacking.

### *3.4 Validation*

To check whether the model runs smoothly and does not have any mistakes in it, validation tests were performed as follows. The product 'yoghurt' was used to do the test. First, the amount of calories of yoghurt was set to 0. This resulted in every output model to 0 calories with respect to yoghurt. The same applied for the macro- and micronutrients in the model. This showed the VLOOKUP (VERT.ZOEKEN) function in Excel is used in the right way. The same was true for the price of fresh products. When the total amount of yoghurt eaten was set to 0, also the sales unit, so the amount of packages bought, and the cost for yoghurt in the output model became 0. In addition, the total number of grams of yogurt eaten in the four persons household also came to 0, as did the number of packages and the total cost in terms of yogurt. To check whether the sales unit could change to four packages of yoghurt, the amount of yoghurt eaten in the output model was made 4 times higher. This resulted in a sales unit of 4 and a price of €3.96, which was 4 times the price of one package (€0.99). To test whether the calculation of the price of long-life products worked well too, the product 'breakfast cereals' was used. The price of one package of breakfast cereals was set to 0. This resulted in the price per gram of breakfast cereals being 0, and the total costs of breakfast cereals in the output model also being 0. To conclude, these examples showed that the model works well and cells were connected in the right way. Next to these changes in the model by hand, formulas were already immediately checked when developing the model. Moreover, the results showed no weird outcomes which implies that the model worked well.

### *3.5 Output scenarios*

The basic scenario was the general diet of people in the Netherlands. To determine this basic scenario, the results of the RIVM report on food consumption were used (van Rossum, 2020). The total population were man and women from 1-79 years old that participated in the Dutch National Food Consumption Survey 2012-2016. This total population was further divided into different subgroups based on age, gender, educational level, and weight. Age is split into age groups of 1-18 years, 19-30 years, 31-50 years, 51-70 years, and 71-79 years. Gender is divided into male and female, level of education into lower, intermediate, and higher, and weight into normal and underweight, and obese and overweight. An example of the diet of the total population is presented in table 3. Columns 4-10 show the frequency of consumption, i.e., how many servings of a food item are consumed during the day.



Different groups might benefit from different changes in the diet to make it more healthy. In this section various ways to improve the diet are discussed. Each scenario is applied to all age, education, and weight groups.

- Scenario 1: add fruits and vegetables.

The recommended amount is 2 pieces of fruits and 250 grams of vegetables per day. By eating more fruit and vegetables the diet will be made healthier. Next to this, it is recommended to vary in the type of fruit and vegetables and make sure not the same type of fruit or vegetable is consumed every day. To improve the current diet half of the recommended amount is added, so 125 grams of vegetables and one piece of fruit.

- Scenario 2: replace food products with healthier products.

Some products do not deliver sufficient nutrients. These products can be replaced by other products that contain more beneficial nutrients. For example, white rice and pasta can be replaced by whole grain rice and pasta. Whole grain products provide more nutrients than non-whole grain products. Also, whole wheat bread and cereal products are a good alternative. Next to this, it might be beneficial to replace animal products with more plant-based products or sugary products, such as sweets and confectionary or drinks with a lot sugar, with products with less sugar. To improve the current diet by switching products, seven changes are made. First during breakfast and lunch, jam is replaced by dairy spread, chocolate sprinkles by 100% peanut butter, and whole yoghurt by low-fat yoghurt. Then during dinner, white rice and pasta is replaced by brown rice and whole wheat pasta. One meat product is replaced by chickpeas and one meat product is replaced by a meat substitute.

- Scenario 3: remove the snacks in the diet.

In general, unhealthy snacks contain relative high amounts of fat and sugar. The body does not need these in huge amounts. Therefore, these snacks, such as crisps, desserts, salted nuts, or cookies can be removed from the diet without leaving out good nutrients. To improve the current diet half of the desserts, cookies and crisps are removed.

- Scenario 4: replace drinks with healthier drinks.

The advice is to drink between 1,5 and 2 litres every day. Drinking enough is important to get enough fluids. The body needs this to compensate for the loss through breathing, sweating, and urine. Coffee, tea, water, and milk are good options that Voedingscentrum recommends. People should limit the consumption of sugary drinks and alcohol. Alcoholic beverages can be replaced by non-alcoholic beverages, as the advice is to drink not more than one glass of alcohol per day and not every day. To improve the current diet, some changes according to drinks are made. First, the total amount of drink consumed per day is set at 2 litres. Coffee and tea consumption is limited to 4 cups a day in total. Every day one glass of milk is consumed, because it contains important nutrients such as vitamin B2, B12 and calcium. There is no limit set on the amount of water. Sugary drinks are limited to one glass per day, because it contains a lot of sugar. And lastly, the amount of alcohol consumed is limited to one glass a day, on the days that a group drank alcohol already before. The other days it is still not consumed.

## **4. Results**

The results are broken down by research question.

### *3.1 Current standard diets, reflecting different groups of people, in the Netherlands*

Table 4 presents an overview of the estimated costs (in euros per week) and nutrient intakes of the total population and subgroups. The total estimated costs are further divided into the costs of fresh and long-life products. Next to this, the estimated intake of calories, fat, carbohydrates, protein, fibre, and salt are presented. Total fat intake is split into saturated and unsaturated, and total carbohydrates also included sugar. Calorie intake is shown in kilocalories per week and the other nutrients in grams per week. As can be seen from this table, the amount of calories eaten in a week varies between 13510 and 18609 kcal, with an overall amount of 15616 kcal. By looking at age, the least amount of calories is eaten by the group of people aged 1-18 and 71-79 years old and the most by the group of 19-30 and 31-50 years old. Next to this, male ingests more calories than female. The amount of macro- and micronutrients eaten corresponds to the amount of calories. When more calories are ingested, in general also more of the nutrients are eaten. The total amount of fat consumed is between 473 grams and 657 grams with an overall intake of 592 grams, of which the amount of unsaturated fat is between 59-62% of the total in every group. The amount of carbohydrates ingested is between 1564 grams and 2146 grams, with an overall intake of 1881 grams. The amount of sugars eaten ranges between 41-43% of the carbohydrates. An outlier with 52% sugar eaten are the people aged 1-18 years old. The amount of grams eaten of proteins ranges between 410 and 628, with an overall intake of 513 grams. Lastly, the micronutrients fibre and salt are evaluated. The amount of fibre eaten ranges between 134 and 183 grams, with an overall intake of 161 grams. Salt intake during a week is between 27 and 41 grams, with an overall intake of 32.

	Total population	Subgroups											
	Overall	Age					Gender		Education			Weight	
		1-18y	19-30y	31-50y	51-70y	71-79y	Male	Female	Lower	Intermediate	Higher	Normal and underweight	Obese and overweight
Estimated total costs (€/week)	77	66	77	79	78	78	82	74	79	79	81	82	79
Estimated costs of fresh products (€/week)	67	59	68	68	68	69	71	66	69	69	71	71	69
Estimated costs of long-life products (€/week)	10	7	9	10	10	9	11	8	10	10	10	10	9
Estimated intake of calories (kcal/week)	15616	13511	16698	16447	15321	13865	18609	13706	15717	16219	16248	16738	16013
Estimated intake of total fat (g/week)	592	473	602	627	598	535	714	522	606	617	633	658	637
Estimated intake of saturated fat (g/week)	210	175	207	220	214	199	252	195	218	230	229	242	240
Estimated intake of unsaturated fat (g/week)	368	286	379	391	369	322	444	313	372	371	388	399	381
Estimated intake of total carbohydrates (g/week)	1881	1814	2069	1941	1729	1565	2146	1616	1832	1900	1846	1920	1801
Estimated intake of carbohydrates, of which sugar (g/week)	843	944	883	816	708	682	848	689	789	801	747	802	751
Estimated intake of protein (g/week)	513	410	547	549	532	487	629	481	537	560	568	568	572
Estimated intake of fibre (g/week)	161	134	169	165	159	155	183	148	157	163	173	179	164
Estimated intake of salt (g/week)	32	27	35	35	34	31	41	31	34	36	35	36	35

Table 4: Description of the diet characteristics and costs of the total population and subgroups.

### 3.2 Costs of the diets

The estimated costs of the diets of different groups are presented in table 3. The overall total costs per week adds up to €77, varying between €66 and €82. The weekly diet costs are lowest for people aged 1-18 years (€66), whereas the other age groups range between €77 and €79. The weekly diet costs of males are €8 more than the costs of females. The difference in costs in the education and weight subgroups are small.

The estimated costs for fresh products are on average around 88% of the total diet costs. The costs for fresh products ranges between €59 and €71. People aged 1-18 years spend €59, the other age group ranges closely to each other between €68 and €69. Males spend about 5 euros more than females on fresh products. In the education and weight subgroups the differences in costs are again small.

Figure 1 presents two bar charts on the amount of nutrients and costs related to different food groups of fresh products. As can be seen in figure 1.1, vegetables are representing 3% of the total amount of calories and meat and fish 21%. When looking at figure 1.2 the costs for these vegetables come down to 19% and for meat and fish 34%. This shows that the costs per calorie for these food groups are high. On the other hand, bread represents 23% of the total amount of calories and only 6% of the total costs. Soft drinks and fruit juice contain half of the amount of sugar, while the costs for these products are only 5%, which shows that the costs per gram sugar in these drinks are low. The same result is seen with the costs per gram fibre in bread. The amount of fibre in bread is half of the total fibre intake and the costs for bread are only 6% of the total cost. This shows that the costs per gram fibre in bread are low. When looking at figure 1.2, each subgroup spends proportionally about the same amount on each food group.

Figure 1.1: Estimated nutrient distribution across different food groups consisting of fresh products.

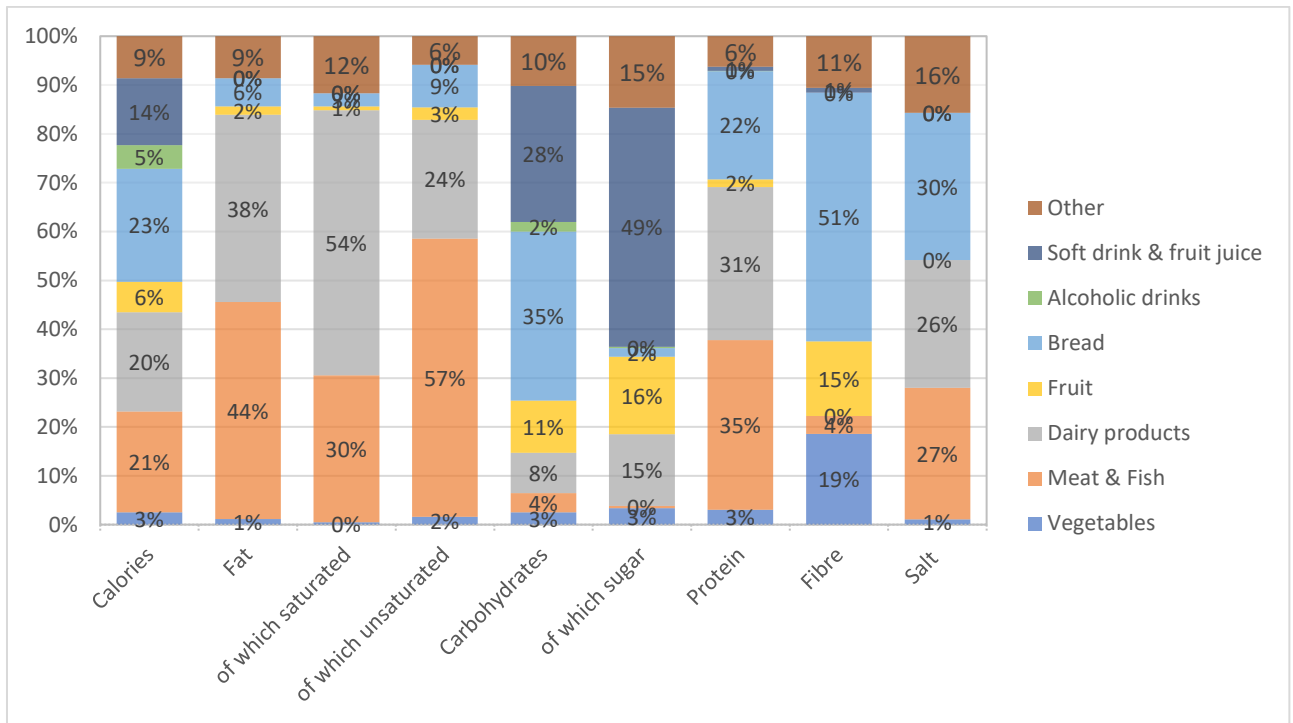
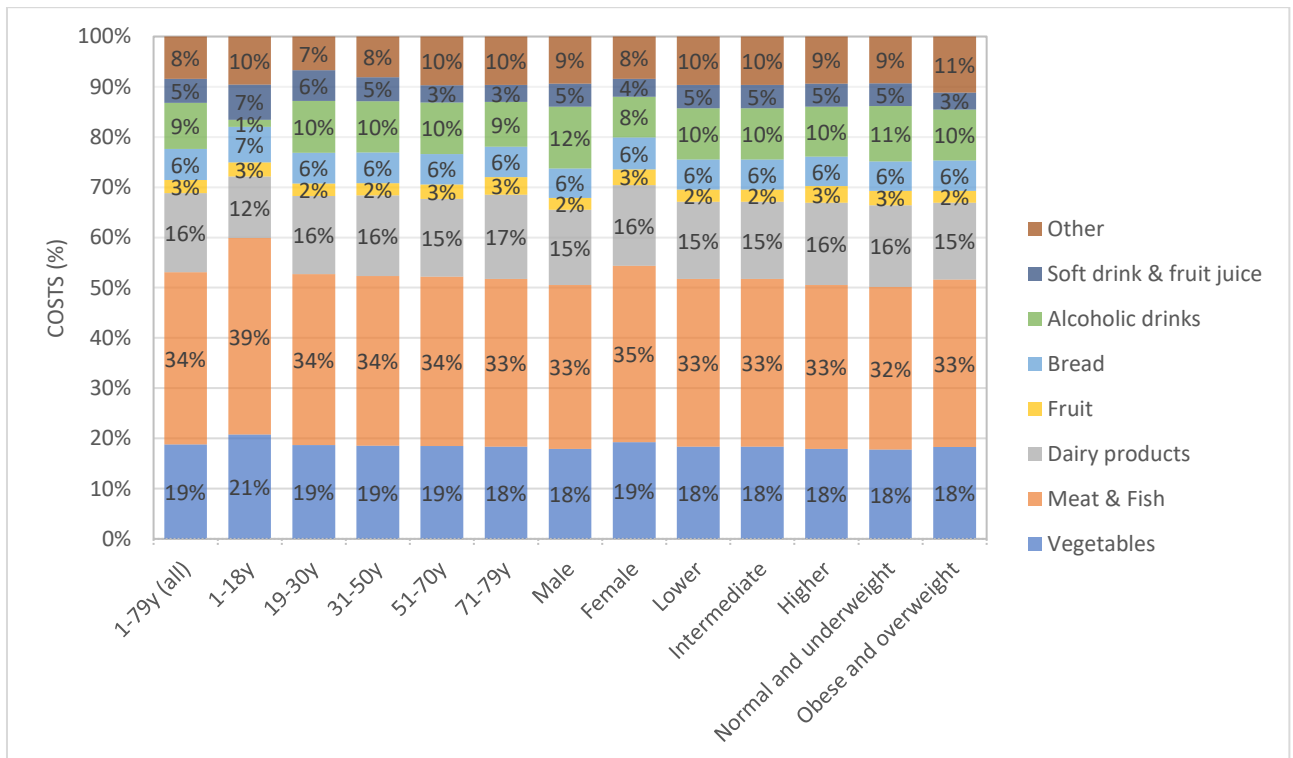


Figure 1.2: Estimated costs distribution across different food groups of fresh products in different subgroups.





### 3.3 Effect of household size on diet price

The estimated total costs and the costs per person in euros per week in a four persons household are shown in table 5. For comparison, the costs per person in a one-person household is also presented. The costs per person in a four persons household are 37% lower than in a one-person household.

*Table 5: The estimated costs of a four persons household compared to a one-person household of the total population and subgroups.*

		<b>Four persons household</b>		<b>One-person household</b>
<b>Four persons household</b>		Estimated total costs (€/week)	Estimated costs per person (€/week)	Estimated costs per person (€/week)
<b>Overall</b>		192	48	77
<b>Age</b>	1-18y	164	41	66
	19-30y	203	51	77
	31-50y	201	50	79
	51-70y	201	50	78
	71-79y	196	49	78
<b>Gender</b>	Male	222	56	82
	Female	173	43	74
<b>Education</b>	Lower	196	49	79
	Intermediate	200	50	79
	Higher	200	50	81
<b>Weight</b>	Normal and underweight	204	51	82
	Obese and overweight	203	51	79

### *3.5 Scenarios for a healthier diet*

Based on the defined diets (current diets) and the recommendations from the Voedingscentrum (see paragraph 1.1), four scenarios are defined regarding improved diets:

1. Add fruits and vegetables
2. Replace food products with healthier products
3. Remove snacks from the diet
4. Replace drinks with healthier drinks

In table 6, the differences in estimated nutrient intakes between the current diet and the improved diets are shown. As can be seen, adding fruits and vegetables leads to a higher calorie intake and replacing food products, removing snacks, and replacing drinks lead to a lower calorie intake. Especially removing snacks shows the biggest difference. By looking at total fat, removing snacks results in a decrease in intake, the other differences are small. The diet of replacing food products shows hardly any difference in total fat, but contains less saturated fat and more unsaturated fat. The estimated intakes of carbohydrates and sugar show a similar pattern. Adding fruit and vegetables leads to a higher intake of carbohydrates and sugar. The other three improved diets contain less carbohydrates and sugar. In estimated protein intake no major difference is seen between the current diet and the improved diets. By looking at estimated fibre intake, a diet with added fruits and vegetables and replaced food products contains a higher amount of fibre, removed snacks slightly lower, and replaced drinks more or less the same. Lastly, there are no differences in salt intake. The characteristics of these four improved diets are stated in tables 1-4 with a detailed explanation (Appendix).

Next to this, for every group specifically the current diet and the four improved diets are compared. The total nutrient intakes between different groups varies. For example, in general, male have a higher intake of all nutrients than female. However, the pattern that is found is similar as for the overall population. So for example, in general, the amount of calories consumed by adding fruits and vegetables is for all groups higher than in the current diet. For every group a bar chart with the differences between the current diet and improved diets in estimated nutrient intakes is also presented in the Appendix.

Table 6: The differences in estimated nutrient intakes between the current diet and the four improved diets.

	<b>Current diet</b>	<b>1: Added fruits and vegetables</b>	<b>2: Replaced food products with healthier products</b>	<b>3: Removed snacks from the diet</b>	<b>4: Replaced drinks with healthier drinks</b>
<b>Estimated intake of calories (kcal/week)</b>	15616	+907	-399	-1327	-576
<b>Estimated intake of total fat (g/week)</b>	592	+9	-3	-66	+4
<b>Estimated intake of saturated fat (g/week)</b>	210	+2	-19	-26	+3
<b>Estimated intake of unsaturated fat (g/week)</b>	368	+6	+16	-40	+1
<b>Estimated intake of total carbohydrates (g/week)</b>	1881	+169	-118	-160	-125
<b>Estimated intake of carbohydrates, of which sugar (g/week)</b>	843	+137	-110	-79	-115
<b>Estimated intake of protein (g/week)</b>	513	+19	+12	-17	+14
<b>Estimated intake of fibre (g/week)</b>	161	+38	+29	-10	+1
<b>Estimated intake of salt (g/week)</b>	32	0	-1	-2	0

### *Healthier diets in a more persons household*

Lastly, the costs of a four persons household are considered in combination with the improved diets. The total costs per week and the costs per person for the current diet and each of the four scenarios are presented in table 7. The healthier diet by adding fruits and vegetables has the highest cost per person and the other healthier diets and the current diet show the same costs. Per group, the costs for every diet show similar patterns. For example, male spend in the current diet and healthier diets a higher amount than female. Next to this, people aged 1-18 years spend the lowest amount of all groups. The other groups spend about similar amounts.

Table 7: The estimated total costs and costs per person in a four persons household for the current and healthier diets.

<b>Four persons household</b>		<b>Current diet</b>		<b>Added fruits and vegetables</b>		<b>Replaced food products with healthier products</b>		<b>Removed snacks from the diet</b>		<b>Replaced drinks with healthier drinks</b>	
		Estimated total costs (€/week)	Estimated costs per person (€/week)	Estimated total costs (€/week)	Estimated costs per person (€/week)	Estimated total costs (€/week)	Estimated costs per person (€/week)	Estimated total costs (€/week)	Estimated costs per person (€/week)	Estimated total costs (€/week)	Estimated costs per person (€/week)
<b>Overall</b>		192	48	217	54	189	47	184	46	185	46
<b>Age</b>	1-18y	164	41	187	47	164	41	157	39	156	39
	19-30y	203	51	228	57	200	50	197	49	188	47
	31-50y	201	50	227	57	197	49	195	49	191	48
	51-70y	201	50	228	57	198	49	194	49	188	47
	71-79y	196	49	223	56	192	48	190	47	185	46
<b>Gender</b>	Male	222	56	249	62	218	55	214	53	202	51
	Female	173	43	200	50	170	42	169	42	174	43
<b>Education</b>	Lower	196	49	221	55	192	48	189	47	186	47
	Intermediate	200	50	226	56	197	49	194	48	189	47
	Higher	200	50	228	57	197	49	194	49	188	47
<b>Weight</b>	Normal and underweight	204	51	232	58	201	50	196	49	193	48
	Obese and overweight	203	51	231	58	200	50	195	49	195	49

### 3.6 Marginal costs of the healthier diets

In table 8 the marginal costs of a healthier diet are presented. The current diet is specified with their total costs and the scenarios are presented with a + or – sign to specify the higher (+) or lower (-) costs in respect of the current diet. The diet with added fruits and vegetables costs more than the current diet and the diets with replaced food products, removed snacks, and replaced drinks costs less than the current diet. As can be seen, the differences in costs are observable in the costs of fresh products. The costs of long-life products show no change. Within the diet, the difference between groups of the diet with added fruits and vegetables is largest. The age groups of 51-70 years and 71-79 years spend more than the others. The education and weight groups show similar patterns. The other improved diets show no big difference between groups and the overall population.

Table 8: The marginal costs of a healthier diet compared to the current diet in which 1 = total costs, 2 = costs of fresh products, 3 = costs of long-life products

	Current diet			Added fruits and vegetables			Replaced food products with healthier products			Removed snacks from the diet			Replaced drinks with healthier drinks		
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
<b>Overall</b>	77	67	10	+5	+6	0	-2	-1	0	-2	-2	-1	-1	-1	0
<b>1-18y</b>	66	59	7	+4	+4	0	-2	-2	0	-2	-1	-1	-3	-3	0
<b>19-30y</b>	77	68	9	+5	+5	0	-2	-2	0	-1	0	-1	-3	-4	0
<b>31-50y</b>	79	68	10	+5	+6	0	-2	-2	0	-2	0	-1	-3	-2	0
<b>51-70y</b>	78	68	10	+9	+9	0	-1	-2	0	-2	-1	-1	-2	-1	0
<b>71-79y</b>	78	69	9	+10	+10	0	-2	-2	0	-2	-1	-2	-1	-1	0
<b>Male</b>	82	71	11	+6	+6	0	-2	-2	0	-3	-1	-1	-4	-4	0
<b>Female</b>	74	66	8	+6	+6	0	-2	-2	0	-1	0	-1	-1	-1	0
<b>Lower</b>	79	69	10	+6	+6	0	-2	-2	0	-2	-1	-1	-3	-2	0
<b>Intermediate</b>	79	69	10	+7	+7	0	-2	-2	0	-2	-1	-1	-3	-2	0
<b>Higher</b>	81	71	10	+6	+6	0	-3	-3	0	-3	-1	-1	-3	-3	0
<b>Normal and underweight</b>	82	71	10	+8	+9	0	-2	-2	+1	-3	-1	-1	-4	-3	0
<b>Obese and overweight</b>	79	69	9	+4	+5	0	-2	-2	+1	-3	-1	-1	-2	-1	0

## ***5. Discussion***

First, a short summary of the results is given. The most obvious difference in costs is seen between the current diet and scenario 1. In scenario 1 fruit and vegetables are added to the diet, which implies that these are relatively expensive. This result shows that a healthier diet is indeed more expensive than an unhealthy diet, as also stated in news articles and literature discussed before. However, in scenarios 2, 3, and 4 this is not evident. In these scenarios the costs are less than the costs of the current diet. It is to be expected that when half of the unhealthy snacks are removed from the diet, as is done in scenario 3, the total costs will be lower compared to the current diet as less food will be consumed. The results of scenarios 2 and 4 are not expected to be so clear. When replacing food products or drinks the costs could become both more expensive and cheaper. In this case, the diet became slightly cheaper, what suggests that healthier products are cheaper than the products in the current diet. Next to this, it is shown that the difference in costs is mainly in the cost of fresh products, and there are no major differences between the various groups. The most striking result is that in scenario 1 people aged 51-70, 71-79 and normal and underweight people spend around 9 or 10 euros more than the current diet, and the other groups 4, 5, or 6 euros. Moreover, when looking at a four persons household the costs per person are a lot lower than in a one-person household. This makes sense, because the cost of the same product can be spread over several people. One person often does not consume the whole product, but must pay the same for it. This is in line with the findings of Nibud. Nationaal Instituut voor Budgetvoorlichting (Nibud) is an organisation that also did research on household expenses in the Netherlands. It has examined what a household spends on average on food and drink (NIBUD, 2022). For example, they state that women aged 14-69 spend €6,70 per day and man aged 14-69 €7,28 per day, which then comes down to €46,90 and €50,96 euros per week. This is based on a household of two persons. According to Nibud, a one-person household is 10% more expensive and a four persons household 30% cheaper. So, Nibud calculates less costs for a diet than what in this research is calculated.

So far, it is assumed that the improved diets are really healthier, but is this really the case when considering nutrient intakes? Adding fruits and vegetables results in higher amounts of calories, carbohydrates, sugar, and fibre. This is expected because the amount of grams eaten becomes 1950 grams higher as more products are added to the diet and these products consist of a lot of sugar. A higher intake of fibre is also beneficial for someone's health. Then, replacing food products by healthier products results in less calories and carbohydrates. These carbohydrates consist almost exclusively of sugar. Next to this, total fat intake remains the same, but consists of less saturated fat and more unsaturated fat. This shows that this diet is healthier as the current diet, as also the total amount of grams eaten were about the same. The improved diet by removing snacks consists of 367 grams less than the current diet. The intake of all nutrients is also less, the intake of calories is 1327 kcal less. This diet is healthier as unhealthy products are removed and results in less nutrient intakes. The last scenario of an improved diet is by replacing drinks with healthier drinks. The total amount of grams eaten is 425 grams lower than the current diet. The amount of calories is 576 kcal lower. The intake of fat stays the same and the intake of carbohydrates, which consists almost exclusively of sugar, becomes lower. The

nutrient intakes of these improved diets show that these diets are all somewhat healthier than the current diet.

The calculation model used in this research uses unique calculations. It also gives insight into people's spending on food products and the overall health of different groups of people in the Netherlands. This report, and especially the model, is a great addition to the current RIVM report of the Dutch National Food Consumption Survey 2012-2016. It includes the results of this survey in terms of dietary intake and combines it with the cost of these diets. It also adds several scenarios of a healthier version of this diet with associated costs. In the end, it shows the marginal monetary costs of a healthier diet for Dutch consumers.

Similar research was already conducted in Australia. In the background information paragraph, studies on the costs of the recommend and current Australian diet were discussed. The results showed that recommend diets were less expensive than current diets. This is comparable with the results of the current research. Three out of the four scenarios were a little less expensive than the current diet. The other scenario was clearly more expensive due to the addition of fruits and vegetables.

This is a general model that works well to discover a diet with their costs, but of course this varies in each personal situation. There are a few imperfections in this model. The food groups in the Dutch National Food Consumption Survey 2012-2016 were classified into a limited amount of 48 products. Obviously, in reality a diet consists of many more products, so these food groups could be classified into many more. Next to this, it assumes that products that are not fully consumed are thrown away. Especially in a one-person household the portion thrown away could be very large. Therefore, not everyone will throw this away, but consume it later. Different types of vegetables and meat have been added to the diet, because people like variety. However, what is left over must also be thrown away, but will not be done in every household. In this study, the four persons household consists of four people from the same group, so for example, four people aged 51-70. Probably in a real household this will not be the case, and a four person household will rather consist of 2 parents and 2 children for example. Because of this, the costs will be slightly different. Another issue is that the price of products differs over time. In this model the price is set at February 24, 2023. As an example, 18 of the 48 products had a different price on April 21, 2023 compared to February 24, 2023. 10 products were slightly cheaper and 8 products slightly more expensive. The price level can depend on the origin of a product or seasonality, for example. Lastly, fresh fruit and vegetables were included in the diet. By adding frozen fruit and vegetables instead of fresh the diet may be somewhat cheaper.

So, a healthier diet which consists of more fruit and vegetables is more expensive than the current diet. But what can be done to make people buy these products with lots of beneficial nutrients despite the higher price? One suggestion might be to make the unhealthier products more expensive. Logically, it is expected that people buy the cheaper healthier products more often. Other possibilities to make consumers choose healthier products is by making these products stand out more in the assortment, by making them cheaper, or by indicating which products are popular with others and often bought. Moreover, a tax on soft drinks might be an option. In England already such a soft drink tax is implemented (AD, 2020). The tax is based



on the amount of sugar. Drinks with less sugar have less tax. This stimulates the producers to make more drinks with less sugar, as these will be cheaper than the ones with a lot of sugar. Pricing strategies such as a sugar tax might be effective in promoting healthier diets. Especially low socioeconomic groups might benefit from such strategies as they pay more attention to low-cost products than healthy products (Mackenbach et al., 2015).

Further research can focus on the results of the Dutch National Food Consumption Survey 2019-2021, which will be published soon. This will contain more recent data on the eating patterns of the Dutch and this calculation model developed in this report can also be used for these results. In this way, the change in eating pattern with their costs can be made clear. Next to this, the model of this study can be transformed into an optimization model, using linear programming. Linear programming is a mathematical technique to maximize or minimize the outcomes of a linear function under various constraints (*Linear Programming*, n.d.). Managers use it to make decisions about the most efficient use of resources. In this case, a linear function of the costs of a diet can be developed. Various constraints can be added to this, such as restrictions on the total amount of calories, amount of carbohydrates, amount of fats, amount of meat, or minimum levels of proteins, vitamins, and minerals. Besides by creating optimal diets, by varying the constraints, the importance of the constraints for the price of the diet can be studied.

## **6. Conclusion**

The aim of this research was to estimate the marginal monetary costs of more healthy diets for different types of Dutch households. A healthy diet consisting of more fruit and vegetables cost on average €5 euros more than the current Dutch diet. Removing half of the snacks from a diet to make it more healthy or replacing unhealthier products for healthier ones resulted in a diet costing €2 euros less than the costs of the current diet. Replacing unhealthy drinks by more healthy drinks resulted in a reduction of diet costs of €1 euro. Thus, one scenario of a healthier diet resulted in higher marginal costs, and three scenarios did not. The costs per person in a four persons household amounted to €48 euros and in a one-person household €77 euros, in the current diet. Also, for the scenarios of the healthier diets this was the case. So, this research has shown that a healthy diet does not necessarily have high marginal costs and that the costs per person were lower in a more persons household than in a one-person household.

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*Appendix A: Detailed tables of the estimated costs and nutrient intakes of the four improved diets*

Table 1: Estimated costs and nutrient intakes of the improved diet by added fruits and vegetables.

	Total population	Subgroups											
	Overall	Age					Gender		Education			Weight	
		1-18y	19-30y	31-50y	51-70y	71-79y	Male	Female	Lower	Intermediate	Higher	Normal and underweight	Obese and overweight
Estimated total costs (£/week)	82	70	82	84	87	88	88	80	85	86	87	90	83
Estimated costs of fresh products (£/week)	72	63	73	74	77	79	77	72	75	76	77	80	74
Estimated costs of long-life products (£/week)	10	7	9	10	10	9	11	8	10	10	10	10	9
Estimated intake of calories (kcal/week)	16523	14488	17607	17356	16299	14773	19518	14615	16626	17128	17226	17646	16922
Estimated intake of total fat (g/week)	601	482	611	637	607	543	723	530	616	627	641	668	647
Estimated intake of saturated fat (g/week)	212	177	209	222	216	200	254	197	220	232	231	244	242
Estimated intake of unsaturated fat (g/week)	374	292	386	398	375	328	451	319	379	378	394	406	388
Estimated intake of total carbohydrates (g/week)	2050	1998	2233	2105	1913	1733	2311	1784	1996	2064	2030	2084	1965
Estimated intake of carbohydrates, of which sugar (g/week)	980	1094	1020	953	858	820	985	826	926	938	897	939	888
Estimated intake of protein (g/week)	532	431	566	568	552	506	649	500	557	580	588	587	591
Estimated intake of fibre (g/week)	199	173	208	204	198	193	222	186	196	202	212	218	203
Estimated intake of salt (g/week)	32	27	35	36	34	31	41	31	35	37	36	36	35

*Detailed explanation of table 1:*

The costs of this diet ranged between €70 and €90 euros per week, with an average of €82. Looking at the age groups, more is spent as one gets older with people aged 1-18 years spending €70 and 71-79 years €88. The other age groups were between these two amounts. Male spent €88 and female €80 and normal and overweight people spent €90 and obese and overweight €83. The education groups spent about the same (€85-€87). The costs for fresh products were on average €72, with a range of €63-80. The costs for long-life products were on average €10. The amount of calories consumed lay between 14488 and 19518 kcal, with an average of 16523 kcal. The lowest amounts were consumed by people aged 1-18 years (14488 kcal), 71-79 years (14773 kcal) and female (14615 kcal). The highest amount was consumed by male. The others groups were all between 16299 and 17646. Normal and underweight consumed 17646 kcal and obese and overweight 16922 kcal. The amount of fat eaten was on average 601 grams in total, ranging between 482 and 723 grams. All groups ate between 607 and 668 grams, except people aged 1-18 years (482 grams), 71-79 years (543 grams), female (530 grams), and male (723 grams). The amount of unsaturated fat was 60-63% of the total amount of fat in every group. The amount of carbohydrates ingested ranged between 1733 and 2311 grams, with an average of 2050 grams. The lowest amounts were consumed by people aged 71-79 years (1913 grams) and female (1784 grams) and the highest amount by people aged 19-30 years (2233 grams) and male (2311 grams). The other groups were between 1913 and 2084 grams. People with a normal weight or underweight (2084 grams) consumed a higher amount of carbohydrates than obese and overweight people (1965 grams). The percentage sugar of these carbohydrates ranged between 43-55%, with an average of 48%. The highest percentage is found by people aged 1-18 years (55%) and the lowest percentage by male (43%). Other groups were all between 44-47%. The amount of protein lay between 431 and 649 grams, with an average of 532 grams. Groups that ate amounts below average were people aged 1-18 years (431 grams), 71-79 years (506 grams), and female (500 grams). The highest amount was consumed by male (649 grams) and all other groups lay between 552 and 591 grams. Fibre consumption was on average 199 grams per week with a range of 173-222 grams. An amount of 32 grams of salt was consumed on average, ranging between 27 and 41 grams. Males ingested 41 and females 31 grams of salt per week. People aged 1-18 years and 71-79 years ingested 27 and 31 grams respectively. All other groups ingested 34-37 grams per week.

Table 2: Estimated costs and nutrient intakes/diet characteristics of the improved diet by replacing products for healthier products.

	Total population	Subgroups											
	Overall	Age					Gender		Education			Weight	
		1-18y	19-30y	31-50y	51-70y	71-79y	Male	Female	Lower	Intermediate	Higher	Normal and underweight	Obese and overweight
Estimated total costs (€/week)	75	64	75	77	77	76	80	72	77	77	78	80	77
Estimated costs of fresh products (€/week)	65	57	66	66	66	67	69	64	67	67	68	69	67
Estimated costs of long-life products (€/week)	10	7	9	10	10	9	11	8	10	10	10	11	10
Estimated intake of calories (kcal/week)	15217	13204	16308	15982	14882	13417	18149	13290	15317	15818	15805	16304	15597
Estimated intake of total fat (g/week)	589	486	598	620	589	523	707	508	598	613	621	657	624
Estimated intake of saturated fat (g/week)	191	161	184	199	201	185	231	174	200	207	205	222	219
Estimated intake of unsaturated fat (g/week)	384	314	401	406	372	323	460	323	384	392	402	419	391
Estimated intake of total carbohydrates (g/week)	1763	1681	1947	1812	1620	1463	2014	1518	1725	1778	1732	1784	1704
Estimated intake of carbohydrates, of which sugar (g/week)	733	814	777	700	611	585	732	599	691	687	647	673	662
Estimated intake of protein (g/week)	525	427	562	560	537	492	641	490	546	575	581	584	581
Estimated intake of fibre (g/week)	190	157	203	200	187	179	218	176	186	193	205	207	192
Estimated intake of salt (g/week)	31	27	34	35	34	31	40	30	34	35	34	35	34

*Detailed explanation of table 2:*

The total costs lay between €64 and €80 euros per week. The lowest amount was €64 spent by people aged 1-18 years. The other groups ranged between €75 and €80, with the lowest spent by people aged 31-50 years and highest by male and normal and underweight people. The costs for fresh products were on average €65, with a range between €57 and €69. Most groups spent around €66-68. The costs of long-life products were on average €10 euros per week. The amount of calories consumed were on average 15217 kcal, ranged between 13204-18149 kcal. The lowest amounts were eaten by people aged 1-18 years (13204 kcal), 51-70 years (14882 kcal), 71-79 years (13417 kcal), and female (13290 kcal). The highest amount is eaten by male (18149 kcal). The other groups were between 15317 and 16308 kcal. The amount of fat that was consumed lay between 486 and 707 grams, with an average of 589 grams. All groups were between 589 and 657 grams, except people aged 1-18 years (486 grams), 71-79 years (523 grams), male (707 grams), and female (508 grams). The percentage of unsaturated fat is on average 65% of the total amount of fat, with a range between 62-67%. The amount of carbohydrates consumed was on average 1763 grams. The highest amounts are consumed by people aged 19-30 years (1947 grams), 31-50 years (1812 grams) and male (2014 grams), and the lowest amounts are consumed by people aged 71-79 years (1463 grams) and female (1518 grams). The other groups consumed around average. The sugar consumption ranged between 37-48% of the amount of carbohydrates. The highest amount of 48% was consumed by people aged 1-18 years. The other groups ranged between 37-40%. The average protein consumption was 525 grams, with a range of 427-641 grams. Most groups consumed between 537 and 584 grams, except people aged 1-18 years (427 grams), 71-79 years (492 grams), male (641 grams) and female (490 grams). Fibre consumption was ranging between 157 and 218 grams, with an average of 190. Most groups were between 186 and 207 grams. The amount of salt eaten was on average 31 grams, most groups consumed around 34-35 grams per week.

Table 3: Estimated costs and nutrient intakes/diet characteristics of the improved diet by removing half of the snacks.

	Total population	Subgroups											
	Overall	Age					Gender		Education			Weight	
		1-18y	19-30y	31-50y	51-70y	71-79y	Male	Female	Lower	Intermediate	Higher	Normal and underweight	Obese and overweight
Estimated total costs (£/week)	75	64	76	77	76	76	79	73	77	77	78	79	76
Estimated costs of fresh products (£/week)	66	58	68	68	67	68	70	66	68	68	70	70	68
Estimated costs of long-life products (£/week)	9	6	8	9	9	8	10	7	9	9	9	9	8
Estimated intake of calories (kcal/week)	14289	12305	15428	15164	14095	12776	17172	12678	14409	14959	15131	15344	14554
Estimated intake of total fat (g/week)	526	413	534	562	538	484	641	471	541	553	576	587	566
Estimated intake of saturated fat (g/week)	184	151	185	195	188	173	224	174	191	205	208	216	210
Estimated intake of unsaturated fat (g/week)	328	250	333	351	334	297	400	284	334	332	354	356	340
Estimated intake of total carbohydrates (g/week)	1721	1668	1923	1786	1578	1425	1974	1488	1672	1749	1712	1754	1624
Estimated intake of carbohydrates, of which sugar (g/week)	764	873	827	747	632	604	767	626	710	731	683	724	657
Estimated intake of protein (g/week)	496	396	533	535	517	474	612	470	521	545	554	550	551
Estimated intake of fibre (g/week)	151	126	160	157	150	147	173	140	148	154	165	168	152
Estimated intake of salt (g/week)	30	25	32	33	32	29	38	29	32	34	33	34	33

*Detailed explanation of table 3:*

The costs per week ranged between €64 and €79 euros per week, with an average of €75. Male spent €79 and female €73. People aged 1-18 spent €64. The other groups spent similar amounts around €76 and €79. When looking at the costs for fresh products, most groups spent between €68 and €70 euros on these products. The costs of long-life products are between €8 and €10. The average amount of calories consumed is 14289 kcal, although most groups are above this value. The groups are people aged 19-30 years (15428 kcal), 31-50 years (15164 kcal), male (17172 kcal), all education groups (14409, 15131, 15344 kcal), and both weight groups (15344 and 14554 kcal). People aged 1-18 years, 51-70 years, 71-79 years, and females consumed lower amounts. The amount of fat eaten was between 413 and 641 grams, with an average of 526 grams. The lowest amounts were eaten by people aged 1-18 years (413 grams), 71-79 years (484 grams), and females (471 grams). The highest amount by male (641 grams), and the other groups were between 534 and 587 grams. The amount of unsaturated fat is 60-62% of the total amount of fat in all groups. The average amount of carbohydrates consumed is 1721 grams, with a range between 1425 and 1974 grams. The highest amounts are from people aged 19-30 years (1923 grams) and males (1974 grams). People aged 51-70 years, 71-79 years, and females consumed less than 1600 grams. The other groups were somewhere between 1600 and 1800 grams. The amount of sugar ranged between 39-52%. The percentages of sugar consumption were the lowest by male and higher educated people (39%) and the highest by 1-18 years (52%). The other groups were between 40-43%. The amount of protein was on average 496 grams, ranging between 396 and 612 grams. The highest amount is consumed by males (612 grams), the lowest by people aged 1-18 years (396 grams), people aged 71-79 years (474 grams) and female (470 grams), and the other groups were between 500 and 550 grams. The amount of fibre consumed was on average 151 grams and salt 30 grams. The salt consumption was by most groups between 30 and 34 grams per week.

Table 4: Estimated costs and nutrient intakes of the improved diet by replacing drinks with healthier drinks.

	Total population	Subgroups											
	Overall	Age					Gender		Education			Weight	
		1-18y	19-30y	31-50y	51-70y	71-79y	Male	Female	Lower	Intermediate	Higher	Normal and underweight	Obese and overweight
Estimated total costs (£/week)	76	63	74	76	76	77	78	73	76	76	78	78	77
Estimated costs of fresh products (£/week)	66	56	64	66	67	68	67	65	67	67	68	68	68
Estimated costs of long-life products (£/week)	10	7	9	10	10	9	11	8	10	10	10	10	9
Estimated intake of calories (kcal/week)	15040	12450	15628	15874	15083	13790	17622	13691	15185	15608	15984	16414	15795
Estimated intake of total fat (g/week)	596	473	605	635	606	542	715	527	610	621	641	665	647
Estimated intake of saturated fat (g/week)	213	175	210	225	219	204	253	199	221	233	236	248	248
Estimated intake of unsaturated fat (g/week)	369	286	380	393	371	324	444	314	373	372	390	401	384
Estimated intake of total carbohydrates (g/week)	1756	1558	1850	1837	1717	1590	2019	1616	1745	1802	1821	1879	1764
Estimated intake of carbohydrates, of which sugar (g/week)	728	692	685	727	711	717	759	694	717	723	737	785	734
Estimated intake of protein (g/week)	527	412	556	567	548	506	633	496	548	570	590	586	596
Estimated intake of fibre (g/week)	162	135	169	166	159	156	183	148	158	163	174	179	164
Estimated intake of salt (g/week)	32	27	35	36	35	31	41	31	35	37	36	37	36



*Detailed explanation of table 4:*

The costs per week ranged between €63 and €78 euros per week, with the lowest being the groups aged 1-18 years (€63). All other groups ranged between €73 and €78. When looking at gender, male spend €78 and female €73. The costs for fresh products ranged between €64 and €68, except for age group 1-18 years (€56). The costs for long-life products were on average €10. The number of calories ranged between 12450 kcal and 17622 kcal, with an average of 15040 kcal. Looking at the age groups, 1-18 years ingested 12450 kcal, followed by 71-79 years with 13790 kcal, and the other age groups and all education groups between 15000 and 16000 kcal per week. Male ingested 17622 kcal and female 13691 kcal. The normal and underweight ingested 16414 kcal and obese and overweight 15795 kcal per week. The amount of fat eaten was between 473 and 715 grams. The lowest amount is consumed by people aged 1-18 years (473 grams) and 71-79 years (542 grams) and females (527 grams). The male ate the highest amount with 715 grams. The other groups were between 600 and 700 grams. The amount of unsaturated fat was in all groups between 60 and 63% of the total amount of fat. The average amount of carbohydrates eaten was 1756 grams. Five groups consumed a lower amount; 1-18 years (1558 grams), 51-70 years (1717 grams), 71-79 years (1590 grams), female (1616 grams), and lower educated people (1745 grams). Six groups consumed a higher amount; 19-30 years (1850 grams), 31-50 years (1837 grams), male (2019 grams), intermediate educated (1802 grams), higher educated (1821 grams), normal and underweight (1879 grams), and obese and overweight (1764 grams). The amount of sugar of these carbohydrates ranged between 685 and 785 grams, with an average of 728 grams. This corresponded to an amount of sugar of 37-45% of carbohydrates. Most groups consumed between 500 and 600 grams of protein, the exceptions were people aged 1-18 years (412 grams), male (633 grams), and female (496 grams). The average amount of fibre that people consumed was 162 grams, with a range between 135 and 183 grams. The average amount of salt ingested is 32 grams. Male ingested 41 grams and female 31 grams of salt. Most groups were around 35-37 grams per week.

## Appendix B: Detailed figures of the estimated nutrient intakes of all diets by subgroup

Figure 1: Estimated nutrient intake of current diet and improved diets for people aged 1-18 years.

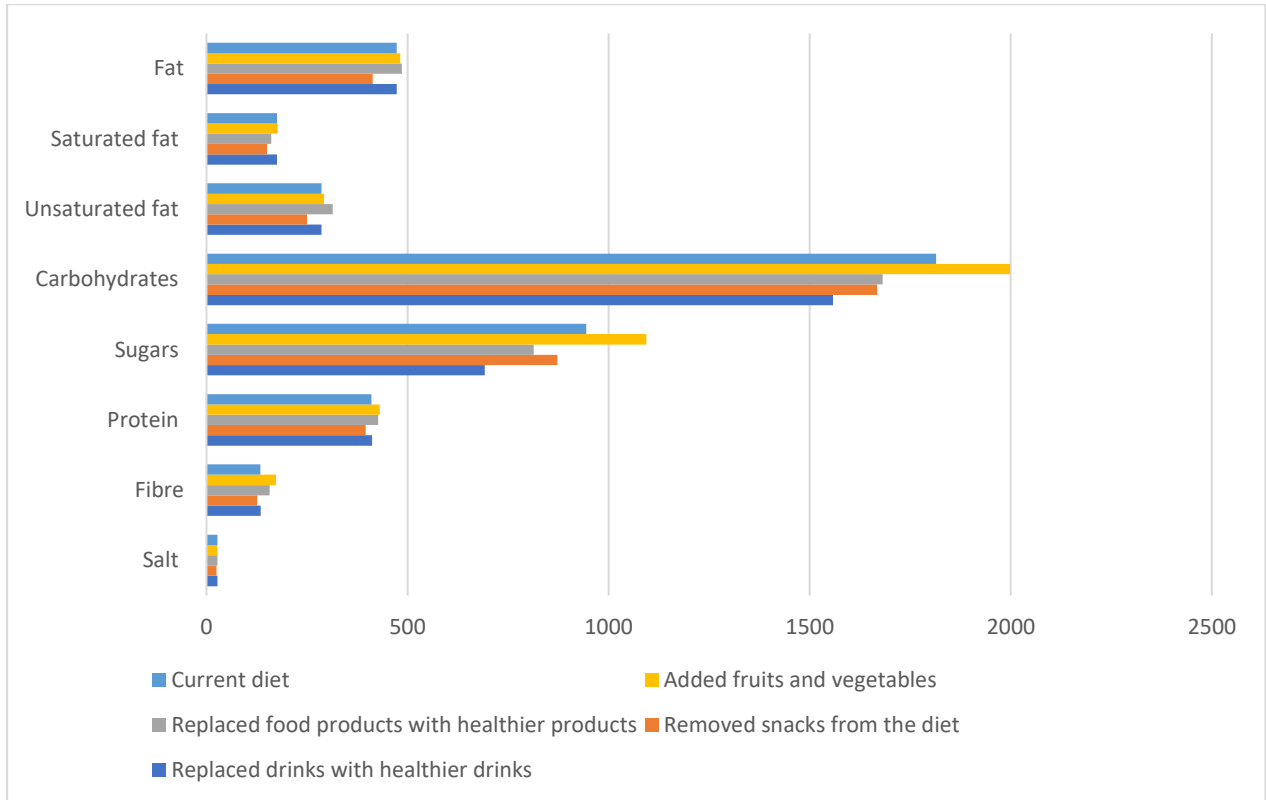


Figure 2: Estimated nutrient intake of current diet and improved diets for people aged 19-30 years.

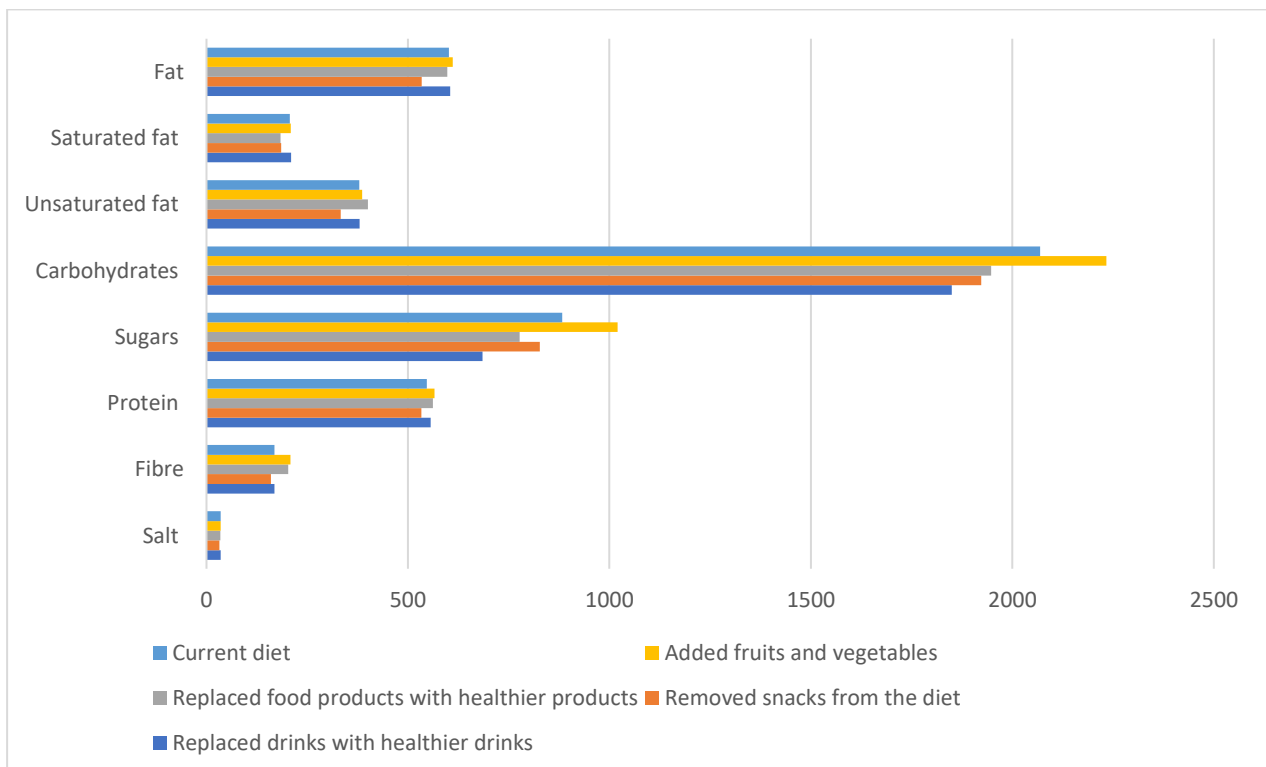


Figure 3: Estimated nutrient intake of current diet and improved diets for people aged 31-50 years.

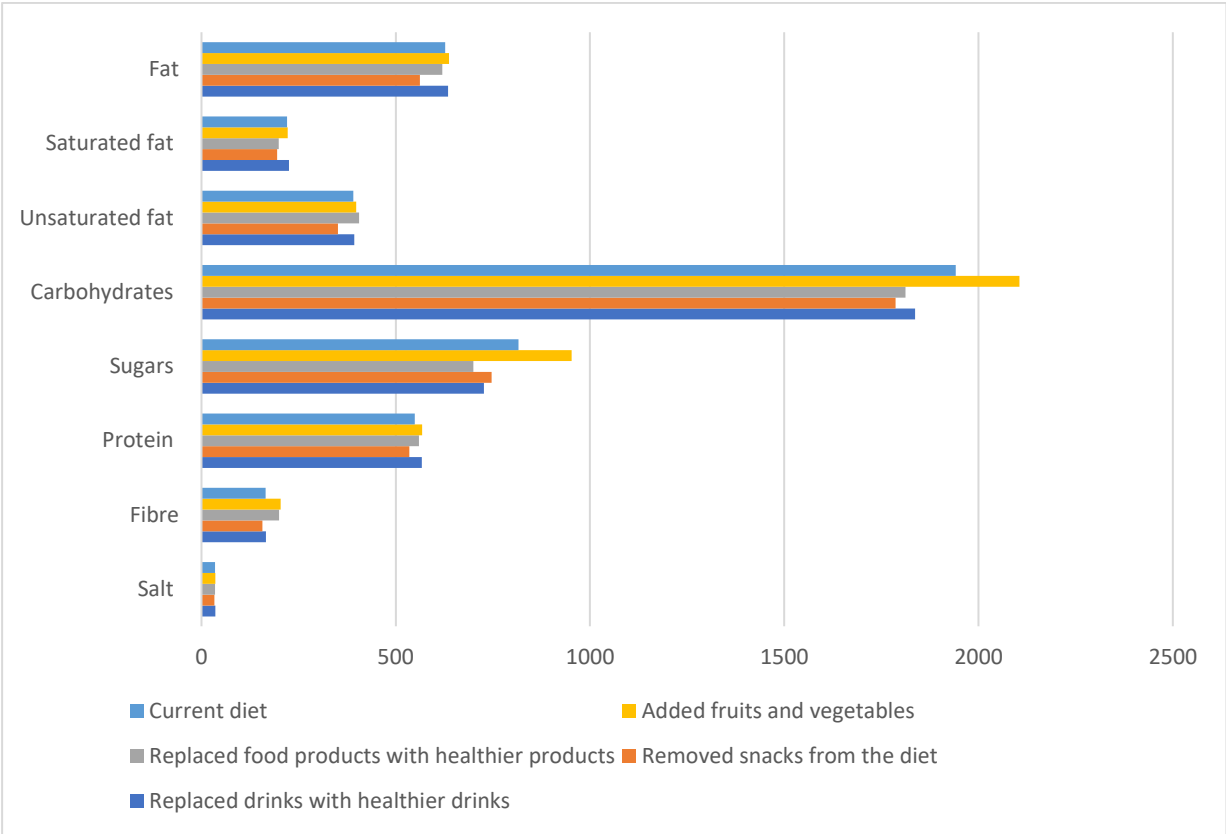


Figure 4: Estimated nutrient intake of current diet and improved diets for people aged 51-70 years.

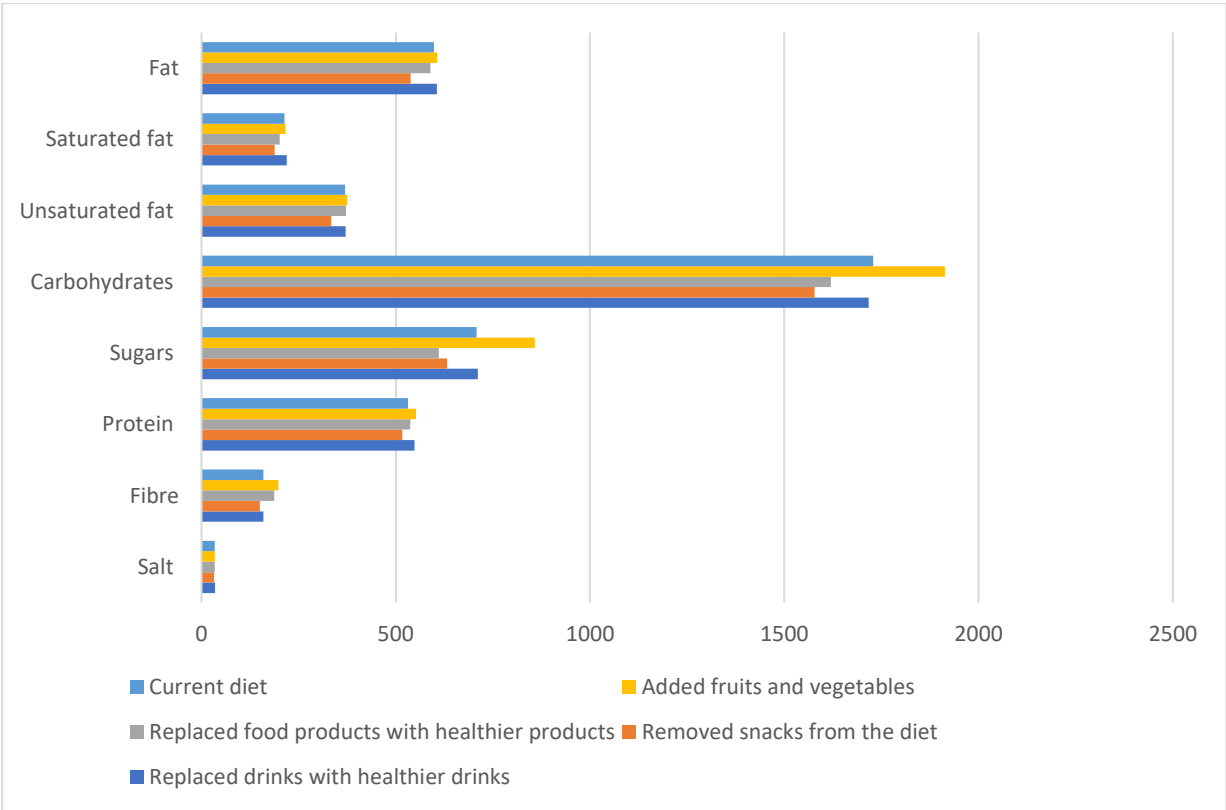


Figure 5: Estimated nutrient intake of current diet and improved diets for people aged 71-79 years.

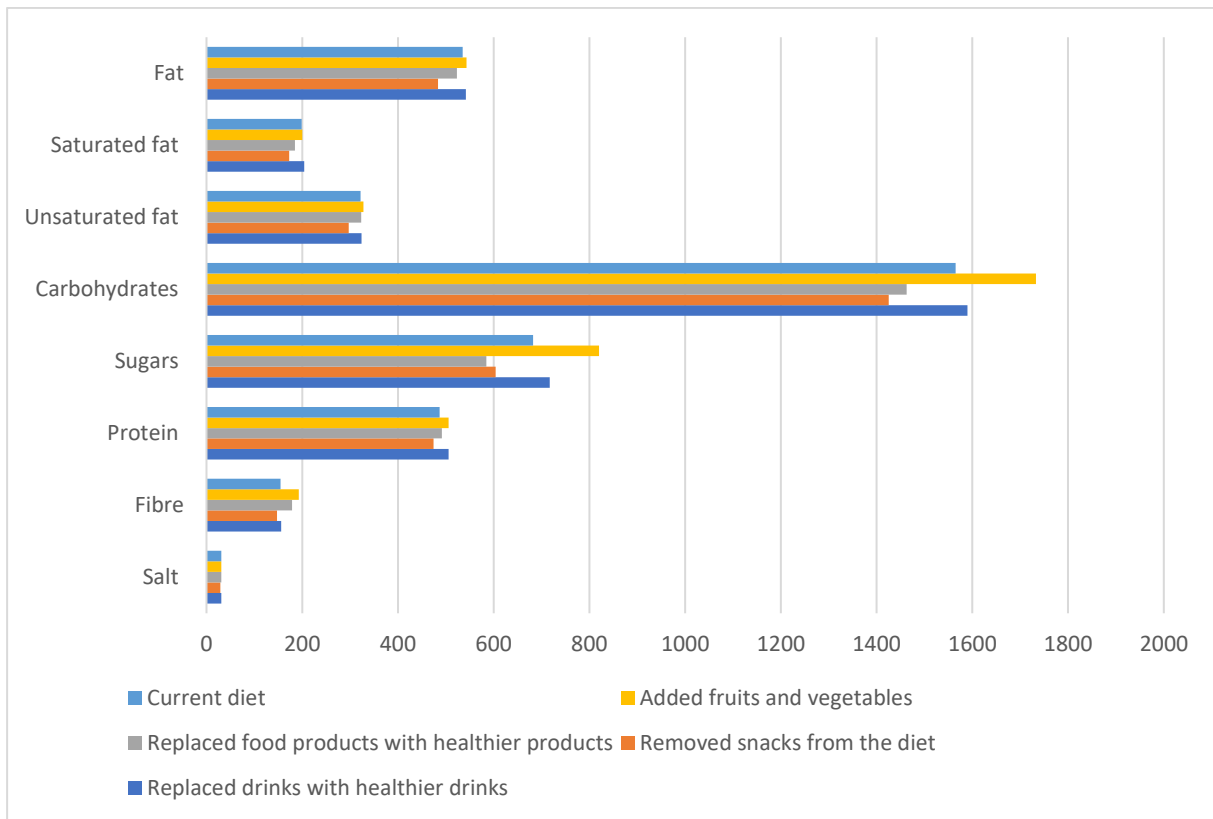


Figure 6: Estimated nutrient intake of current diet and improved diets for male.

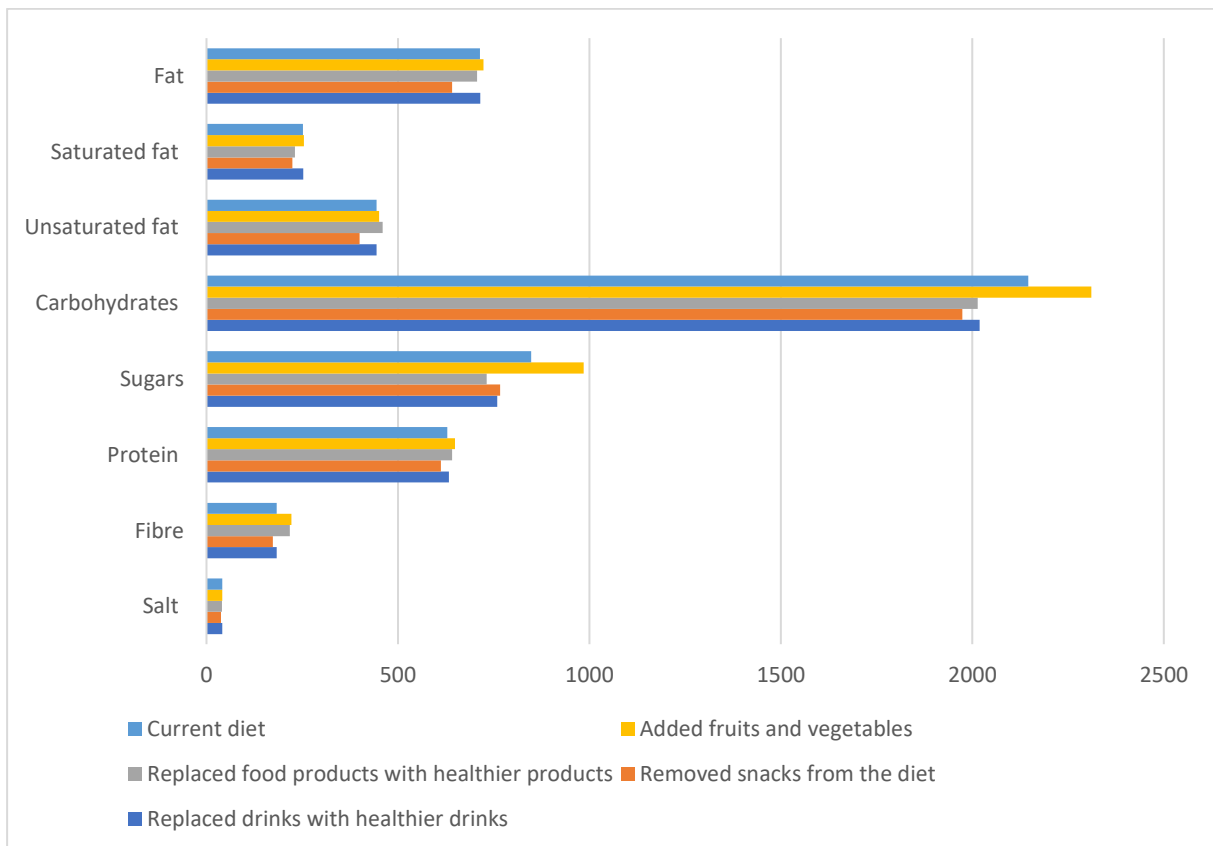


Figure 7: Estimated nutrient intake of current diet and improved diets for female.

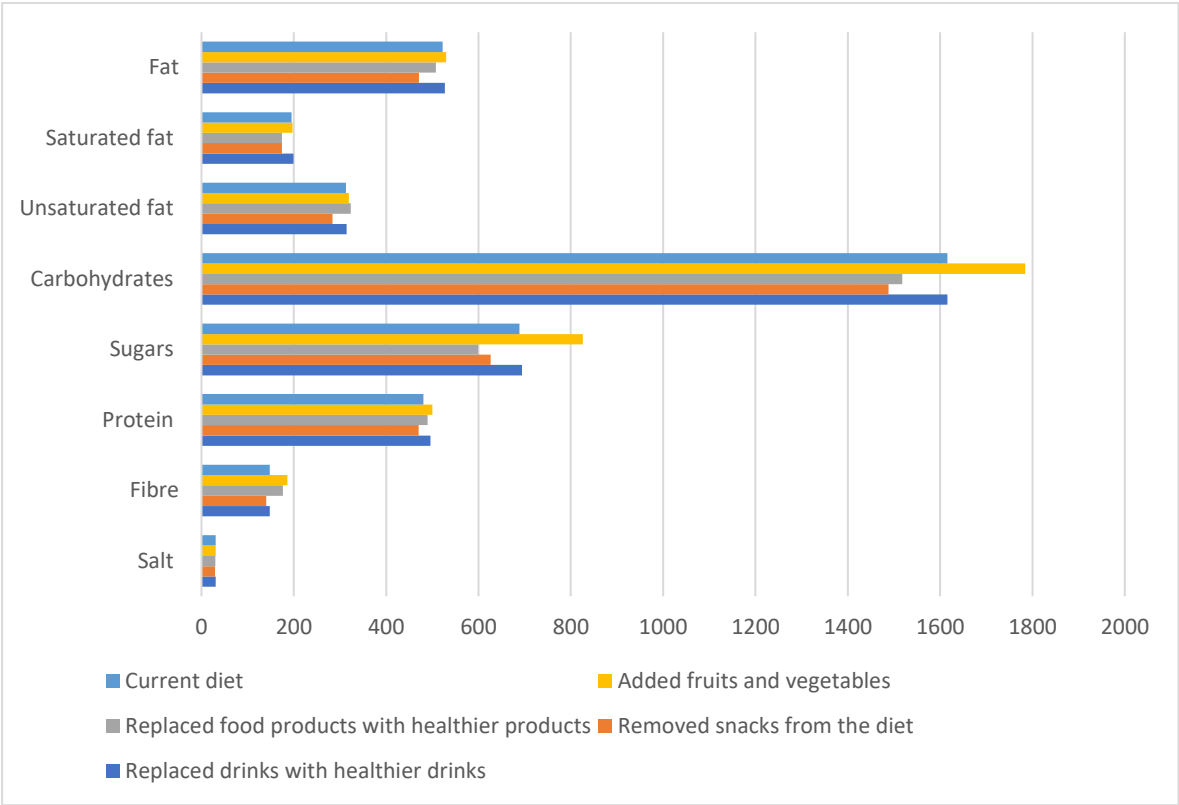


Figure 8: Estimated nutrient intake of current diet and improved diets for lower educated people.

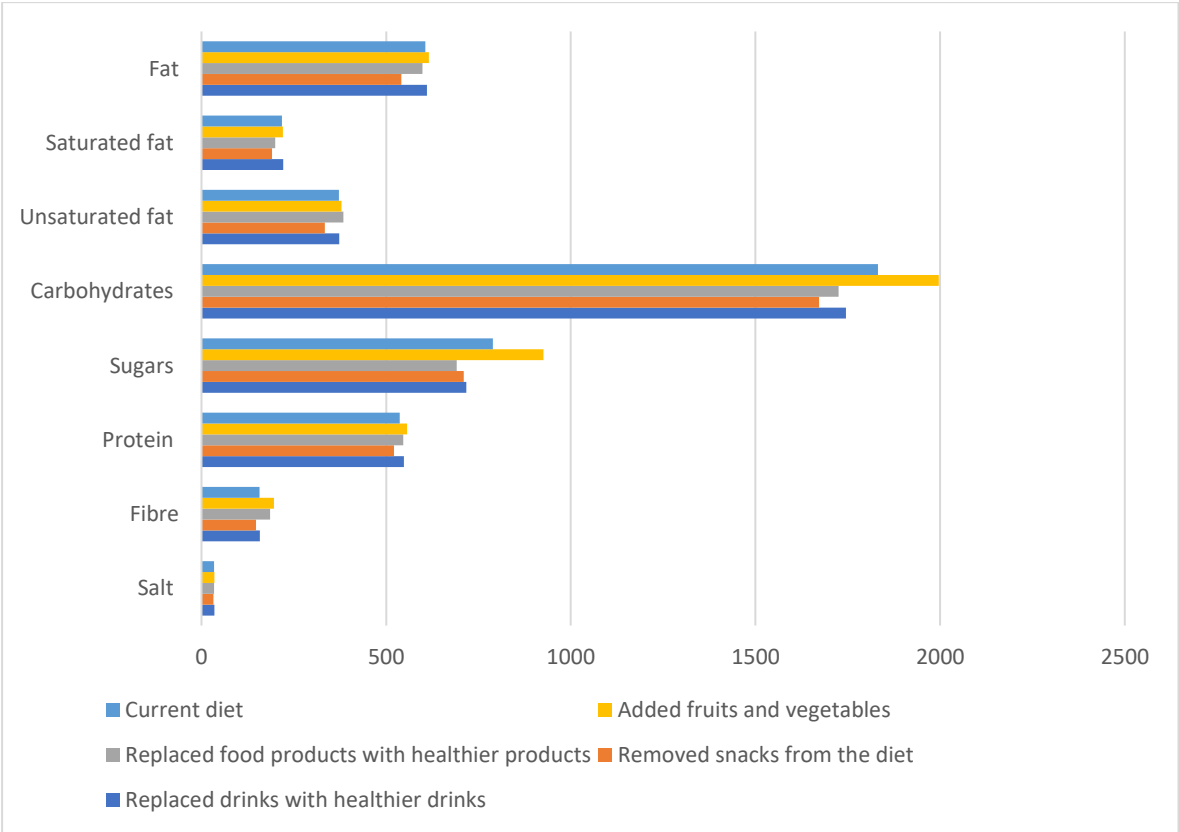


Figure 9: Estimated nutrient intake of current diet and improved diets for intermediate educated people.

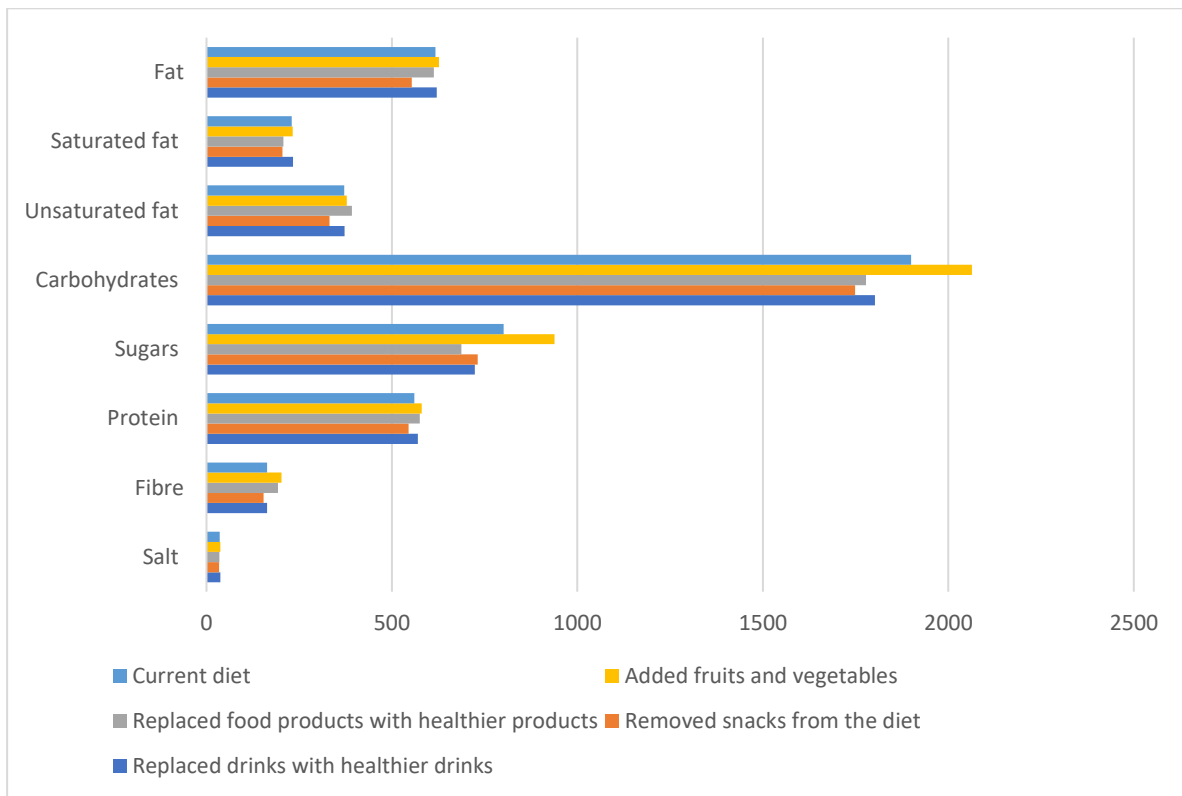


Figure 10: Estimated nutrient intake of current diet and improved diets for higher educated people.

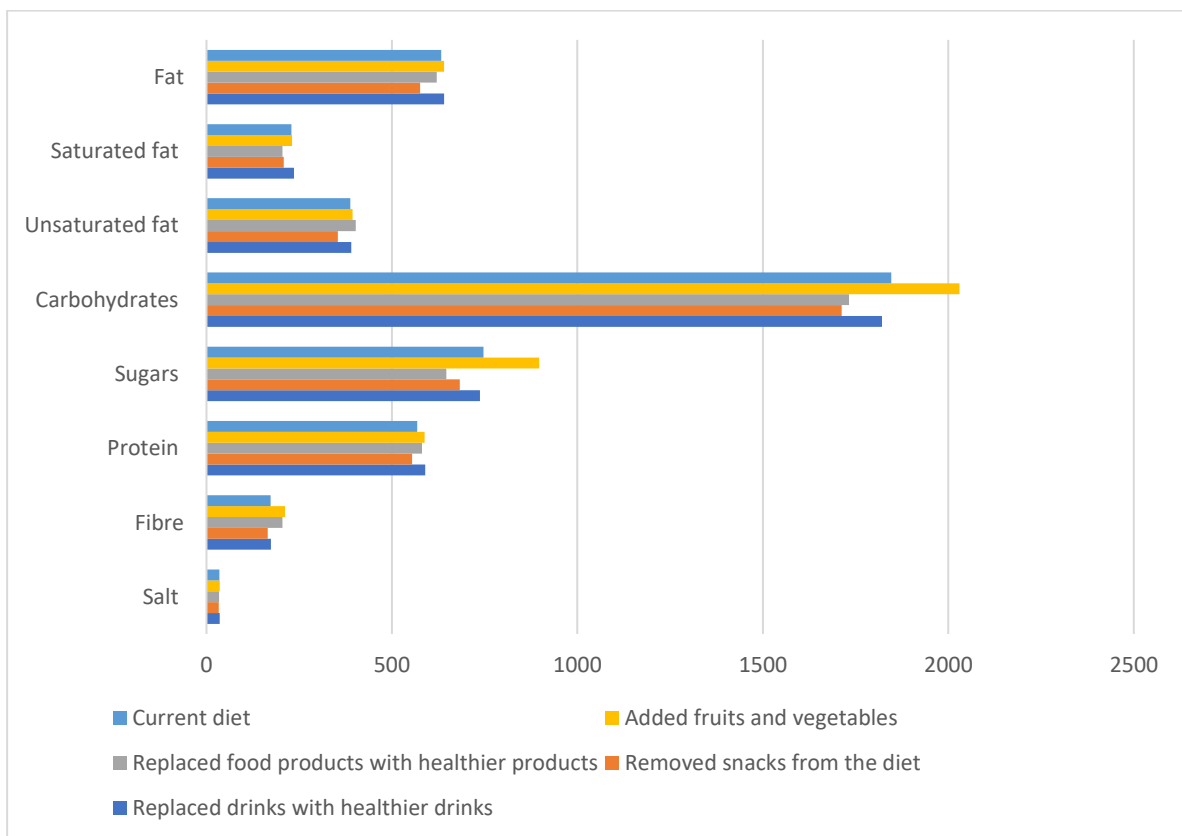


Figure 11: Estimated nutrient intake of current diet and improved diets for people with normal or underweight.

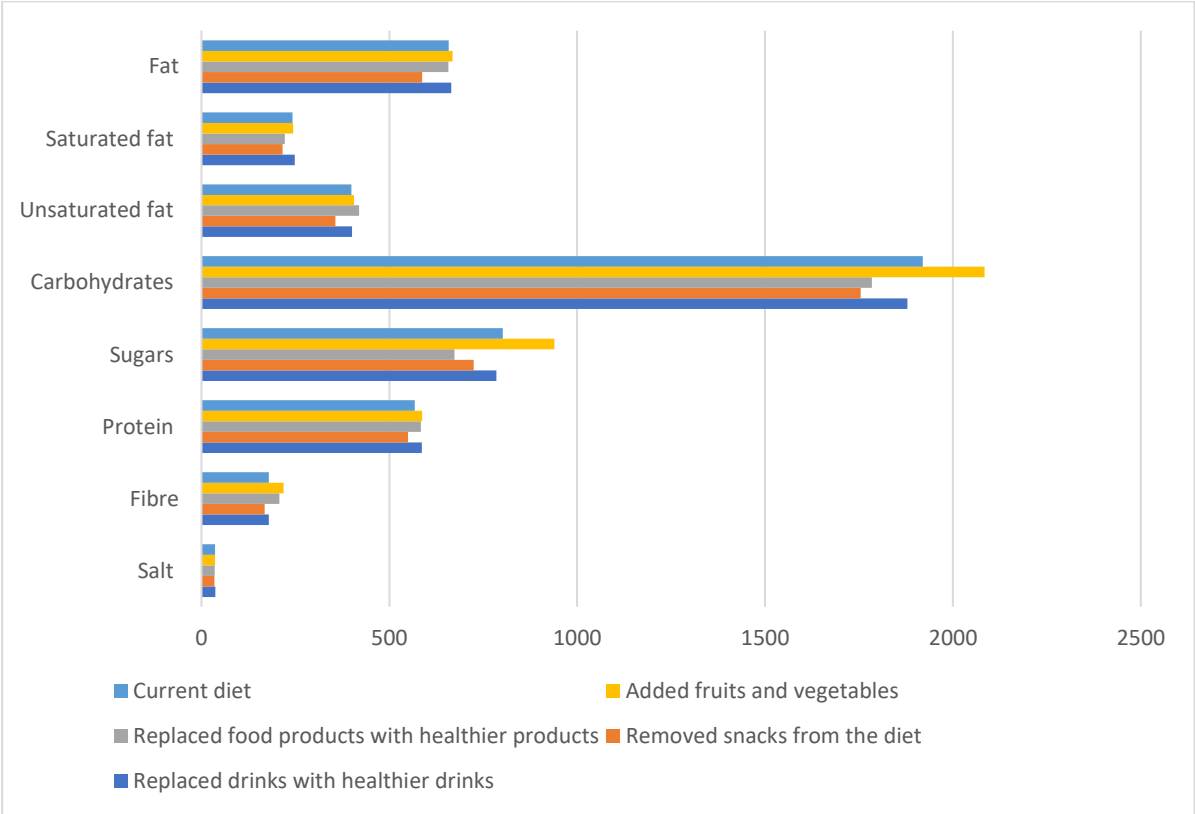


Figure 12: Estimated nutrient intake of current diet and improved diets for people with obese and or overweight.

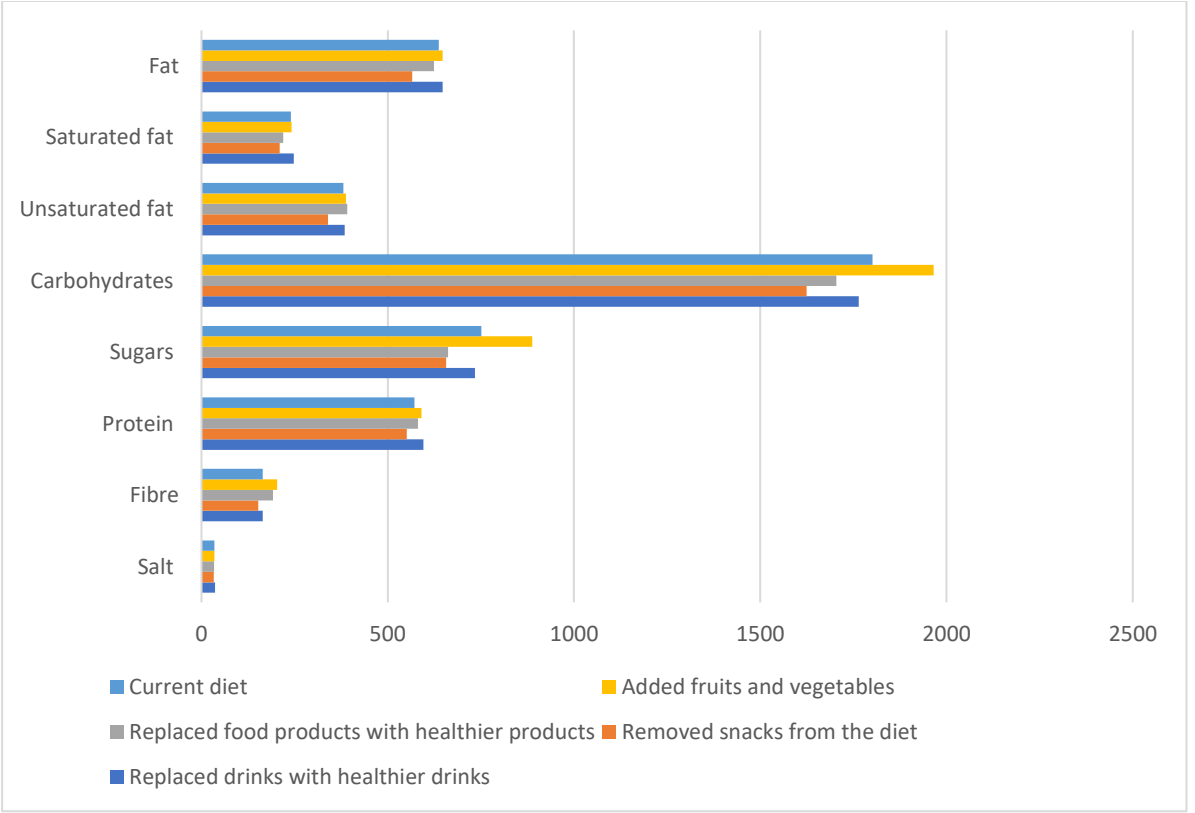


Figure 13: Estimated calorie intake for all groups in the current diet and improved diets.

