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Article

The impact of Corona pandemic on consumer's food consumption – Vulnerability of households with children and income losses and change in sustainable consumption behavior

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Abstract: This study demonstrates that the corona pandemic has a significant impact on consumers' eating habits. More food is eaten, and more convenience products such as ready-made meals and canned food with a longer shelf life are purchased. The consumption of alcohol and sweets has also increased. In return, there is a reduced consumption of fresh fruits and vegetables. The findings reveal that families who are financially affected by the pandemic represent a vulnerable group. With the ongoing pandemic, repeated lockdowns, corona-related closings of schools and kindergartens, severe health consequences are to expect in the medium to long term, especially for this population group.

Keywords: Covid-19; Corona; consumer behaviour; food; health.

1. The pandemic – a catalyst of an unhealthy diet?

The ongoing corona pandemic affected many people worldwide by restrictions in their everyday lives. It is to highlight that the pandemic has also influenced the eating behaviour and shopping habits of consumers. Due to possible quarantine phases, consumers were concerned about which type of food and its quantities should be stored [1]. In addition, there were short-term out-of-stock situations in the food retail sector [2] for selected products (e.g. flour, pasta, disinfectants, etc.).

In this context, the Lower Saxony State Food Industry Association - LI Food (www.li-food.de) carried out a representative online survey with 973 participants in April 2020. The survey aimed to determine which effects the corona pandemic had on food consumption, shopping behaviour and eating habits in Germany. The aspects of sustainability and health were given special consideration in the study, reflecting people choices of healthier and more environmentally conscious foods. Moreover, the survey reflected whether there were changes in the consumption quantity in different product categories or food waste avoidance. Changes in purchases of organic and locally produced products due to corona effects were also considered. The focus was primarily on households with children and households affected by a loss of income due to the lockdown. In general, the question arises to what extent the pandemic has accelerated diet trends or general differences in food consumption between different population groups. The next section briefly describes existing studies on the subject before presenting the methodology and the study results.

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2. Psychological and physical effects of the pandemic and possible effects on the eating and purchasing behaviour of consumers

2.1. "More food - an instrument for reducing stress"

It is to hypothesize that the pandemic has a direct impact on people's psyche. Even in regions with a relatively low risk of infection, the population was exposed to massive risk communication and media reporting in 2020, which in itself was a relevant psychological stress factor. Also, a considerable part of the population was affected by short-time work or unemployment or was worried about a possible job loss, which could likewise impact psychological well-being [3,4]. In such situation, eating "more" can be a coping strategy to polarize ones' psychology for dealing with the pandemic and the stress it causes. Increased consumption of (alcoholic) beverages and food can represent an attempt to feel better under stress temporarily [5,6]. For Italy's first lockdown, it was observed that households mainly consumed more processed "comfort foods" such as chocolate, chips and snacks [7,8]. The longer the lockdown measures persists, the higher is the probability that a permanent risen consumption leads to a higher prevalence of obesity. The consequences are more diabetes, coronary diseases and cancer in the population [9].

2.2. Reduced physical activity as an amplifying factor for negative effects

During the pandemic, physical and sport activities in the population have declined. Children and parents alike spent more time on computer games and online media [10]. In the current edition of the specialist journal "Nervenheilkunde", an article by the well-known neurologist Manfred Spitzer [10] anecdotally quotes a teacher as follows:

> *"The students, whom I was able to see again for a few hours, spent the 7 weeks almost without exception playing in front of the computer. On average they were 5-10 kilos heavier [...]."*

The fatal consequences of the outlined situation becomes more obvious against the background of a publication in the journal Lancet, that states that a 10% reduction in physical inactivity could lead to additional 533,000 deaths per year worldwide [11].

2.3. Fear as a driver for the (increased) purchase of specific product categories

Another mediator of consumer behaviour is the associated risk with Covid-19 of falling ill or dying. Consumers could reduce their risk of infection by using delivery services or buying more packaged foods that are considered more hygienic [7]. It can also be assumed that foods with a longer shelf life will be bought (and thus fewer fresh products such as fruits and vegetables) to minimize shopping frequency and risk of infection in supermarkets. Monteiro [12] and Monteiro et al. [13] argue that more processed foods have a negative impact on consumers' health status. Contrarily, there is the behavioural strategy of buying healthier food to strengthen the immune system [14]. It is conceivable that this could result in an increasing demand for more fruits and vegetables or ecologically and regionally produced food.

Another factor influencing consumer behaviour are concerns about food shortages, leading to certain food stockpiling [7]. The market research institute Innofact (Düsseldorf, Germany) interviewed 1,037 consumers from March 24^{th} to 25^{th}, 2020, and found that every third German bought significantly more noodles, ready-made meals, toilet paper, rice, flour, and kitchen rolls [15]. This behaviour change is confirmed by scanner data from the Federal Statistical Office for calendar weeks 9 to 16, in which there was a "shopping boom" for the products mentioned. The overview across some recent study results, show a trend towards increased consumption and towards stockpiling.

2.4. Consequences of corona-related loss of income or unemployment

In Germany, the pandemic led to increased unemployment and short-time work due to the pandemic (Homepage - Statistics of the Federal Employment Agency, n.d.). Besides, there is evidence that the lower the education level, the higher the proportion of people

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who went on short-time work, unpaid vacation or unemployment. A job loss is twice as likely for someone with an intermediate level of education than for someone with a high level of education. In addition, it was mainly employees with a higher education who had the opportunity to work from home office. As a result, this group was exposed to a significantly lower risk of infection than those in employment with an intermediate or low level of education [16].

A study from the UK [3,17] showed that losing a job can lead to weight gain over certain time. Furthermore, in low-income households, the (high) price can be an obstacle to buying fruit and vegetables [18]. During the financial crisis, spending on groceries were reduced in many western industrialized countries, which can be ascribed to a decline in income [19,20]. Since the corona pandemic also represents an economic crisis, it is to hypothesize that the effects described can also be transferred to the recent situation.

3. Sample and methodology of the study

In a population survey 973 consumers were interviewed via an online survey about their eating, buying and cooking behaviour before and during the corona pandemic in the period from April 22nd to 27th 2020 (see Table 1). The questionnaire and the idea for this research was developed by an international consortia of universities and research institutions under the led of the Danish Technology Institute, and the Copenhagen Business School (see https://www.food-covid-19.org/).

Table 1. Sociodemography of the survey sample (n=973)

	%
gender: male	57.3
ages groups:	
20-39 years	31.5
40-59 years	38.8
60+ years	29.7
household constellation:	
with children (0-19 years)	23.1
with children (<12 years)	12.0
two adults without children	47.0
singles	30.5
school education:	
low	10.5
middle	54.1
high	35.5
income loss: yes	26.1

The respondents were recruited via the consumer panel of the agency respondi (www.respondi.com). Responsibility for household shopping was used as a screening parameter. Only people responsible for purchasing groceries or who stated to share this task at least to 50% with other members of the household. The collected data went through a quality and plausibility check by the German Institute of Food Technology's consumer science research platform. The online questionnaire was sent to the panellists via the DIL - Quick Smart-Survey Server (www.survey.dil-ev.de).

To measure the change in the total amount of food consumed due to Covid-19, a five-point Likert scale with the categories "much less", "slightly less", "no change", "a little more" and "much more" was applied.

To measure the change across different product groups, respondents were asked how often they consumed these foods before and during the Covid-19 pandemic for each analyzed product group. The studied product groups were fruit/vegetables, meat, fish, bread, milk, frozen goods, canned food, ready-made meals, cakes/biscuits, sweets and alcohol. The response options for the consumption frequency ranged from "less than once every two weeks or never" to "daily" (see Table 2).

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Table 2. Answer options on the frequency of consumption of various foods

Coding	*Answer categories*
1	less then once every two weeks or never
2	between once a week and once each two weeks
3	once a week
4	2-3 times per week
5	4-6 times per week
6	daily

For the analysis for each product category (see Figure 3), the mean value (based on the number coding for the response categories) before the pandemic ($\bar{x}_{before\ Covid-19}$) and the mean of the change caused by the pandemic ($\bar{x}_{change} = \bar{x}_{before\ Covid-19} - \bar{x}_{during\ Covid-19}$) was calculated. A two-sided *t*-test was applied to analyze whether the consumption frequency in a product category was significantly changed due to the corona pandemic. The H_0-hypothesis aimed to check whether the measured change in the consumption quantity was equal to zero ($\mu_{change} = 0$). The change in consumption frequency is also shown at an individual level in the result section. The values of the numerical coding for the consumption frequency before and during the pandemic were subtracted from each other at the level of the individual respondent (see formula I), so that numbers of a maximum of +5 (change from "daily" to "less than once every two weeks or never ") to -5 (change from" Less than once every two weeks or never "to" Daily ") were possible results (see Figure 3).

$$\Delta Eating\ frequency = Eating\ frequency_{during\ Covid-19} - Eating\ frequency_{before\ Covid-19} \quad (1)$$

To measure further changes in consumer behaviour due to the corona pandemic, again a 5-pole Likert scale with the answer options "much less", "a little less", "no change", "a little more" and "much more" was used. The χ^2-test was used to test the relationship between consumers' fear of not getting food and the question of whether more food would be stored during the pandemic [21].

The study is relying on the hypothesis that the pandemic has a stronger impact in certain household segments (see Section 4.2). Therefore, four household segments were created for an in-depth analysis (see Table 3). The presence of children in the household and the extent to which a corona-related loss of income was affected were used as segmentation variables. Differences in consumer behaviour of the analysed households segments were checked via a row of Fisher's exact tests for 2x2 tables. For this purpose the 5-pole Likert scale with the answer options "much less", "a little less", "no change", "a little more" and "much more" was condensed into the three categories "less" (sum of "much less" and "little less"), "no change" and "more" (sum of "little more" and "much more").

Table 3. Sample size of the analyzed household segments

	Total sample	no kids & no income loss	kids & no income loss	no kids & income loss	kids & income loss
sample size	973	579	140	169	85
⌀ **household size**	2.29	1.82	4.04	1.79	3.61
age					
20-39 years	31.5	23.8%	46.4%	34.,9%	52.9%
40-59 years	38.8	33.7%	47.1%	45.0%	47.1%
60+ years	29.7	42.5%	6.4%	20.1%	-
education					
low	10,5	12.4%	5.7%	9.5%	7.1%
middle	54.1	53.7%	54.3%	52.1%	60.0%
high	35.5	33.9%	40.0%	38.5%	32.9%

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4. Results

4.1. Stockpiling and the influence of risk perception

Almost a third of the respondents (31.4%) indicated to stockpile more food compared to the time before the pandemic. Simultaneously, the fear of not getting enough food was increased. Before Covid-19, very few of the study participants (3%) were anxious to this effect. In contrast, this value increased almost to 18% (sum of the values "often" and "occasionally") at the time of the survey (see Table 4). Concerning the influence of the fear of not getting enough food on the stockpiling, the results show that the greater this fear was, the more the study participants were stockpiling (χ^2=55.164; df=2, p< 0.001).

Table 4. Has anyone in your household been anxious about obtaining enough food to meet their requirements before and during Covid-19?

	before Covid-19 in %	during Covid-19 in %
frequently	0.2	1.5
occasionally	2.7	16.2
never	97.1	82.2

4.2. Change in the amount of food consumed

A central question of this study was if people consumed more food during the pandemic. Across the entire sample, 20.5%, i.e. around a fifth of the respondents, stated that "more food" was consumed in their household (sum of the top values "much more" and "a little more") (see Figure 1).

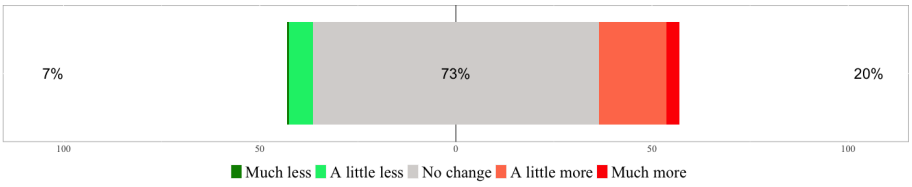

Figure 1. Change in the amount of food consumed during Covid-19.

When the increased consumption was analyzed for the different household segments, a high degree of heterogeneity in the population became obvious (see Figure 2). In households with no children and no income loss, the increase was lower compared to the average. In contrast, there was an increased caloric intake, especially in households with children and/or pandemic-related income losses.

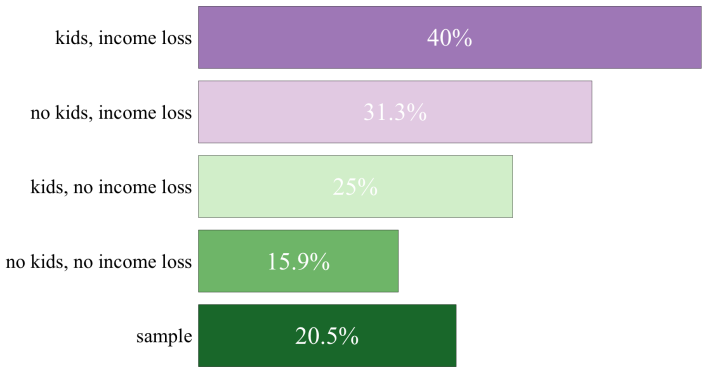

Figure 2. Share of households with an increased consumption of food overall in different household segments (top scores "much more" and "a little more").

Based on fisher's exact test for 2x2 tables (see Table 5) it was checked if the mentioned

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differences between different household segments were significant. This holds for most *p*-values which supports the finding that income loss and kids in the household are drivers for an increased food consumption during the pandemic.

Table 5. Fisher's exact test - *p*-values for groups differences between households segments concerning the increased food consumption

	no kids, income loss vs. kids, income loss	no kids, income loss vs. kids, no income loss	no kids, income loss vs. no kids, no income loss
less vs. no change	0.81	0.01	0.02
less vs. more	0.15	0.05	0.87
no change vs. more	0.06	0.43	0.00
	kids, income loss vs. kids, no income loss	kids, income loss vs. no kids, no income loss	kids, no income loss vs. no kids, no income loss
less vs. no change	0.08	0.27	0.28
less vs. more	0.74	0.07	0.02
no change vs. more	0.01	0.00	0.01

4.3. Change in consumption frequency of various product categories

During the corona pandemic, there were significant decreases in the frequency of consumption of fruits/vegetables, fish and meat (see Figure 3). In contrast, there were significant increases in the categories of canned goods, ready-made meals, cakes/cookies, sweets and alcohol. Thus, there was a tendency for fresh products to be partly substituted by more processed, and more durable (convenience) products or partially unhealthy foods (sweets, alcohol). In the context of the measured risen overall food consumption, it it to conclude that there is not only a substitution but an additional consumption of the latter mentioned products.

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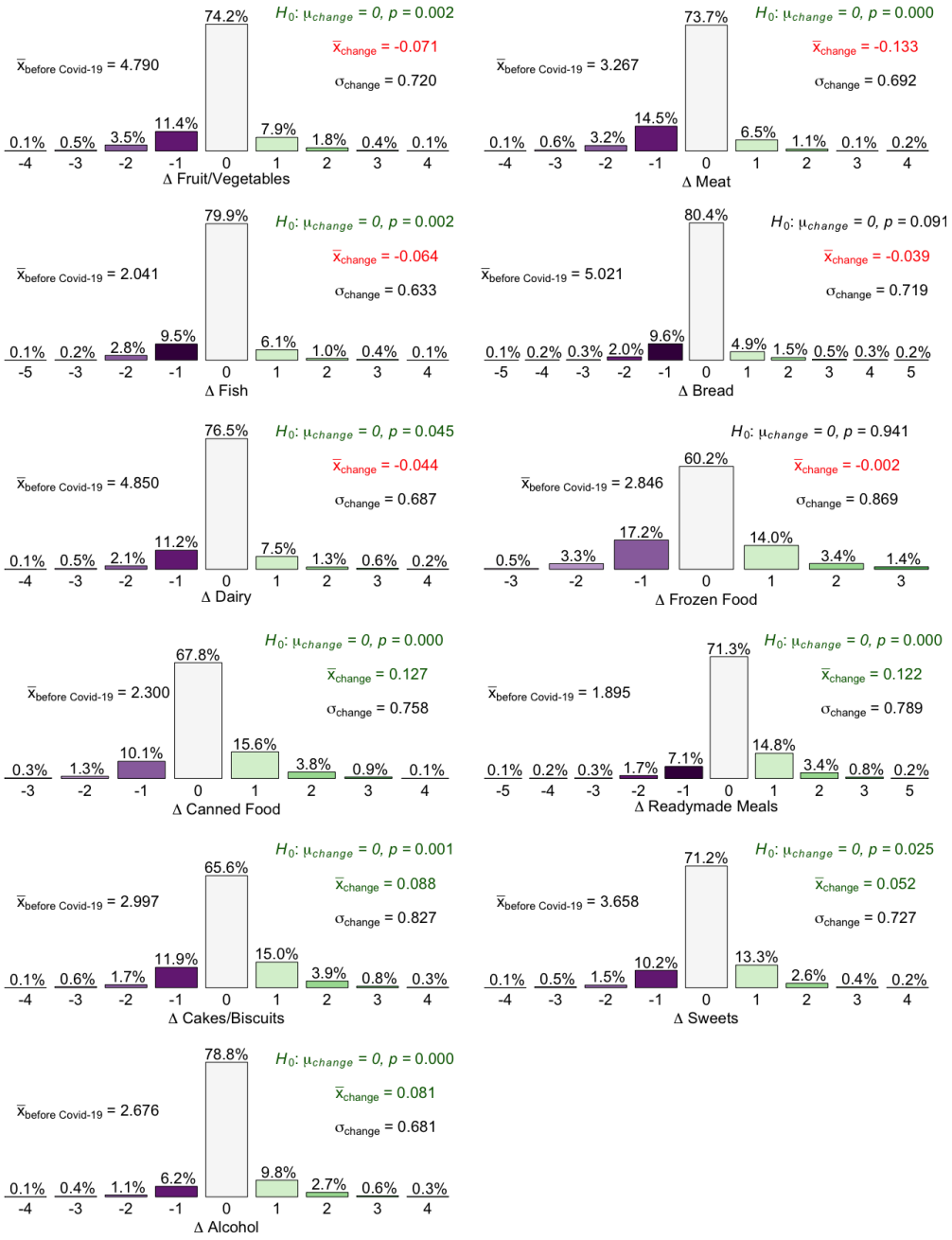

Figure 3. Change in consumption frequency in certain product categories.

For the different household segments (see Table 6), again large group differences become apparent. E.g., 13.4% of the respondents declared a higher consumption of alcohol. However, this parameter increased only to 11.5% for households without children and without loss of income. In contrast, an increased alcohol consumption is found more frequently (21.2%) in households with children and with reduced income.

For fruits and vegetables only 10.8% of the households with children and without income loss stated to consume less of these products. Compared to the time period before Covid-19 the consumption even increased during the pandemic. The opposite holds for households with children and a loss of income (17.7%). In this group the consumption of fruits and vegetables was on average reduced during the crisis.

Contrarily to fruits and vegetables, only 16.6% of respondents from households with children and with no loss of income reported an increased consumption of ready-made meals. For households with children and a loss of income a much higher value could be

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found (28.3%). Similar holds for frozen food. In the product category meat, especially in households with children and a loss of income, meat consumption has declined (27.8%). In households with children without loss of income, this value was only 17.8%.

Based on fisher's exact test for 2x2 tables (see Tables A1-A7 in the Appendix) it was checked if the mentioned differences between different household segments were significant. The analysis revealed that some but not the majority of the group differences were significant. But, it is to highlight that for two groups we had relatively small sample sizes. It is to expect that more of the analysed group differences are significant when a larger sample is considered.

Table 6. Change in consumption frequency according to product groups and household segments (top scores)

	sample	no kids & no income loss	kids & no income loss	no kids & income loss	kids & income loss
more *alcohol*	13.4%	11.5%	13.6%	17.1%	21.2%
less *fruits/vegetables*	15.5%	13.2%	10.8%	16.7%	17.7%
more *ready-meals*	19.2%	16.6%	15.7%	23.6%	28.3%
more *tinned food*	20.4%	18.4%	22.8%	24.8%	24.7%
more *frozen food*	18.8%	16.7%	16.4%	20.8%	26.0%
more *sweets*	16.9%	15.0%	17.1%	17.8%	22.4%
less *meat*	18.4%	16.7%	17.8%	20.8%	27.8%

*Note: For the product categories for which the increased consumption is indicated, the top scores "much more" and "a little more" are combined for the presentation. For the product categories for which the reduced consumption is shown, the top scores "a little less" and "much less" are combined.

4.4. Price perception

During the corona pandemic, there were price increases for meat and vegetables [22]. Agricultural economic research shows that lower-income households usually react more flexibly than the average household to price increases [23]. That is plausible, because households with a lower income have to calculate more precisely to get along with their financial budget. Accordingly, higher-income households may react in a less reflective way. Against this background it is to highlight that food prices during the corona pandemic were perceived very different across the segments. The majority (63.9%) of households with children and income losses stated to spent more money on food compared to the pre-Covid-19 period. For households with children but no loss of income, this value was only 25.0%.

4.5. Changed eating habits in the context of the aspect of sustainability

The study revealed only minor changes in consumer's behaviour concerning locally or organically produced food. There was no push towards locally or organically produced products as a result of the pandemic (see Figure 4). The changes in the positive as well as in the negative direction almost compensate each other.

In the context of sustainability, however, it can be shown that a relatively large group of 26% of the households threw away less food. In addition, more than a third planned meals and/or their grocery list more in advance. Based on a χ^2-square test, a significant relationship between the changed extent of planning and food waste avoidance could be found. Households, which planned "a lot more" or "more" in advance indicated more often to threw away "a little less" or "much less" food during the pandemic (χ^2=139,77; df=16; p< 0,001).

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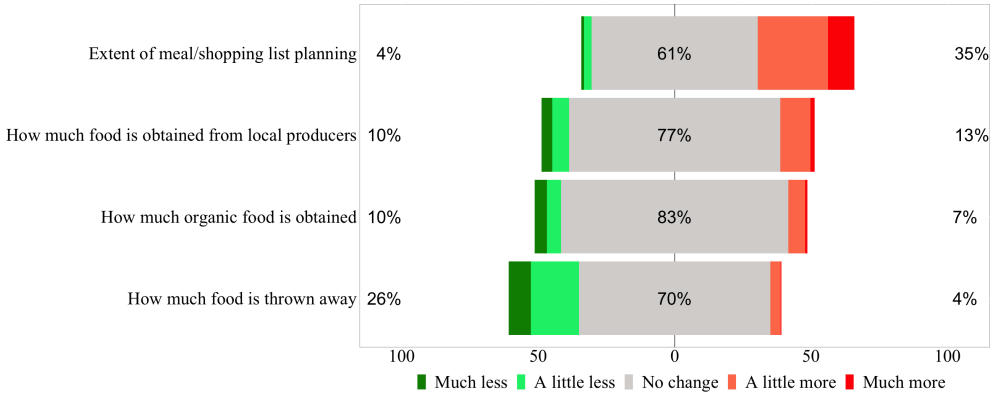

Figure 4. Change in sustainable household behavior due to the corona pandemic

Across household segments, differences in the change of sustainable consumer behaviour could be found. In particular in households with kids, meals and shopping lists are planned more in advance (see Table 7). Concerning local food, the highest rise can be found for households with kids but no income loss. Likewise this group indicated compared to all other segment most often (30.0%) to produce less food waste during the pandemic. Interestingly, in households with kids but an income loss the lowest value for the reduction of food waste could be found (22.4%).

Table 7. Change in sustainable household behaviour according to product groups and household segments (top scores)

	sample	no kids & no income loss	kids & no income loss	no kids & income loss	kids & income loss
more *planning*	35.4%	31.8%	42.1%	32.3%	44.7%
more *local*	12.5%	11.9%	17.1%	10.7%	12.9%
more *organic*	7.0%	6.9%	6.4%	7.1%	8.2%
less *food waste*	25.8%	24.2%	30.0%	29.6%	22.4%

*Note: The top scores "much more" and "a little more" are combined for the presentation respectively the top scores "a little less" and "much less" are combined.

5. Conclusion and recommendations to politics, industry and research

This empirical study demonstrates that the corona pandemic has a significant influence on eating habits of households. More food is eaten, and more convenience products such as ready meals and canned food with a longer shelf life are purchased. The consumption of alcohol and sweets has also increased. In return, the consumption of fresh fruits and vegetables has declined.

These changes occurred to varying degrees in different household types. The overall increase in food consumption could be measured in particular for households with children and corona-related income losses. In households affected by budget restrictions, the factor "child" alone leads to a deterioration in the household diet. In other words, an increase in calorie intake that is well above average and a stronger switch towards an increased consumption of more unhealthy product groups. In this context, it is worrying that alcohol consumption has risen most strongly in precisely these households. Families who are financially affected by the pandemic represent a vulnerable group. With the ongoing duration of the pandemic, repeated lockdowns, corona-related closings of schools and kindergartens, severe health consequences are to expect in the medium to long term, especially for this population group. The following measures can be taken by politicians and other stakeholders related to food production to counteract this negative development:

- Keeping schools and kindergartens opened as long as possible. This measure can have a direct influence on the children's nutrition through meal planning. The application of the DGE quality standard (https://www.schuleplusessen.de/) for healthy and sustainable catering in community facilities for children should be made mandatory in this context.
- This is, the quality of community catering for children must be massively increased. Freshness, health and enjoyment must be in the foreground. The caloric content of the menus must be adapted to the children's age. In addition, constant random quality controls by higher-level authorities are required.
- The municipalities and districts with the support of the state governments must not act according to the standard "good and above all cheap".

Due to the increase in the consumption of more processed food, the industry can also contribute to improve the health value of these (convenience) products by using more gentle and improved production methods and processes (e.g. high-pressure technology, pulsed electric fields). Government support can be provided from two sides in this context. On the one hand, it is to recommend to focus on sustainable and healthy food in research funding to optimize the underlying procedures and processes or, if necessary, to develop them. On the other hand, we propose to set the Nutri-Score as mandatory by law. This allows the consumer to differentiate between the offered options.

It is to highlight, that a considerable part of the population feared not getting enough food during the pandemic. Therefore, it is recommended that responsible state ministries run educational campaigns in non-pandemic times that encourage the population to stockpile certain amount of foods on a mid- to long-term base in order to avoid a run on grocery stores in times of crisis. Nonetheless, there is need for research to what extent this measure can prevent out-of-stock situations. Furthermore, it should be analysed to what extent the communication of political actors in the media has triggered the fear of not getting enough food.

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Conflicts of Interest: The authors declare no conflict of interest.

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Appendix A

Table A1. Fisher's exact test - *p*-values for groups differences between households segments concerning the consumption of alcohol

	no kids, income loss vs. kids, income loss	no kids, income loss vs. kids, no income loss	no kids, income loss vs. no kids, no income loss
less vs. no change	0.10	0.08	0.30
less vs. more	0.40	0.07	0.07
no change vs. more	0.29	0.63	0.11
	kids, income loss vs. kids, no income loss	kids, income loss vs. no kids, no income loss	kids, no income loss vs. no kids, no income loss
less vs. no change	0.82	0.18	0.22
less vs. more	0.44	0.66	0.70
no change vs. more	0.14	0.01	0.37

Table A2. Fisher's exact test - *p*-values for groups differences between households segments concerning the consumption of Ready-Meals

	no kids, income loss vs. kids, income loss	no kids, income loss vs. kids, no income loss	no kids, income loss vs. no kids, no income loss
less no vs. change	0.34	1.00	0.54
less vs. more	1.00	0.62	0.23
no change vs. more	0.21	0.19	0.31
	kids, income loss vs. kids, no income loss	kids, income loss vs. no kids, no income loss	kids, no income loss vs. no kids, no income loss
less vs. no change	0.32	0.55	0.43
less vs. more	0.79	0.42	0.84
no change vs. more	0.02	0.03	0.53

Table A3. Fisher's exact test - *p*-values for groups differences between households segments concerning the consumption of frozen food

	no kids, income loss vs. kids, income loss	no kids, income loss vs. kids, no income loss	no kids, income loss vs. no kids, no income loss
less vs. no change	1.00	0.88	0.82
less vs. more	0.84	0.21	0.08
no change vs. more	0.75	0.15	0.08
	kids, income loss vs. kids, no income loss	kids, income loss vs. no kids, no income loss	kids, no income loss vs. no kids, no income loss
less vs. no change	0.86	0.76	0.91
less vs. more	0.20	0.08	1.00
no change vs. more	0.12	0.09	0.90

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Table A4. Fisher's exact test - *p*-values for groups differences between households segments concerning the consumption of fruits and vegetables

	no kids, income loss vs. kids, income loss	no kids, income loss vs. kids, no income loss	no kids, income loss vs. no kids, no income loss
less vs. no change	1.00	0.14	0.55
less vs. more	1.00	0.11	0.73
no change vs. more	1.00	0.58	1.00
	kids, income loss vs. kids, no income loss	kids, income loss vs. no kids, no income loss	kids, no income loss vs. no kids, no income loss
less vs. no change	0.22	0.63	0.18
less vs. more	0.18	0.82	0.12
no change vs. more	0.66	1.00	0.45

Table A5. Fisher's exact test - *p*-values for groups differences between households segments concerning the consumption of canned food

	no kids, income loss vs. kids, income loss	no kids, income loss vs. kids, no income loss	no kids, income loss vs. no kids, no income loss
less vs. no change	0.63	0.71	0.41
less vs. more	0.79	0.29	0.06
no change vs. more	0.88	0.27	0.10
	kids, income loss vs. kids, no income loss	kids, income loss vs. no kids, no income loss	kids, no income loss vs. no kids, no income loss
less vs. no change	0.36	0.20	0.89
less vs. more	0.20	0.09	0.86
no change vs. more	0.50	0.31	0.90

Table A6. Fisher's exact test - *p*-values for groups differences between households segments concerning the consumption of meat

	no kids, income loss vs. kids, income loss	no kids, income loss vs. kids, no income loss	no kids, income loss vs. no kids, no income loss
less vs. no change	0.05	1.00	0.91
less vs. more	0.13	0.35	0.47
no change vs. more	0.81	0.30	0.34
	kids, income loss vs. kids, no income loss	kids, income loss vs. no kids, no income loss	kids, no income loss vs. no kids, no income loss
less vs. no change	0.05	0.01	0.90
less vs. more	0.57	0.28	0.68
no change vs. more	0.78	0.82	0.72

Table A7. Fisher's exact test - *p*-values for groups differences between households segments concerning the consumption of sweets

	no kids, income loss vs. kids, income loss	no kids, income loss vs. kids, no income loss	no kids, income loss vs. no kids, no income loss
less vs. no change	0.23	0.18	0.89
less vs. more	1.00	0.36	0.42
no change vs. more	0.30	0.76	0.47
	kids, income loss vs. kids, no income loss	kids, income loss vs. no kids, no income loss	kids, no income loss vs. no kids, no income loss
less vs. no change	0.02	0.28	0.07
less vs. more	0.31	0.70	0.09
no change vs. more	0.21	0.07	0.80

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