



Dutch consumers' attitude towards industrial food processing

Dieuwerke P. Bolhuis^{a,b,*}, Annet J.C. Roodenburg^c, A.P.J. Pieter Groen^a, Sylvie Huybers^c

^a Department of Food Quality and Design, Wageningen University and Research, P.O. Box 17, 6700, AA Wageningen, the Netherlands

^b Wageningen Food & Biobased Research, P.O. Box 17, 6700, AA Wageningen, the Netherlands

^c Department of Food & Industry, HAS Green Academy, Onderwijsboulevard 221, 5223, DE 's-Hertogenbosch, the Netherlands

ARTICLE INFO

Keywords:

Industrial food processing
Ultra-processed food
Consumer awareness
Health communication
Food choice

ABSTRACT

Industrial food processing and its possible adverse effects on health are widely debated in scientific literature and media. There is not much known about consumers' attitudes towards the processing of foods. Therefore, a questionnaire (n = 463) was distributed and interviews (n = 11) were conducted with Dutch consumers to evaluate the attitudes and associations towards industrial food processing and to assess opinions about communications on food processing and health. The results showed that 51% of the respondents had a neutral, 23% had a positive, and 26% had a negative attitude towards food processing. Respondents with a background in food by profession or education (n = 159) had more frequently a positive attitude towards food processing (P = 0.008). Respondents and interviewees pointed out both positive and negative associations with industrial processing: additives, artificial, not fresh, low nutritional value, unnatural, but also palatability, food safety, shelf life, and convenience. The questionnaire showed that 70% of the respondents thought food processing had a (slightly) negative health effect. Most interviewees indicated that when doing groceries, food processing *per se* is not relevant in food choices, although some critically inspected the ingredients. Furthermore, interviewees indicated that communication about food and health is scattered and complex. They would like to gain easy and straightforward information from a central source. From the questionnaire respondents, 60% indicated that they would like to have more information about food processing. In conclusion, most Dutch consumers in this study have a neutral and nuanced attitude towards industrial food processing. A connection with food via profession or education showed a more positive attitude, which may indicate the importance of knowledge and the need for clear communication about nutrition, ingredients, and food processing.

1. Introduction

The increased prevalence of obesity and related non-communicable diseases (NCDs) is a growing problem worldwide (World Health Organization, 2023). Changing eating habits and more unhealthy diets play a major role in the aetiology of obesity and NCDs (López-Bueno et al., 2024). Simultaneously with the rise in obesity, the sales and consumption of industrially processed foods have increased up to ~60% (Baker et al., 2020; Cordova et al., 2023; Mertens et al., 2022; Vandevijvere et al., 2019; Vellinga et al., 2021). A food product is considered processed when it is seasoned, cooked, preserved, mixed with other food ingredients or in any way altered from its original state (Petrus et al., 2021).

Industrial food processing has historically been performed to produce safe and palatable foods with an extended shelf life and can be classified according to the extent of industrial processing. In the

frequently used NOVA classification (Monteiro et al., 2019) products range from unprocessed (NOVA-1) to the highest level of food processing, called "ultra-processed foods (UPF)" (NOVA-4), which can be defined as: "formulations of ingredients, mostly of exclusive industrial use, that result from a series of industrial processes".

Many of these highly (ultra) processed products are associated with low diet quality, i.e. high in energy, fat, sugar and salt (Abreu & Martins, 2023; Correa-Madrid et al., 2023; Ferreiro et al., 2021). It has been shown that ad libitum consumption of ultra-processed food increases daily energy intake with a consecutive increase in body weight compared to unprocessed food (Hall et al., 2019). Other studies (Louzada et al., 2015) support this association which suggests that the extent of industrial food processing might play a role in the obesity pandemic (Cordova et al., 2021). Moreover, various studies have found that highly (ultra) processed foods have been associated with hypertension (Nardocci et al., 2021), breast-, prostate-, and colorectal cancer (Fiolet et al.,

* Corresponding author. Department of Food Quality and Design, Wageningen University and Research, P.O. Box 17, 6700, AA Wageningen, the Netherlands.

E-mail address: Dieuwerke.bolhuis@wur.nl (D.P. Bolhuis).

<https://doi.org/10.1016/j.appet.2024.107615>

Received 24 April 2024; Received in revised form 9 July 2024; Accepted 29 July 2024

Available online 30 July 2024

0195-6663/© 2024 The Authors. Published by Elsevier Ltd. This is an open access article under the CC BY license (<http://creativecommons.org/licenses/by/4.0/>).

2018), cardiovascular diseases (Juul & Hemmingsson, 2015), and diabetes type 2. This has caused different governments to implement food processing into dietary guidelines such as in Brazil (FAO, 2014), or there are discussions to add information on food processing to front-of-pack logo's (FOPs) such as Nutri-Score (Srouf et al., 2023).

Recently, industrial (ultra) processing of foods and its possible adverse effects on health are widely debated in scientific literature and media as well as the usefulness of the different food processing classification systems to determine the healthiness of a food product (Astrup et al., 2022; Forde, 2023; Monteiro et al., 2022; Scientific Advisory Committee on Nutrition, 2023). Not much is known about consumer's perceptions of industrial food processing or (ultra) processed foods, though a limiting number of studies is available (Aguirre et al., 2019; Ares et al., 2016; Bolhuis et al., 2022; Machín et al., 2020). Consumers in Uruguay, Argentina and Ecuador associated ultra-processed foods with the presence of many artificial ingredients and additives, and in general negative effects on health (Aguirre et al., 2019; Ares et al., 2016). In addition, an online study where respondents had to evaluate pictures of food items based on healthiness, showed that the UPFs were rated as less healthy compared to minimal processed foods despite similar Nutri-Scores (Bolhuis et al., 2022). However, most of the studies were executed in South America and those consumers may have more negative associations with industrial food processing because UPF are recommended to be avoided in the dietary guidelines in most countries in that continent (Food and Agriculture Organization, n. d.). There is no such recommendation in the Dutch dietary guidelines, however Dutch consumers may have been exposed negatively to UPF via media channels or their social environments. Moreover, there is a strong distrust in the food industry in some parts of different societies (Edelman, 2019; Harbers et al., 2021).

This study aimed to identify the general attitude towards industrial food processing in the Dutch population and more specifically to map possible differences in associations and opinions between people with a negative or positive attitude. In this way, the underlying causes for various opinions on processed food among consumers can be better understood. This was assessed by a questionnaire and consecutive interviews in adult Dutch consumers.

2. Materials and methods

2.1. Participants

Dutch-speaking adults with a minimum age of 18 years were included in this study. Respondents for the questionnaire (n = 463) were recruited via the researchers' network, Facebook groups, LinkedIn, and the distribution of flyers in low-income neighbourhoods in order to obtain a representative selection of the general population. Eleven interviewees from the questionnaire were selected for the interviews.

This study was performed in line with ethical guidelines and all respondents signed informed consent. The questionnaire study was executed by researchers at the HAS green academy and the proposal was assessed by the ethical advisory committee of HAS green academy (No. P2022-23). The interviews were executed by researchers at Wageningen University and the proposal was assessed by the Social Sciences Ethic Committee of Wageningen University & Research (No. 2022-145-Bolhuis-2).

2.2. Questionnaire

Data were collected from April to December 2022. The questionnaire was developed based on findings of previous studies together with insights of focus groups executed by students of the HAS green academy prior to the present study (data is not published). The questionnaire was designed in Google Forms and consisted of 35 questions which took approximately 10–15 min to fill out. Respondents were further subdivided according to their demographic characteristics: age (18–24,

25–34, 35–49, 50–64, >65 years), gender (male, female, no answer), highest educational level (high school, associate's degree level 1–2, associate's degree level 3–4, bachelor's degree, master's degree), food background by education or profession (yes, no) and body mass index (BMI) (<18.5, 18.5–25, >25 kg/m²). In addition, the answers of the respondents were subdivided according to their answers on the following questions: are you familiar with the term ultra-processed food (UPF) (yes, no), does food processing contribute to food safety ((slightly) disagree, neutral, (slightly) agree), what is the effect of food processing on health (do not know, (slightly) negative, neutral, (slightly) positive), does food processing influence perceived own food purchases (no influence, sometimes, (almost) always) and would you like to receive more information about food processing (yes, no). Most questions were multiple choice and a few open questions, see **Supplementary material** for the complete questionnaire.

2.3. Interviews

At the end of the questionnaire, respondents could indicate if they were interested to participate in an interview by giving their email address. Out of those responses we selected 11 interviewees based on a variation in their attitude towards industrial processing (either positive, neutral and negative), as the aim of this part of the study was to have a deeper insight in the opinions of those with different attitudes. In addition, a wide range in age, educational level was selected of men and women. With 11 interviews no new information was collected, so we reached data saturation. Most of the opinions were stated by (at least) more than one respondent. Semi-structured interviews were conducted using an interview guide, to get a deeper insight into the consumers' associations and opinions in terms of industrial food processing, the perceived relation with health, food purchases, and the communication about food and health in general. To initiate conversations about industrial food processing, the interviewer selected some food products based on recent grocery receipts of the interviewees. The products were mainly highly (ultra) processed foods (Monteiro et al., 2019) with variations in healthiness according to the Nutri-Scores (Santé Publique France, n. d.). The interviewee was then asked to what extent they perceived the products as processed, how healthy they found the products and why they had purchased them.

2.4. Data analysis

Data from the questionnaire were collected and analysed in SPSS Statistics 27 (IBM). The central attribute within the questionnaire was the consumers' attitude towards industrial food processing, which was determined on a 5-point Likert scale (1 = very negative; 2 = negative; 3 = neutral; 4 = positive; 5 = very positive). The respondents were assigned to one of three attitude groups: (very) negative, neutral, (very) positive. Responses of respondents were further subdivided according to their demographic characteristics, and answers to questions about industrial food processing. Pearson Chi-square tests were used to determine differences between the different attitude groups ((very) negative, neutral, (very) positive) of the categorial data obtained by the questionnaire. The interviews were audio-recorded and subsequently transcribed verbatim. The interviews were analysed with Atlas.ti using a mixture of inductive codes (n = 9) and deductive codes (n = 17) and individually checked by two independent researchers for reliability and alignment on the used codes.

3. Results

3.1. Study population and general attitude towards industrial food processing

From the total of 463 respondents of the questionnaire, 56% were female and 43% were male (Table 1). Of all respondents, 34% reported

Table 1
Characteristics of questionnaire respondents in frequencies (%) and its effect on attitude towards food processing.

%		Attitude towards food processing				P
		(Very) negative (n = 121)	Neutral (n = 238)	(Very) positive (n = 104)	Total (n = 463)	
Gender	Male	37	45	47	43	0.09
	Female	61	55	53	56	
	No answer	1.7	0	0	0.4	
Age	18–24	26	34	36	33	0.48
	25–34	16	15	13	15	
	35–49	21	19	24	21	
	50–64	25	21	23	23	
	>65	12	10	3.8	9.1	
BMI	<18.5	1.7	2.1	1.0	1.9	0.33
	18.5–25	66	65	56	63	
	>25	31	33	43	35	
Educational level	High school	8.3	11	6.7	10	0.69
	Associate's degree (1/2)	4.1	3.4	3.8	3.7	
	Associate's degree (3/4)	19	19	14	18	
	Bachelor's degree	39	38	37	38	
	Master's degree	30	28	38	31	
Background in food	Yes	31	30	47	34	0.008
	No	69	70	53	66	

to be connected to food by profession or education (e.g. degree in food-related science, working in the catering industry or in food industry, medical occupations, sport or health coaches). Most consumers (51%) showed a neutral attitude towards food processing, 23% had a (very) positive attitude, and 26% a (very) negative attitude. Those who are related to food by profession or education were more likely to have a positive attitude towards food processing ($P = 0.008$). No significant differences were found for gender, age, BMI, and educational level in relation to attitude towards food processing.

Eleven respondents from the questionnaire were selected for the interviews based on age, gender, educational level, and attitude towards food processing (Table 2). Respondents with a higher age were underrepresented.

These interviewees elaborated on their attitude towards food processing in the interviews.

Those with positive and neutral attitude pointed out positive effects such as palatability (flavour, texture), food security, food safety and shelf life, see citation below:

“I think that food processing mostly can improve the things that I find important in food, and then I'm talking about taste experience, texture, shelf life and affordability. I think there are mainly positive aspects to it, I don't really see any negative aspects.” (P4)

During the interviews it became clear that the positive or neutral attitudes were quite nuanced, see citation below:

Table 2
Characteristics of the interviewees.

Participant	Age	Gender	Educational level	Attitude towards FP	Background in food
P1	24	Female	High school	Positive	No
P2	64	Male	Master's degree	Negative	No
P3	32	Male	Master's degree	Negative	Yes ^a
P4	25	Male	Master's degree	Positive	No
P5	46	Female	Bachelor's degree	Negative	No
P6	29	Male	Master's degree	Positive	No
P7	24	Male	High school	Neutral	No
P8	26	Female	High school	Neutral	No
P9	24	Female	Associate's degree (1/2)	Neutral	No
P10	31	Female	High school	Neutral	No
P11	30	Male	Master's degree	Positive	No

^a Food law advisor, FP = food processing.

“Some types of food processing are good, for example for yoghurt. Gluten-free products, many people benefit from them and so do I. There are so many lactose-free and sugar-free products that otherwise would simply not have been there. But I think a lot of negative products have been developed by food processing, a lot of added sugars, people are addicted to sugar. And also E-numbers that may be carcinogenic, which still have not been researched.” (P10)

Most of the interviewees with a neutral or positive attitude did mention though that in general, unprocessed foods are more likely to be healthy than (ultra) processed foods. In contrast, those with a negative attitude were mainly negative about food processing. They explained their attitude by not knowing what is happening to our foods (lack of transparency) and a lack of trust in the food industry, see citations below:

“I think I have a pretty bad trust in the food industry. The food industry also wants to minimize costs and therefore does not always choose the ingredients that are best for the consumer.” (P3)

“I think processing is mainly, it doesn't have to be, but in my view, processing is mainly done to get people to consume more and not to make it healthier.” (P5)

3.2. Familiarity and associations with industrial (ultra) food processing

Most respondents of the questionnaire (75%) were not familiar with the term highly/ultra-processed food (UPF). Especially those with a neutral attitude were relatively unfamiliar with UPF compared to respondents with a positive or negative attitude ($P < 0.001$) (Table 3).

Although most respondents had not heard of the term ultra-processed foods specifically, they indicated their associations with industrial food processing in general in a drop down menu (multiple answers possible). The most frequently selected associations among all three attitude groups were “additives”, “artificial”, “preparation” and “not fresh” (Fig. 1A). However, the attitude groups differ considerably in their selected associations (Fig. 1B). Those with negative attitude more frequently selected: “additives”, “artificial”, “not fresh”, “unclear” and “unhealthy”, whereas those with positive attitude more frequently selected “food preparation”, “necessary” and “food safety”. The latter was in line with the results that 80% of the respondents with a positive attitude towards food processing think processing contributes to food safety compared to 37% in the group with a negative attitude ($P < 0.001$) (Table 3).

Table 3
Opinions on food processing in relation to food safety, health, food purchases and communication shown in frequencies (%) and per attitude group.

%		Attitude towards food processing			Total (n = 463)	P
		(Very) negative (n = 121)	Neutral (n = 238)	(Very) positive (n = 104)		
Familiar with term UPF	Yes	31	17	36	25	<0.001
	No	69	83	64	75	
FP contributes to food safety	(Slightly) disagree	42	13	2.9	18	<0.001
	Neutral	21	36	17	28	
	(Slightly) agree	37	51	80	54	
Influence FP on health	Do not know	6.6	22	15	16	<0.001
	(Slightly) negative	92	65	55	70	
	No influence	0.8	5	10	5	
	(Slightly) positive	0.8	8	20	9	
Influence of FP on own food purchases	No influence	12	39	49	34	<0.001
	Sometimes	36	42	43	40	
	(Almost) always	52	19	8	25	

FP = food processing, UPF = ultra-processed food.

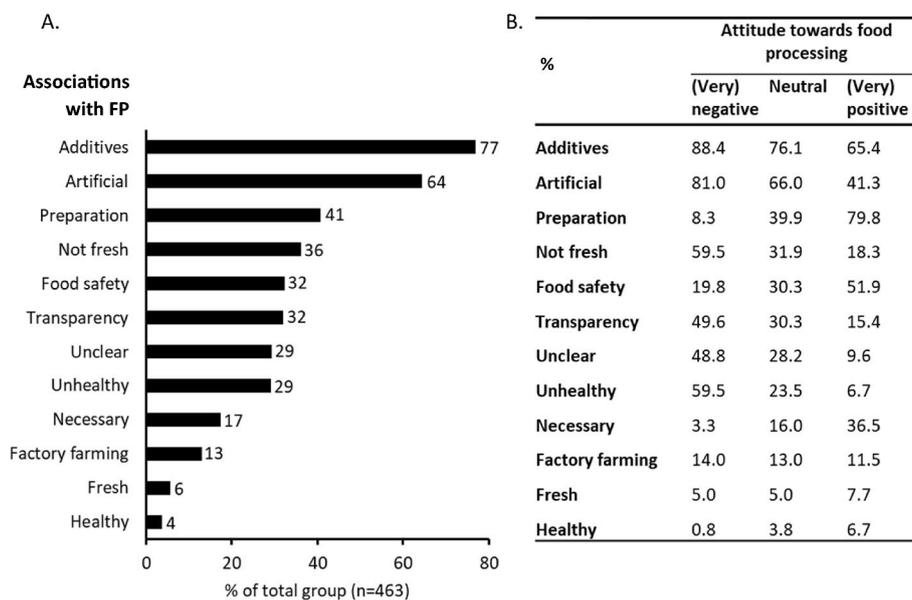


Fig. 1. Answers to the question: “What terms do you associate most with food processing?”; multiple answers possible. (A) Associations with industrial food processing as frequencies (%) of the total study population (n = 463) and (B) as frequencies (%) per attitude group towards food processing (negative, n = 121; neutral, n = 238; positive, n = 104).

When the interviewees were asked whether the selected ultra-processed foods from their grocery receipt were processed, they all confirmed this. The most frequent explanation of why they thought the food was processed was the lack of perceived naturalness. The term naturalness was often mentioned in combination with industrial (ultra) food processing, with one example being the following quote:

“You can’t see the natural form of its origins (e.g. bugles crisps). The taste is also just very synthetic. The packaging doesn’t help either, if it’s sold in a foil bag. A foil bag makes something really look more processed”. (P11)

One interviewee (P1) highlighted that she determined if a product was industrially processed by thinking whether she could find it in nature, or the “intactness” of its origins/ingredients (P4). Another interviewee (P2) explained that she estimated whether the product would look similar if she would prepare it herself at home.

Another association that was frequently mentioned by interviewees was the shelf life. Interviewees with a positive attitude stressed that industrial processed foods have a longer shelf life. Some other interviewees perceived an extended shelf life as a negative attribute, one even found the shelf-life of an industrially processed food she had

purchased to be suspicious as a result of the addition of additives as can be read in the following quote:

About self-bought pre-packed cheese salad: “I don’t even know what exactly it consists of, it shouldn’t stay fresh that long, it has mayonnaise in it and it’s greasy. It is suspicious that it stays fresh for such a long time”. (P10)

Other associations that were mentioned in combination with highly/ultra-processed foods in both the open questions in the questionnaire and interviews were: mass production, similarity of all products, and the addition of ingredients/additives, for example to increase the shelf life. Moreover, the additions of sugar, fat and salt to make foods more palatable were also frequently mentioned.

3.3. Perceived influence of industrially processed food on health

The respondents were asked whether they believed processed foods to have an impact on their health. In general, 70% of the respondents thought it had a (slightly) negative health effect, 17% did not know, 9% believed it had (slight) positive health effects, and 5% thought it had no effect on health (Table 3). Those with a negative attitude were more

likely to believe that food processing had a negative effect on one's health ($P < 0.001$).

Depending on whether respondents believed that food processing either had a (slightly) positive ($n = 41$) or (slightly) negative ($n = 322$) effect on their health, the questionnaire had a drop down menu wherein they could select health consequences. Frequencies of negative aspects regarding health consequences that were selected were: "additives" (72%), "overweight/obesity" (70%), "cardiovascular disease" (49%), "high calorie content" (43%), "cancer" (39%), "gastro-intestinal disease" (37%), and malnutrition (4.7%). Frequencies of selected positive health effects were: "food safety" (83%), "shelf life extension" (66%), "added nutrients" (34%), "additives" (27%), and "varied diet" (12%).

When interviewees were asked about the healthiness of the (ultra) processed foods, first according to their own groceries and later in general, they frequently explained that healthiness was determined by nutrient and calorie contents rather than industrial processing. Interviewees frequently spoke about nutrients in relation to health, like proteins, vitamin content, sugar content, fibers, calories, fats, and carbohydrates. These nutritional indicators were used to explain to what extent they believed a product to be (un)healthy. Nevertheless, they indicated an inverse relationship between the extent of food processing and the healthiness. When a product was more processed, it was generally considered to be less healthy and vice versa. The following quote illustrates the perceived relationship between the extent of processing and healthiness:

"When it comes to processed products, I'm more likely to think that they are unhealthy". (P2)

When the interviewees were asked about their perception of the healthiness of processed foods, most interviewees (7 out of 11) mentioned that this depends on the type and extent of processing. For example, when a product was simply cooked, the product was not seen as too processed and benefits such as convenience and food safety were mentioned.

Several interviewees with a negative attitude also associated processed foods with overconsumption, which was sometimes mentioned in combination with the high amounts of calories. This overconsumption was often mentioned in relation to the idea that processed foods were produced to be palatable as a result of the added sugars, salt, fat and other additives.

One interviewee (P7) stated that processed foods save time to prepare meals which may indirectly lead to healthier diets, highlighted in the following quote:

"I also think that the fact that processed food saves time and effort motivates to cook more often, order less frequently, and eat fewer junk food. So even if it does not have a direct positive effect on your health, it can have an indirect positive effect on your health. For example, if everyone now has to eat unprocessed things and get along with it, then I think that will create greater barriers. So processed food somehow also reduces the barriers to eating healthy, because you don't necessarily have to go for the healthiest, but you can also take a step in the right direction, and processed products can certainly help". (P7)

Finally, there was also one interviewee who said there are too many different things to take into account when determining the healthiness of foods and that it sometimes was a bit of an overload, as illustrated in the following quote:

"I think about it (processing in relation to health), but sometimes it's just too much. If you think about everything that relates to health, it's just too much. You have to accept that food processing exists". (P10)

3.4. Influence of industrial food processing on food choice

From all 463 respondents 34% did not pay attention to industrial food processing during shopping, and 40% sometimes (Table 3). Those with a negative attitude were more likely to pay attention to food processing when doing groceries (Table 3). In an open question in the questionnaire, respondents could indicate how they pay attention to the extent of food processing. Most of them indicated to pay attention to (artificial) additives, (number of) ingredients (sugar, salt fat), E numbers, and organic origins.

Among the 11 interviewees, seven occasionally paid attention to the extent of processing, two as much as possible (P3 and P5, negative attitude) and for two interviewees it had no influence (P1 and P4, positive attitude). Other interviewees stated that it was not specifically a dimension that they took into account when buying food.

Among the two interviewees who always paid attention to food processing when purchasing food (P3, P5), one explained that she looks at the back of pack label and avoids some additives, whereas the other stated she always chooses unprocessed foods, but occasionally chose to indulge and then she pays less attention to it.

Based on their own grocery receipts, the interviewees had several different reasons as to why they chose to consume (ultra) processed foods. Hedonic arguments (e.g. taste of product, I feel like eating, convenience) were most frequently used by the interviewees when they explained why they purchased a processed food product, especially when the product also had a low (unhealthy) Nutri-Score.

One final thing that needs to be highlighted is the importance of balance in the diet which was a focal point amongst all attitude groups. This was frequently stressed to explain why they purchased a certain processed food product despite deeming it unhealthy, as food intake is about the bigger picture according to them. Most interviewees (9 out of 11) repeatedly stated that it was not a problem to consume unhealthy ultra-processed foods, as long as it did not happen too often and there were healthy products to balance.

3.5. Communication about industrially processed foods, nutrition and health

Respondents indicated that they obtained most information from nutrition and health related topics from tv (commercials or shows) (65%), newspapers/magazines (41%), social media (42%) and websites (29%). When asking the preferred communication channel, information on the product was frequently indicated (37%), as well as TV (commercial or show) (36%), social media (35%), and websites (30%). When the interviewees ($n = 11$) were asked where they got their knowledge about healthy eating and processed foods from, most of the interviewees said they had picked up small pieces of information from different sources, such as friends and relatives in their direct surroundings, the news, internet (social media, googling things themselves etc), school, the Dutch Nutrition Centre and magazines. The internet as an information source was often mentioned, including social media, however, some interviewees were more hesitant about getting their information from social media, as it felt less reliable.

The respondents were asked on which health related topics they would like to have more information. 60% of all respondents selected that they wanted to have more information of industrial food processing. People with a negative attitude did more frequently indicate (78%) that they want to learn about food processing than people within the positive attitude group (43%). However, most interviewees (9 out of 11) highlighted that information about healthy eating and especially food processing was very complex. This was the case for all three attitude groups. Some stated that there are a lot of factors which determine whether a product is healthy and that the concept of what is healthy is constantly shifting. Experts do not seem to agree on this which results in conflicting information. Other interviewees who spoke about the complexity believed that the general Dutch food-based dietary guidelines (Wheel of

Five) were already hard enough to adhere to and thought that extra information about food processing would add complexity and confusion to healthy eating, as highlighted in the following quote:

“It is already difficult to take the Wheel of Five into account, I have the idea that most people don’t really do that, but that is also based on my personal point of view. However, I think that if you add that extra dimension of unprocessed and processed, food advice will become very complex, then you have too many factors to puzzle with in a diet.” (P4)

Despite this, the interviewees stressed the importance of education on healthy eating in general and some also on food processing. Many of them stated that there was a lot of information missing among the wider public about health and food processing. More specifically they highlighted that there was no information on products itself about what process they had undergone. This is in line with the respondents from the questionnaire as they also indicated the information on the food itself as most preferred communication channel. For interviewees with a negative attitude towards food processing, this lack of information is an issue. Interviewees also stated that some general information is missing about the healthiness of light products or influence of additives. The interviewees emphasized the importance of organized information briefings (campaigns) surrounding food processing, so people can have a basic understanding of what food processing is, what it does to your health, and which types of processing should be avoided. This is also illustrated in the following quote:

“I think that if people do not know much about this, it is important to inform them. Or that at least there is something where they can find more about it in an easy and accessible way, about food choices, what food processing is and what it does with food.” (P1)

Thus, despite that some believe there is already too much information available, the interviewees virtually all agreed that more education is crucial for better understanding with a focus on distinguishing what information is true and what is not. One frequently mentioned condition for education and extra information is that it needs to be accessible, for instance, information on the packaging itself that is understandable for the average person without difficult terms. Interviewees also stressed the importance of a central and independent information source about topics such as health in relation to processed foods.

4. Discussion

This study evaluated the Dutch consumers’ attitude towards and associations with industrially processed food. The results indicate that half of the study population has a neutral attitude whereas the other half is about equally divided over a negative and positive attitude. A background in food by profession or education was associated with a more positive view on industrial food processing, suggesting that knowledge of nutrition is a key factor to influence consumers’ perception. To determine the healthiness of a food, most respondents indicated to look mainly at (unhealthy) ingredients and less to industrial processing *per se*. Despite the fact that the majority associated food processing with negative health effects, it did not seem to directly influence the food purchases for most respondents.

In this study, 75% of the respondents indicated to be unfamiliar with the term “ultra-processed foods” specifically. In particular, those with a neutral attitude towards industrially food processing were relatively unfamiliar with this term. This is relatively high compared to other studies (Ares et al., 2016; Bolhuis et al., 2022), but could be explained by the type of question used, i.e. yes/no answer instead of making a selection out of multiple proposed definitions of ultra-processed foods. It could also be that the Dutch term that has been used in this study to translate ultra-processed foods, is considered to be less popular when compared to the English term. The unfamiliarity with the term ultra-processed food as found in this study points out that further

clarification is needed when used in communication. Furthermore, it suggests that the ultra-processed foods debates are mainly held in the scientific community and some media channels, and that the general population might be less concerned and knowledgeable about this topic in the Netherlands.

When the respondents were asked about their associations with industrial food processing, they most frequently mentioned additives and artificial, which is in line with other studies (Aguirre et al., 2019; Ares et al., 2016; Bolhuis et al., 2022). Nevertheless, the associations greatly varied depending on the attitude towards food processing. People with a negative attitude also frequently mentioned not fresh and unhealthy, whereas people with a positive attitude associated it more with the benefits of food processing such as preparation, food safety and necessary/essential. This difference might be explained by the higher percentage of food professionals in the positive attitude group. Food background, but not educational level, was associated with a more positive attitude towards food processing. More specific knowledge about nutrition and food processing could make people more aware of the necessity for a safe and reliable food supply.

Consumption of industrially processed food is associated with negative health effects by most consumers of the study population, even in the group that has a positive attitude towards food processing, and this relationship is supported by literature (Aguirre et al., 2019; Ares et al., 2016; Bolhuis et al., 2022; Machín et al., 2020; Szocs & Lefebvre, 2016). This negative health perception might be encouraged by the negative attention food processing received in the media and numerous studies that found a link between consumption of high amounts of highly (ultra) processed food and the incidence of non-communicable diseases (Barbaresko et al., 2024; Cordova et al., 2021, 2023; Lane et al., 2024; Qu et al., 2024; Torres-Collado et al., 2024). Highly (ultra) processed food is associated with lower nutritional quality, i.e. high amounts of salt, saturated fat and sugar and low fibre content (Abreu & Martins, 2023; Ferreiro et al., 2021). Interestingly, a recent study focussed on product categories to establish a link between food processing and health effects. More evidence points towards negative health effects of consuming highly (ultra) processed foods belonging to the product categories animal-based products and artificially and sweetened sugar beverages, whereas there is a positive health effect due to consumption of ultra-processed breads and cereals (Cordova et al., 2023). This suggests that selecting food products based on nutritional value and/or food category might be more helpful for the consumer than avoiding all highly (ultra) processed foods. Indeed, most interviewees mentioned that they select healthy products based on nutrient content by reading the ingredient list and/or nutritional values and not via assessing the degree of food processing which is in line with other consumer studies (Lazzarini et al., 2016; Machín et al., 2020; Plasek et al., 2020). By selecting products with a high nutrient quality consumers unconsciously select for less processed products in many cases.

On the other hand, interviewees mentioned that it is difficult to judge if a food product is healthy or not due to the scattered information and the abundance of factors taken into account, also confirmed by others (Machín et al., 2020). People tend to look at ingredients and retrieve only simple information from the packaging (Cowburn & Stockley, 2005). Adding extra information about the degree of food processing would make it even more complex. It is shown that placing nutrient or food processing claims or images of natural foods on unhealthy highly (ultra) processed foods increase healthiness perception (Devia et al., 2021; Moraes et al., 2023). However, the use of a front-of-pack logo that combined the Nutri-Score (indicating nutritional quality of a product) with the term ultra-processed increased the objective understanding of nutritional quality and food processing of food products in a randomised clinical trial (Srouf et al., 2023). More research is required to study how communication on food processing influences the actual consumer purchase behaviour. Whether the level of industrial food processing as such should be implemented into dietary guidelines is a burning issue, and it has already been implemented in a number of countries in South

America and Europe. The British Nutrition foundation recently published its statement on highly (ultra) processed foods, indicating that due to the lack of agreed definition, the need for better understanding of mechanisms involved and concern about its usefulness as a tool to identify healthier products, the concept of highly (ultra) processed foods does not warrant inclusion within policy ([Scientific Advisory Committee on Nutrition, 2023](#)).

In this study, some interviewees indicated that a balanced diet is of importance which shows that they have a nuanced view on a healthy diet. To be able to eat healthy they would like to have more information on nutrition and food processing, implying their primary interest in healthy food. Especially respondents with a negative attitude towards food processing were suspicious about the food industry in general. This highlights the importance of providing the consumer with easy and understandable information that is accessible from a central and trustworthy source. The differences in associations and opinions in various subgroups of the population would be interesting to further explore and use these insights to design effective and tailored communication strategies.

As indicated earlier, most respondents had a neutral attitude towards industrial food processing. The interviews revealed that even those with a positive or negative attitude were mostly nuanced in their opinion. What do these attitudes mean for actual behaviour? The prediction of attitude on behaviour depends on the strength of the attitude, as well as the ambivalence of the attitude ([Armitage & Christian, 2003](#)). An univalent attitude is more predictive in behaviour compared to an ambivalent attitude ([Conner & Sparks, 2002](#)). Most respondents had either a neutral (considered as “weak”) or nuanced (considered as ambivalent) attitude. These attitudes will likely not greatly affect behaviour or intentions with regard to industrial food processing. This is confirmed by the findings that the degree of industrial food processing hardly influenced food purchases in those with neutral or positive attitude (who were nuanced/ambivalent) ([Table 3](#)). Those with a negative attitude might be more opinionated, partly due to a lack of trust in the food industry which was extracted from the interviews. This negative and stronger attitude has probably more consequences for the behaviour, this is supported by the results that showed that those with a negative attitude indicated that industrial food processing does play a role in food purchases. The attitudes and consequently the behaviour may change when the topic of highly (ultra) industrial processing receives more positive or negative attention through various canals, or incorporation into dietary guidelines. A study showed that Brazilian consumers were more familiar and had a stronger negative opinion about the healthiness of UPFs compared to Dutch and Italian consumers, probably as a result of incorporation into the dietary guidelines ([Bolhuis et al., 2022](#)).

Although we have tried to obtain a representative sample of the Dutch population, the 463 respondents included in the survey had a higher educational level (high 69%, medium 18%, low 14%) compared to the general Dutch population (high 44%, medium 41%, low 15%). In addition, the overall mean age of the survey participants was lower than the general population. Especially the group between 18 and 24 years were overrepresented (33% instead of 6.5% in the general population) and the group with an age >65 years were underrepresented (9% compared to 20% in the general population). These data are based on information from the Dutch Central Statistics Agency ([Statistics Netherlands, 2022](#)). However, we managed to include a relatively large group of men (43%). It is not clear to what extent this deviation from the general population has influenced the results.

In conclusion, most Dutch consumers in this study had a neutral attitude towards industrial food processing, but in general associated consuming industrially processed foods with negative health effects. The attitude towards food processing is influenced by food background. It seems that industrially or highly (ultra) processed foods debates are mainly held in the scientific community and some media channels, and that the general population is less concerned and knowledgeable about this topic according to the present study. However, respondents

indicated that information about nutrition and food processing is scattered and complex and especially those with a negative attitude towards industrial food processing would like to be more informed. Therefore, it is recommended to educate and inform the consumer in a transparent and easy manner about food processing and health. The government can play an important role by providing easy and scientifically proofed information about nutrition related health effects as well as the food industry by being transparent about product processes.

Ethical statement

This study was performed in line with ethical guidelines and all participants signed informed consent. The questionnaire study was executed by researchers at the HAS green academy and the proposal was assessed by the ethical advisory committee of HAS green academy (No. P2022-23). The interviews were executed by researchers at Wageningen University and the proposal was assessed by the Social Sciences Ethic Committee of Wageningen University & Research (No. 2022-145-Bolhuis-2).

Funding

The research was funded by the Dutch Top-Consortium for Knowledge and Innovation Agri & Food (TKI-Agri-food) Project Restructure; (TKI 22.150). For more information go to <https://restructureproject.org/>.

CRediT authorship contribution statement

Dieuwerke P. Bolhuis: Writing – review & editing, Writing – original draft, Supervision, Software, Methodology, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Annet J.C. Roodenburg:** Writing – review & editing, Supervision, Project administration, Methodology, Funding acquisition, Conceptualization. **A.P.J. Pieter Groen:** Writing – review & editing, Methodology. **Sylvie Huybers:** Writing – review & editing, Writing – original draft, Supervision, Methodology, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

Acknowledgements

We kindly acknowledge Yassir Sefu, Jasmijn van Asperen, Maaike Verhoeven, Merel Kloosterman for their assistance in executing this study.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.appet.2024.107615>.

References

- Abreu, S., & Martins, M. L. (2023). Cross-classification analysis of food products based on nutritional quality and degree of processing. *Nutrients*, 15(14), 3117. <https://doi.org/10.3390/NU15143117>
- Aguirre, A., Borneo, M. T., El Khori, S., & Borneo, R. (2019). Exploring the understanding of the term “ultra-processed foods” by young consumers. *Food Research International*, 115, 535–540. <https://doi.org/10.1016/J.FOODRES.2018.09.059>

- Ares, G., Vidal, L., Allegue, G., Giménez, A., Bandeira, E., Moratorio, X., Molina, V., & Curutchet, M. R. (2016). Consumers' conceptualization of ultra-processed foods. *Appetite*, 105, 611–617. <https://doi.org/10.1016/j.appet.2016.06.028>
- Armitage, C. J., & Christian, J. (2003). From attitudes to behaviour: Basic and applied research on the theory of planned behaviour. *Current Psychology*, 22(3), 187–195. <https://doi.org/10.1007/S12144-003-1015-5>, 2004 22:3.
- Astrup, A., Monteiro, C. A., & Ludwig, D. S. (2022). Does the concept of “ultra-processed foods” help inform dietary guidelines, beyond conventional classification systems? *no. American Journal of Clinical Nutrition*, 116(6), 1482–1488. <https://doi.org/10.1093/AJCN/NQAC123>
- Baker, P., Machado, P., Santos, T., Sievert, K., Backholer, K., Hadjilakou, M., Russell, C., Huse, O., Bell, C., Scrinis, G., Worsley, A., Friel, S., & Lawrence, M. (2020). Ultra-processed foods and the nutrition transition: Global, regional and national trends, food systems transformations and political economy drivers. *Obesity Reviews*, 21(12), Article e13126. <https://doi.org/10.1111/OBR.13126>
- Barbarek, J., Bröder, J., Conrad, J., Szczerba, E., Lang, A., & Schlesinger, S. (2024). Ultra-processed food consumption and human health: An umbrella review of systematic reviews with meta-analyses. *Critical Reviews in Food Science and Nutrition*, 16, 1–9. <https://doi.org/10.1080/10408398.2024.2317877>
- Bolhuis, D., Mosca, A. C., & Pellegrini, N. (2022). Consumer awareness of the degree of industrial food processing and the association with healthiness—a pilot study. *Nutrients*, 14(20), 4438. <https://doi.org/10.3390/NU14204438>
- Conner, M., & Sparks, P. (2002). Ambivalence and attitudes. *European Review of Social Psychology*, 12(1), 37–70. <https://doi.org/10.1080/14792772143000012>
- Cordova, R., Kliemann, N., Huybrechts, I., Rauber, F., Vámos, E. P., Levy, R. B., Wagner, K. H., Viallon, V., Casagrande, C., Nicolas, G., Dahm, C. C., Zhang, J., Halkjær, J., Tjønneland, A., Boutron-Ruault, M. C., Mancini, F. R., Laouali, N., Katzke, V., & Chour, B. (2021). Consumption of ultra-processed foods associated with weight gain and obesity in adults: A multi-national cohort study. *Clinical Nutrition*, 40(9), 5079–5088. <https://doi.org/10.1016/j.clnu.2021.08.009>
- Cordova, R., Viallon, V., Fontvieille, E., Peruchet-Noray, L., Jansana, A., Wagner, K.-H., Kyro, C., Tjønneland, A., Katzke, V., Bajracharya, R., Schulze, M. B., Masala, G., Sieri, S., Panico, S., Ricceri, F., Tumino, R., Boer, J. M. A., Verschuren, W. M. M., Schouw, Y. T. van der, ... Freisling, H. (2023). Consumption of ultra-processed foods and risk of multimorbidity of cancer and cardiometabolic diseases: A multinational cohort study. *The Lancet Regional Health – Europe*, 35, Article 100771. <https://doi.org/10.1016/j.lanepe.2023.100771>
- Correa-Madrid, M. C., Correa Guzmán, N., Bergeron, G., Restrepo-Mesa, S. L., & Cediel, G. (2023). Validation of the NOVA score for the consumption of ultra-processed foods by young women of Medellín, Colombia. *Annals of the New York Academy of Sciences*, 1528(1), 69–76. <https://doi.org/10.1111/NYAS.15054>
- Cowburn, G., & Stockley, L. (2005). Consumer understanding and use of nutrition labelling: A systematic review. *Public Health Nutrition*, 8(1), 21–28. <https://doi.org/10.1079/PHN2004666>
- Devia, G., Forli, S., Vidal, L., Curutchet, M. R., & Ares, G. (2021). References to home-made and natural foods on the labels of ultra-processed products increase healthfulness perception and purchase intention: Insights for policy making. *Food Quality and Preference*, 88, Article 104110. <https://doi.org/10.1016/j.foodqual.2020.104110>
- Edelman. (2019). 2019 edelman trust barometer: Food and beverage. https://www.edelman.com/sites/g/files/aatuss191/files/2019-04/2019_Edelman_Trust_Barometer_Food_and_Beverage_report.pdf?utm_source=downloads&utm_campaign=trust_barometer.
- FAO. (2014). Food-based dietary guidelines Brazil. <https://www.fao.org/nutrition/education/food-based-dietary-guidelines/regions/countries/brazil/en/>
- Ferreiro, C. R., Pablos, D. L., & Cámara, A. G. de la (2021). Two dimensions of nutritional value: Nutri-score and NOVA. *Nutrients*, 13(8), 2783. <https://doi.org/10.3390/NU13082783>
- Fiolet, T., Srour, B., Sellem, L., Kesse-Guyot, E., Allès, B., Méjean, C., Deschasaux, M., Fassier, P., Latino-Martel, P., Beslay, M., Hercberg, S., Lavalette, C., Monteiro, C. A., Julia, C., & Touvier, M. (2018). Consumption of ultra-processed foods and cancer risk: results from NutriNet-Santé prospective cohort. *BMJ*, 14, 360. <https://doi.org/10.1136/bmj.k322>. k322.
- Food and Agriculture Organization. (n.d.). Food-based dietary guidelines. Retrieved July 8, 2024, from <https://www.fao.org/nutrition/education/food-based-dietary-guidelines>.
- Forde, C. G. (2023). Beyond ultra-processed: Considering the future role of food processing in human health. *Proceedings of the Nutrition Society*, 82, 406–418. <https://doi.org/10.1017/S0029665123003014>
- Hall, K. D., Ayuketah, A., Brychta, R., Cai, H., Cassimatis, T., Chen, K. Y., Chung, S. T., Costa, E., Courville, A., Darcy, V., Fletcher, L. A., Forde, C. G., Gharib, A. M., Guo, J., Howard, R., Joseph, P. V., McGehee, S., Ouwkerker, R., Raisinger, K., ... Zhou, M. (2019). Ultra-processed diets cause excess calorie intake and weight gain: An inpatient randomized controlled trial of ad libitum food intake. *Cell Metabolism*, 30(1), 67–77.e3. <https://doi.org/10.1016/j.cmet.2019.05.008>
- Harbers, M. C., Middel, C. N. H., Stuber, J. M., Beulens, J. W. J., Rutters, F., & van der Schouw, Y. T. (2021). Determinants of food choice and perceptions of supermarket-based nudging interventions among adults with low socioeconomic position: The supreme nudge project. *International Journal of Environmental Research and Public Health*, 18(11), 6175. <https://doi.org/10.3390/ijerph18116175>
- Lane, M. M., Gamage, E., Du, S., Ashtree, D. N., McGuinness, A. J., Gauci, S., Baker, P., Lawrence, M., Rebolz, C. M., Srour, B., Touvier, M., Jacka, F. N., O'Neil, A., Segasby, T., & Marx, W. (2024). Ultra-processed food exposure and adverse health outcomes: Umbrella review of epidemiological meta-analyses. *BMJ*, 384, Article e077310. <https://doi.org/10.1136/bmj-2023-077310>
- Lazzarini, G. A., Zimmermann, J., Visschers, V. H. M., & Siegrist, M. (2016). Does environmental friendliness equal healthiness? Swiss consumers' perception of protein products. *Appetite*, 105, 663–673. <https://doi.org/10.1016/j.appet.2016.06.038>
- López-Bueno, R., Núñez-Cortés, R., Calatayud, J., Salazar-Méndez, J., Petermann-Rocha, F., López-Gil, J. F., & Del Pozo Cruz, B. (2024). Global prevalence of cardiovascular risk factors based on the life's essential 8 score: An overview of systematic reviews and meta-analysis. *Cardiovascular Research*, 120(1), 13–33. <https://doi.org/10.1093/CVR/CVAD176>
- Louzada, M. L., Baraldi, L. G., Steele, E. M., Martins, A. P., Canella, D. S., Moubarac, J. C., Levy, R. B., Cannon, G., Afshin, A., Imamura, F., Mozaffarian, D., & Monteiro, C. A. (2015). Consumption of ultra-processed foods and obesity in Brazilian adolescents and adults. *Prev Med*, 81, 9–15. <https://doi.org/10.1016/j.ypmed.2015.07.018>
- Machín, L., Antúnez, L., Curutchet, M. R., & Ares, G. (2020). The heuristics that guide healthiness perception of ultra-processed foods: A qualitative exploration. *Public Health Nutrition*, 23(16), 2932–2940. <https://doi.org/10.1017/S1368980020003158>
- Mertens, E., Colizzi, C., & Peñalvo, J. L. (2022). Ultra-processed food consumption in adults across Europe. *European Journal of Nutrition*, 61, 1521–1539. <https://doi.org/10.1007/s00394-021-02733-7>
- Monteiro, C. A., Astrup, A., & Ludwig, D. S. (2022). Does the concept of “ultra-processed foods” help inform dietary guidelines, beyond conventional classification systems? *yes. The American Journal of Clinical Nutrition*, 116(6), 1476–1481. <https://doi.org/10.1093/AJCN/NQAC122>
- Monteiro, C. A., Cannon, G., Levy, R. B., Moubarac, J.-C., Louzada, M. L., Rauber, F., Khandpur, N., Cediel, G., Neri, D., Martínez-Steele, E., Baraldi, L. G., & Jaime, P. C. (2019). Commentary ultra-processed foods: What they are and how to identify them. *Public Health Nutrition*, 22(5), 936–941. <https://doi.org/10.1017/S1368980018003762>
- Moraes, J., Moraes, C., Alvarenga, M., & Sproesser, G. (2023). Effect of nutrient, processing and hedonic claims on food-related perceptions: An experimental online study in Brazil and Germany. *Appetite*, 190, Article 107033. <https://doi.org/10.1016/j.appet.2023.107033>
- Nardocci, M., Polsky, J. Y., & Moubarac, J. C. (2021). Consumption of ultra-processed foods is associated with obesity, diabetes and hypertension in Canadian adults. *Can J Public Health*, 112(3), 421–429. <https://doi.org/10.17269/s41997-020-00429-9>
- Petrus, R. R., do Amaral Sobral, P. J., Tadini, C. C., & Gonçalves, B. C. (2021). The NOVA classification system: A critical perspective in food science. *Trends in Food Science & Technology*, 116, 603–608. <https://doi.org/10.1016/j.tifs.2021.08.010>
- Plasek, B., Lakner, Z., & Temesi, Á. (2020). Factors that influence the perceived healthiness of food—review. *Nutrients*, 12(6), 1–20. <https://doi.org/10.3390/NU12061881>
- Qu, Y., Hu, W., Huang, J., Tan, B., Ma, F., Xing, C., & Yuan, L. (2024). Ultra-processed food consumption and risk of cardiovascular events: A systematic review and dose-response meta-analysis. *EclinicalMedicine*, 69, Article 102484. <https://doi.org/10.1016/j.eclinm.2024.102484>
- Santé publique France. (n.d.). Retrieved October 14, 2021, from <https://www.santepubliquefrance.fr/en/nutri-score>.
- Scientific Advisory Committee on Nutrition. (2023). SACN statement on processed foods and health. www.gov.uk/government/groups/scientific-advisory-committee-on-nutrition.
- Srour, B., Hercberg, S., Galan, P., Monteiro, C., Szabo de Edeleenyi, F., Bourhis, L., Fialon, M., Sarda, B., Druésne-Pecollo, N., Esseddik, Y., Deschasaux-Tanguy, M., Julia, C., & Touvier, M. (2023). Effect of a new graphically modified nutri-score on the objective understanding of foods' nutrient profile and ultra-processing: A randomised controlled trial. *BMJ Nutrition, Prevention & Health*, 6(1), 108–118. <https://doi.org/10.1136/bmjnph-2022-000599>
- Statistics Netherlands. (2022). *Bevolkingspiramide*. CBS. <https://www.cbs.nl/nl-nl/visualisaties/dashboard-bevolking/bevolkingspiramide>.
- Szocs, C., & Lefebvre, S. (2016). The blender effect: Physical state of food influences healthiness perceptions and consumption decisions. *Food Quality and Preference*, 54, 152–159. <https://doi.org/10.1016/j.foodqual.2016.07.009>
- Torres-Collado, L., Rychter, A., González-Palacios, S., Compañ-Gabucio, L. M., Oncina-Cánovas, A., García de la Hera, M., & Vioque, J. (2024). A high consumption of ultra-processed foods is associated with higher total mortality in an adult Mediterranean population. *Clinical Nutrition*, 43(3), 739–746. <https://doi.org/10.1016/j.clnu.2024.01.014>
- Vandevijvere, S., Jaacks, L. M., Monteiro, C. A., Moubarac, J. C., Girling-Butcher, M., Lee, A. C., Pan, A., Benthall, J., & Swinburn, B. (2019). Global trends in ultra-processed food and drink product sales and their association with adult body mass index trajectories. *Obesity Reviews*, 20(S2), 10–19. <https://doi.org/10.1111/OBR.12860>
- Vellinga, R. E., Van Bakel, M., Biesbroek, S., Toxopeus, I. B., De Valk, E., Hollander, A., Van 't Veer, P., & Temme, E. H. M. (2021). Evaluation of foods, drinks and diets in The Netherlands according to the degree of processing for nutritional quality, environmental impact and food costs. *BMC Public Health*, 22(1), 877. <https://doi.org/10.1186/s12889-022-13282-x>
- World Health Organization. (2023). World health statistics 2023: Monitoring health for the SDGs, sustainable development goals. <https://www.who.int/publications/i/item/9789240074323>.