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Determinants of the decision to build up excessive food stocks in the COVID-19 crisis

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ABSTRACT

In 2020, the first COVID-19 lockdowns resulted in food panic buying and excessive food stockpiling across many countries around the world. Many governments recommend keeping emergency food stocks for three to ten days for times of potential shortages in food supply. Based on data from an online survey conducted among Swiss inhabitants, we investigated the effect of knowledge level and stockpiling behaviour according to governmental stockpiling recommendations in normal times on the decision to build up more food stocks than usual during the first lockdown in 2020. For this purpose, we applied a combination of latent class analysis and logistic regression. Latent classes were constructed based on knowledge level and stockpiling behaviour according to governmental stockpiling recommendations in normal times. Subsequently, the information on class membership was used as predictor of the decision to excessively stockpile food during the first lockdown. The variable "class membership" revealed that respondents with a low knowledge level and food stocks below governmental recommendations in normal times had a 7.6 percentage points lower probability of excessively stockpiling food during the first lockdown than respondents with a high knowledge level and recommended food stocks in normal times. Excessive stockpiling was additionally driven by the worry that certain food products would disappear from the supermarket shelves entirely or would be in short supply. Moreover, regression results revealed that respondents who reduced their shopping frequency during the first lockdown in 2020 showed a higher probability of building up more food stocks than usual. Our findings are crucial for food suppliers and policymakers to understand the drivers of panic buying and to prevent this phenomenon in future crises.

1. Introduction

Stockpiling food and water is one of the most important measures individuals can take to be prepared for sudden and temporary supply shortages. Therefore, governments around the world provide recommendations for food and beverage stockpiling in normal times (see, e.g., USA: Centers for Diseases Control and Prevention CDC, 2019; Norway: Direktoratet for samfunnssikkerhet og beredskap, opphavsrett DSB, 2020; Germany: Bundesamt für Bevölkerungsschutz und Katastrophenhilfe BBK, 2020; Australia and New Zealand: Food Standards Australia & New Zealand FSANZ, 2020). Many countries recommend a three-day emergency stock of food and water, whereas a ten-day stock is recommended in Germany (BBK, 2020), and Switzerland recommends stocking enough storable food for seven days (FONES, 2020). Various studies found that around 60–70% of the population follows the governmental stockpiling recommendations in normal times (e.g., Zimmermann & Pescia, 2018 for Switzerland; Menski et al., 2016 for Germany; Laurikainen, 2016 for Finland; Hiatt et al., 2021 for the United States).

Food stockpiling in normal times to be prepared for a crisis contrasts with excessive stockpiling during a crisis. During the first COVID-19 lockdown in 2020, the phenomenon of panic buying and excessive stockpiling, resulting empty supermarket shelves, was observed in many countries (Cecchetto et al., 2021; Kaur & Malik, 2020; Taylor, 2021). Results from Russia (Hassen et al., 2021) indicate that people especially stockpiled larger amounts of non-perishable food items. In Germany (Lehberger et al., 2021), excessive purchases were observed not only for non-perishable food but also, in smaller amounts, for fresh fruits and vegetables. Observed food panic buying and excessive stockpiling during the first lockdown in 2020 must be considered irrational behaviour (Schiller et al., 2021). Interestingly, a variety of studies identified the anticipation of food shortages or fear of potential future food

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unavailability, respectively as a psychological driver of panic buying and excessive food stockpiling (Ammann & Casagrande, 2021; Lehberger et al., 2021; Schiller et al., 2021). Moreover, the fear of getting infected by the coronavirus (Wang & Hao, 2020) caused people to reduce their frequency of shopping trips and to stockpile more than usual (Panzone et al., 2021). Behavioural changes in stockpiling food could in turn have an impact on food intake attitudes and behaviours (Wansink, 2004). In the U.K., Benker (2021) observed a change in the kinds of food purchased during the first COVID-19 lockdown, as well as a change in meal planning, indicating a modification in food intake. In Switzerland, Ammann and Ritzel (2021) found an increase in the consumption of homemade food (e.g., homemade bread) during the first lockdown.

However, the effect of knowledge level and the behaviour of stockpiling food and beverages according to governmental recommendations during normal times on the decision to excessively stockpile food during the first lockdown has not been investigated so far. Against this background, the aim of this paper was to examine factors influencing food and beverage stockpiling during the first COVID-19 lockdown in 2020. We were especially interested in the effect of knowledge level and stockpiling behaviour in normal times according to governmental stockpiling recommendations on the decision to build up more food stocks than usual during the first lockdown in 2020. Our findings are crucial for food suppliers and policymakers to understand the drivers of panic buying and to prevent this phenomenon in future crises. For this purpose, we used Switzerland as a case study.

In Switzerland, the first lockdown due to COVID-19 began on March 13, 2020 (FOPH, 2021a). All stores, restaurants, bars, schools, and entertainment and leisure establishments were closed. Only supermarkets, pharmacies, banks, post offices, hotels, canteens, kiosks, bakeries, and butcher stores remained open. This extraordinary situation first started to relax starting from April 27, 2020, whereby non-essential businesses such as hairdressers, hardware stores, garden centers, flower stores, massage parlours, and beauty parlours were allowed to reopen (Schweizer Tourismus-Verband STV, 2021). Owing to closed borders preventing shopping tourism, closed restaurants, and extreme stockpiling ("panic buying") during March and April 2020, not only did the supermarket shelves for toilet paper remain temporarily empty, but also the shelves for non-perishable food such as rice, flour, and pasta (Bolliger Maiolino, 2020).

For the empirical analysis, in the first step, we constructed latent classes regarding (i) knowledge of the governmental recommendations and (ii) self-reported stockpiling behaviour according to the governmental recommendations in normal times (before the first lockdown in 2020). In the second step, the information regarding class membership was used as an observed predictor of the (binary) decision to build up more food stocks than usual during the first lockdown in 2020. Along with class membership, we used sociodemographic characteristics, psychological factors, and purchasing-related factors as additional predictors. The data for the empirical exercise stem from an online survey conducted in June and July 2020 among 1,028 Swiss respondents (FSVO, 2020).

The remainder of the article is organised as follows: In Section 2, we provide the theoretical framework regarding knowledge level and food stockpiling behaviour (stockpiling habits) in normal times as predictors of excessive food stockpiling during the first lockdown. In Section 2, hypotheses are formulated. In Section 3, we present the data used (Subsection 3.1) and the applied combination of methods (Subsection 3.2). In Section 4, results from the latent class analysis (LCA; Subsection 4.1) and the logistic regression (Subsection 4.2) are presented and discussed before Section 5 concludes.

2. Theoretical framework: Knowledge level and food stockpiling behaviour in normal times as predictors of excessive food stockpiling in the COVID-19 crisis

Fig. 1 depicts our theoretical framework with the two time periods "normal times" (time period before the first COVID-19 lockdown in 2020) and "time period of the first COVID-19 lockdown in 2020". We were especially interested in the effect of the latent (unobserved) construct consisting of (i) knowledge level and (ii) stockpiling behaviour in normal times according to governmental stockpiling recommendations on the decision to excessively stockpile food during the first lockdown in 2020. Furthermore, we investigated the effect of sociodemographic and non-sociodemographic variables (i.e., psychological and purchasing related variables) on the decision to excessively stockpile food during the first lockdown in 2020.

To be prepared for temporary shortages in supply due to a crisis, the (Swiss) Federal Office for National Economic Supply (FONES, 2020) recommends stockpiling 9 L of water and further (non-alcoholic) beverages per person and food for one week for each person living in the household. In our case, respondents had to indicate (i) whether they already knew the governmental recommendations and (ii) how frequently (habitually) they built up household stocks of food and beverages according to the governmental recommendations in normal times.

To be well informed is a prerequisite for effective action, implying that knowledge of the governmental recommendations can promote a behaviour according to the recommendations. However, regarding knowledge predicting future behaviour, the experimental results of Ajzen et al. (2011) question this assumption. The authors found that environmental knowledge had no effect on energy conservation, and alcohol knowledge was unrelated to drinking behaviour. Only between knowledge and pro-Muslim behaviour was a positive correlation obtained. Empirical evidence implies that people who are aware of the governmental stockpiling recommendations in normal times might not behave in accordance with governmental stockpiling recommendations in a crisis.

Benker (2021) described the motivation behind stockpiling behaviour as the minimisation of risk of access loss due to the belief of short supply. Accordingly, stockpiling must be considered fear-based behaviour rather than a rational response to factual existing food shortage (Benker, 2021). A crisis such as the COVID-19 pandemic can lead to excessive stockpiling and food hoarding. Excessive stockpiling behaviour in a crisis is explained by psychological reactions such as panic disorder, anxiety, depression, fear, and uncertainty about the future (Lehberger et al., 2021). If stockpiling food and beverages according to governmental recommendations is frequently exhibited in normal times due to fear of a sudden crisis, it can also be considered a habitual behaviour, which might be predictive of stockpiling behaviour when a crisis emerges (Franklin, 2013; Ouellette & Wood, 1998).

Against this background, our methodological approach allowed us to test the following hypothesis regarding knowledge level and stockpiling behaviour (stockpiling habits) according to governmental recommendations in normal times:

H1. People who were mostly aware of the governmental recommendations, and who frequently (habitually) stockpiled food and beverages according to the recommendations in normal times, would behave in even more fearsome ways and tend to excessively stockpile food during the first COVID-19 lockdown. In contrast, people who mostly did not know about governmental stockpiling recommendations and did not tend to stockpile in normal times would stay calm and thus not tend to excessively stockpile during the first lockdown.

By using an LCA, we were able to identify different classes of people with regard to knowledge of and stockpiling behaviour according to governmental stockpiling recommendations in normal times. The variable "class membership" is included in the regression analysis as an

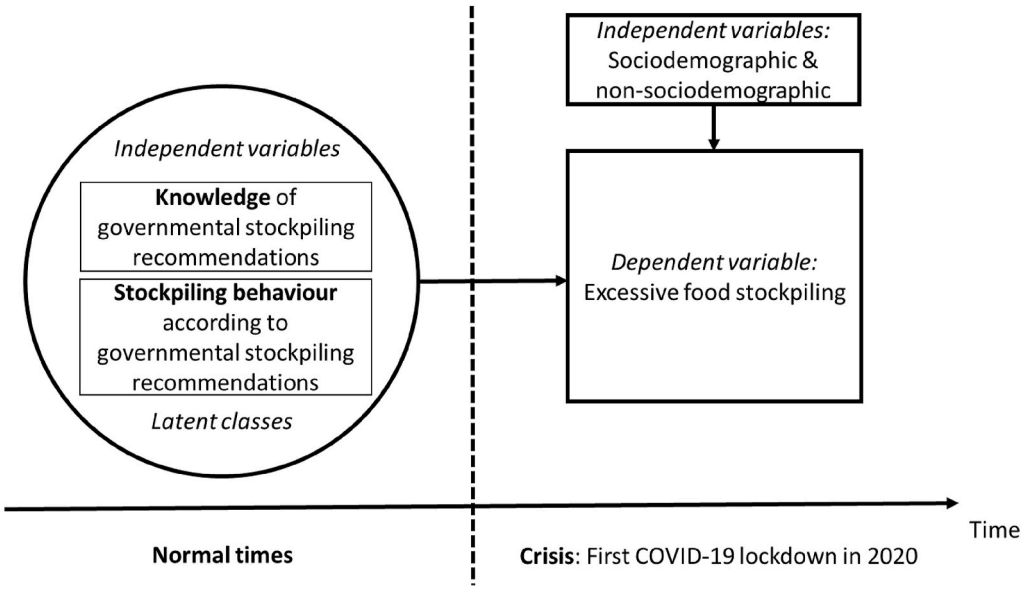

Fig. 1. Theoretical framework depicting the influence of the latent construct and further independent variables on the decision to excessively stockpile food during the first lockdown in 2020.

independent variable. Regarding the effect of further sociodemographic and non-sociodemographic variables on the decision to excessively stockpile food during the crisis, we formulated the following hypothesis:

H2. Women exhibit a higher probability to excessively stockpile food during the first COVID-19 lockdown in 2020 than men.

H2 is considered because even today, women are the primary food purchasers for the household (Crane et al., 2019). It is hardly surprising that women were more likely to build up larger scale food reserves after the outbreak of COVID-19 than men were (Wang et al., 2020).

Food distribution and access differ depending on where people live (i.e., urban vs. rural area) (Smith & Morton, 2009). In general, urban areas face fewer issues in accessing food than rural areas do (Vilar-Compte et al., 2021). This implies that people living in rural areas incur a higher average cost to reach food, especially when driving and walking are considered, compared with urban areas (Losada-Rojas et al., 2021). Thus, people in rural areas might be more fearsome of a short food supply, leading to more excessive stockpiling behaviour compared with people in urban areas. Against this background, we tested Hypothesis 3:

H3. People living in rural areas (i.e., villages) show a higher probability to excessively stockpile food during the first lockdown compared with people living in urban areas (i.e., small, medium, large city).

In general, an increase in household size is associated with purchasing larger amounts of food (Ricciuto et al., 2006). In the context of the COVID-19 pandemic, the findings of Nam et al. (2021) reveal that larger households tended to excessively stockpile necessities compared with smaller households. We hypothesised that the same holds true for food stockpiling behaviour (Hypothesis 4):

H4. Larger households built up more food stocks than usual during the first lockdown in 2020 than smaller households did.

Previous studies on emergency stockpiling in preparation for natural disasters (i.e., earthquake or hurricane) found that high-income households are more likely to stockpile food and drinking water (Kawashima et al., 2012; Pan et al., 2020). The same holds true for the COVID-19 pandemic: High-income consumers were more likely to reserve larger scale food reserves (Wang et al., 2020). Therefore, we tested Hypothesis 5:

H5. Households with a high income would show a higher propensity to excessively stockpile food during the first lockdown than households with a lower income.

Venn et al. (2017) found that highly educated households spend relatively less of their total food budget on foods prepared at home and more on foods purchased at restaurants. However, the COVID-19 pandemic caused highly educated persons to panic buy and build up more food stocks than usual (Dammeyer, 2020; Wang et al., 2020). Regarding empirical evidence on the relationship between education and stockpiling behaviour during the early stage of the COVID-19 pandemic, we tested Hypothesis 6:

H6. Highly educated people stockpiled more food than usual compared with low educated people.

The Italian- and French-speaking regions of Switzerland were initially more affected by COVID-19 than the German-speaking regions (SWI swissinfo.ch, 2020). This, in turn, could have led to more food stockpiling than usual in Italian- and French-speaking regions (Hypothesis 7):

H7. People living in the Italian- and French-speaking cantons would exhibit a higher probability to excessively stockpile food during the first lockdown than people from the German-speaking regions.

Schmidt et al. (2021) used "risk group" as a predictor of changed purchasing behaviour. The binary variable "risk group" reflected whether a person was considered at especially high risk of contracting the coronavirus. According to the Federal Office of Public Health (FOPH, 2021b), the coronavirus can be dangerous for older people, pregnant women, and adults with trisomy 21 or with certain forms of chronic conditions because they could become seriously ill. However, in the study conducted by Schmidt et al. (2021), the effect of "risk group" was statistically non-significant. Nevertheless, people belonging to the risk group reduced their shopping frequency to reduce the risk of getting infected by the coronavirus (Lehberger et al., 2021) while buying more food on each shopping trip. Consequently, we tested Hypothesis 8:

H8. People belonging to the risk group stockpiled more food than usual during the first COVID-19 lockdown.

Several recent studies have used "worried to not find certain foods" or "fears that certain foods are unavailable" as predictors of stockpiling behaviour (Ammann & Casagrande, 2021; Lehberger et al., 2021; Schiller et al., 2021). The findings of these studies highlight that people who were worried about not finding certain foods were responsible for panic buying and excessive food stockpiling. Against this background,

we tested Hypothesis 9:

H9. People who were very worried about not finding certain foods excessively stockpiled food compared with people who were a little bit worried or not worried.

Ready-to-eat foods (i.e., food take-away and delivery services) led to a significant reduction in time spent preparing meals at home (Babar et al., 2021; Griffith et al., 2021). Therefore, food stocks at home could be reduced. In Switzerland, food take-away and home delivery services were permitted during the first lockdown in 2020 (Fallstaff, 2020). Since the COVID-19 outbreak, home delivery and take-away sales have increased (Filho et al., 2021). To the best of our knowledge, neither explanatory variable has been considered in the literature investigating stockpiling behaviour during the COVID-19 lockdown. Nevertheless, we hypothesise that the utilisation of both (food take-away options and food home delivery services) can be assumed to have a negative impact on the decision to stockpile more food than usual (Hypothesis 10):

H10. People who utilise food take-away and/or food home delivery services show a lower probability of stockpiling food excessively during the first lockdown.

Reducing the frequency of shopping trips was considered a strategy to reduce the risk of getting infected with the coronavirus. In this context, Lehberger et al. (2021) found that reducing shopping frequency was a major reason for stockpiling. Therefore, we tested Hypothesis 11:

H11. People who reduced their shopping frequency were more likely to stockpile food excessively during the first Swiss lockdown than people who maintained their shopping frequency.

3. Data and methods

3.1. Data

The data used in our analyses are from an online survey that was conducted by the Swiss Federal Food Safety and Veterinary Office (FSVO) in June and July 2020. The main aim of the online survey was to collect data on dietary, stockpiling and physical activity behaviour of Swiss inhabitants during the period of the COVID-19 measures imposed by the Federal Council from March 13 to April 26, 2020. In total, 1,028 respondents completed the online survey (FSVO, 2020). The online survey contained 42 questions, which were distributed over the following four parts: 1) sociodemographic information; 2) changes in work situation and changes in food consumption and stockpiling caused by the lockdown; 3) changes in physical activity and body weight caused by the lockdown, and body height; 4) worries about availability and affordability of food.

Regarding the representativeness of the online survey, respondents from the French-speaking region (actual population: 24%; survey sample: 47%) and the Italian-speaking region (actual population: 4%; survey sample: 16%) were overrepresented compared with respondents from the German-speaking region (actual population: 72%; survey sample: 37%). Likewise, slight imbalances regarding the frequency distribution of the age groups existed. However, the variables "age" and "age group" were not considered in the empirical analysis.

Although the French- and Italian-speaking parts of Switzerland are overrepresented, we believe that our findings reflect the general tendency regarding excessive food stockpiling of Swiss inhabitants during the first lockdown (Bolliger Maiolino, 2020). Moreover, in most research, only respondents from the German-speaking region were recruited for surveys conducted in Switzerland. Therefore, covering all three language regions can be considered a strength of the online survey conducted by the FSVO (2020).

After deleting answer options "I do not know (value = 98)" and "I do not want to answer (value = 99)", 765 observations remained for the LCA and the regression analysis. Frequency distributions for variables used in the LCA including answer options with values of 98 and 99 can be found in Table 5 in the appendix. Frequency distributions for variables used in the regression analysis including answer options with values of 98 and 99 can be found in Table 6 in the appendix.

For the LCA, we used three nominal-scaled items shown in Table 1. Item 1 refers to whether the government recommendations regarding food and beverage stocks were known (*stockpiling knowledge*). The following three responses were possible: 1 = Yes, before the pandemic; 2 = Yes, since the pandemic; 3 = No. Item 2 refers to whether food stocks had already been built up before March 13, 2020, and Item 3 refers to whether beverages stocks had already been built up before March 13, 2020 (*stockpiling behaviour*) according to governmental recommendations. The following three responses were possible: 1 = Yes, always; 2 = Yes, mostly; 3 = No.

For the logistic regression, we used the variables presented in Table 2. The (binary) dependent variable took the value of 1 if a respondent built up more food stocks than usual during the first lockdown in 2020 and 0 otherwise. As independent variables, we used sociodemographic characteristics, three variables related to food and beverage purchasing behaviour (*utilisation of take-away, utilisation of home delivery service*, and *changed shopping frequency*) and one psychological factor (*worried about not finding food*).

3.2. Methods

For the empirical analysis, we used a combination of (1) LCA and (2) logistic regression (Fig. 2).

In the first step, we applied an LCA. A latent variable or a latent phenomenon is a random variable that cannot be directly overserved. Its value can be inferred from observed items by means of a mathematical model. Individual preferences, behaviours, and attitudes are latent variables that can be conceptualized (or measured) as categorical or continuous items (Porcu & Giambona, 2016). For instance, burnout is a latent phenomenon which can be measured based on the Maslach Burnout Inventory. The Maslach Burnout Inventory is composed of 22 items with a scale ranging from 0 = never to 6 = every day. By means of an LCA the following three (latent) burnout groups can be identified: high burnout, moderate burnout and low burnout (Méndez et al., 2020). Latent or unobserved variables in our analysis were the state of knowledge, the self-reported food and beverage stockpiling behaviour, the number of latent classes, and their share within the total population. The latent classes were constructed based on the (observed) three nominal-scaled items described in Table 1. Consequently, the main aim of an LCA is to divide the total population into clearly definable and relatively homogeneous classes (Lanza et al., 2007).

Instead of applying an LCA, the three nominal-scaled items could be individually integrated into the logistic regression as independent

Table 1
Nominal-scaled items used for the latent class analysis.

Item	Description	Item values	Frequency
1	Do you know the recommendations of the government regarding stockpiling (per person: food stockpiling for one week and 9 L [one sixpack] of water or further non-alcoholic beverages)?	1 = Yes, before the pandemic	251 (32.8%)
		2 = Yes, since the pandemic	129 (16.9%)
		3 = No	385 (50.3%)
2	Did you already build up household stocks of *food* according to the recommendations of the government before March 13?	1 = Yes, always	256 (33.5%)
		2 = Yes, mostly	301 (39.4%)
		3 = No	208 (27.2%)
3	Did you already build up household stocks of *beverages* according to the recommendations of the government before March 13?	1 = Yes, always	190 (24.8%)
		2 = Yes, mostly	195 (25.5%)
		3 = No	380 (49.7%)

Table 2
Variables used for the logistic regression.

	Mean (Std. dev.)	Frequency
Binary dependent variable: Did you stockpile more food than usual between March 13 and April 26?		
1 = Yes, more stockpiling than usual		374 (48.9%)
0 = No, no more stockpiling than usual		391 (51.1%)
Gender (binary)		
1 = Men		395 (51.6%)
0 = Women		370 (48.4%)
Urban or rural life (nominal)		
1 = Large city		149 (19.5%)
2 = Small or medium-sized city		274 (35.8%)
3 = Village		342 (44.7%)
Number of persons in household (min. = 1; max. = 5)	2.5 (1.2)	
Household income (ordinal)	3.6 (1.8)	
1 = Less than CHF 4,500		120 (15.7%)
2 = CHF 4,500 to CHF 6,000		160 (20.9%)
3 = CHF 6,001 to CHF 7,500		116 (15.2%)
4 = CHF 7,501 to CHF 9,000		119 (15.6%)
5 = CHF 9,001 to CHF 12,000		125 (16.3%)
6 = CHF 12,001 to CHF 15,000		76 (9.9%)
7 = More than CHF 15,000		49 (6.4%)
Education (ordinal)	3.3 (1.3)	
1 = Compulsory education		31 (4.1%)
2 = Basic vocational education		259 (33.9%)
3 = Secondary school		127 (16.6%)
4 = Higher vocational education		132 (17.3%)
5 = University		216 (28.2%)
Language region (nominal)		
1 = German-speaking Switzerland		283 (37.0%)
2 = French-speaking Switzerland		362 (47.3%)
3 = Italian-speaking Switzerland		120 (15.7%)
COVID-19 risk group (binary)		
1 = Yes		239 (31.2%)
0 = No		526 (68.8%)
I was worried about not finding certain food (nominal)		
1 = Yes, very		53 (6.9%)
2 = Yes, a little bit		274 (35.8%)
3 = No		438 (57.3%)
Utilisation of take-away (binary)		
1 = Yes		431 (56.3%)
0 = No		334 (43.7%)
Utilisation of home delivery service (binary)		
1 = Yes		295 (38.6%)
0 = No		470 (61.4%)
Changed shopping frequency (nominal)		
1 = No, the same frequency		297 (38.8%)
2 = Yes, more frequently		79 (10.3%)
3 = Yes, lower frequency		363 (47.5%)
4 = Someone else shops for me		26 (3.4%)

variables predicting excessive food stockpiling. Even though variable-level methods such as ordinary regression analysis provide valuable explanations for social phenomena, such methods hide differences between subpopulations by providing findings and conclusions representative for the overall sample. Capturing (unobserved) differences between subpopulations is an important aim of social research. In contrast to variable-level methods, LCA is a person-oriented method which allows for modelling distinct variants of (unobserved) heterogeneity within the overall sample. Therefore, we use LCA because it condenses the information of the three overserved items into one single variable called "class membership". From a technical perspective, integrating the three items individually into the logistic regression would reduce the degrees of freedom. Furthermore, and even more important, by simply integrating the three nominal-scaled items into the logistic regression, we would not be able to capture unobserved heterogeneity. Consequently, by applying an LCA, we are able to empirically determine the interrelationship between the observed items that explain the latent variable or the latent phenomenon encompassing different classes regarding knowledge level, food stockpiling behaviour and beverage stockpiling behaviour according to governmental recommendations in normal times (Scotto Rosato & Baer, 2012).

To capture unobserved heterogeneity, the latent variable was drawn from a population of Q unobserved subpopulations with varying percentage shares (whereby $q = 1, \ldots, Q$). The probability of class membership was estimated by means of a multinomial logistic model. Parameters of the LCA are estimated by means of the Expectation-Maximization Algorithm. The optimal class solution Q (optimal number of latent classes) can be obtained by using comparative model fit criteria such as the Bayesian information criterion (BIC), Akaike information criterion (AIC), and log-likelihood (LL) (Goodman, 2002). Each (latent) class was described with a meaningful label.

In the second step, we estimated a logistic regression (Backhaus et al., 2005), whereby the dependent variable represented a binary variable that took the value of 1 if a respondent built up more food stocks than usual during the first lockdown in 2020 and 0 otherwise (Table 2). Our independent variable of interest, the observed "class membership" (i.e., Class 1, Class 2, and Class 3) of a respondent, was used as a predictor of the binary decision. Additionally, we used socio-demographic characteristics and personal-, psychological-, and purchasing-related factors of the respondents (Table 2) as further independent variables in our regression model. Initially, an average variance inflation factor (VIF) of 4.4 for all independent variables indicated that multicollinearity was not an issue. However, the VIF for the independent variable "age" was 15.6, which is above the tolerated value of 10. Likewise, the alternative (ordinal-scaled) variable "age group" had a high VIF of 9.9. To avoid inconsistent estimates, neither variable was considered in the regression model (note that both variables were non-significant when included in the regression model).

The empirical exercise was conducted in Stata 16. The LCA was performed using the generalised structural equation model command. The respondent-specific variable "class membership" was computed by means of the post-estimation command *predict*. For the logistic regression, we used the *logit* command.

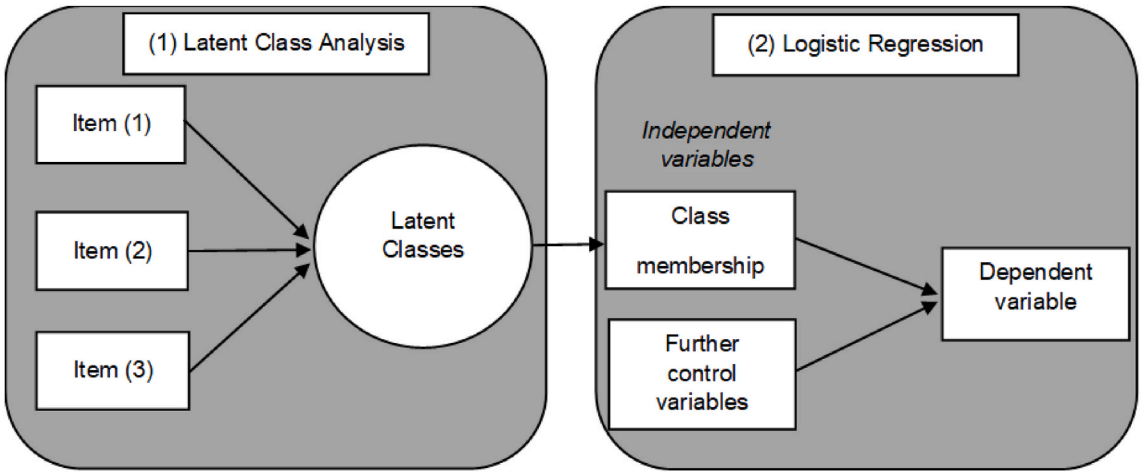

Fig. 2. Combination of (1) latent class analysis and (2) logistic regression.

4. Results and discussion

4.1. Latent class analysis

Table 3 presents the comparative model fit criteria (AIC, BIC, and LL) of the LCA. Values of the comparative model fit criteria decreased until the $Q = 3$ solution, whereas for $Q = 4$, convergence of the model was not achieved. We therefore chose $Q = 3$ as the optimal number of latent classes.

We explored the following classes regarding knowledge level and stockpiling behaviour according to the governmental recommendations in normal times.

The first was a class consisting of people who were mostly aware of the governmental recommendations and who frequently (habitually) stockpiled food and beverages according to the recommendations in normal times.

The second was a class consisting of people who were mostly not aware of the governmental recommendations and who mostly did not stockpile food and beverages according to the recommendations in normal times.

We also explored a third class with regard to knowledge level and stockpiling behaviour in normal times between these two contrasting classes.

In the following, we describe in detail the three latent classes regarding knowledge level and stockpiling behaviour in normal times, as well as their frequency within the total population.

Class 1: "Informed and always following stockpiling recommendations in normal times"

Fig. 3 shows the relative frequencies of the response options of Item 1, "Governmental recommendations known"; Item 2, "Food stocks"; and Item 3, "Beverage stocks" for Class 1.

Class 1 was the second largest class within the total population, with a share of 30.0%. Individuals belonging to Class 1 reported that they always (76.5%) or mostly (23.5%) had food stocks according to the governmental recommendations. A similar picture emerges for beverages. A total of 94.1% of the respondents reported that they always (62.8%) or mostly (31.3%) had beverage stocks. Only a relatively small percentage (5.9%) of the respondents had beverage stocks below the recommendations. In terms of knowledge, 51.7% of the respondents belonging to Class 1 indicated that they were already aware of the governmental recommendations before the pandemic. Thus, Class 1 has a higher-than-average knowledge level. In comparison, 36.8% of individuals in Class 1 were not aware of the recommendations, and 11.5% were aware of the recommendations since the COVID-19 pandemic. Therefore, the class is referred to as *"Informed and always following stockpiling recommendations in normal times."*

Class 2: "Uninformed and mostly following stockpiling recommendations in normal times"

Fig. 4 shows the relative frequencies of the response options of Item 1, "Governmental recommendations known"; Item 2, "Food stocks"; and Item 3 "Beverage stocks" for Class 2.

Class 2 represents the smallest of the three classes (19.0%). Most of the respondents in Class 2 stockpiled food (79.6%) and stockpiled beverages (85.8%) according to the governmental recommendations. However, 13.1% of the respondents in this class had food stocks below the recommendations. In the case of beverages, 11.8% of the respondents stated that their stocks did not meet the recommendations. Only 2.4% of the respondents reported that they always stockpiled beverages according to recommendations. Within Class 2, 44.6% of the respondents did not know the recommendations of the government, 30.5% had been aware of the recommendations before the pandemic, and 24.9% knew them since the COVID-19 pandemic. Thus, more than two thirds of the respondents did not know the recommendations or only knew them since the COVID-19 pandemic. Therefore, the class is referred to as *"Uninformed and mostly not following governmental recommendations in normal times."*

Class 3: "Uninformed and rarely following stockpiling recommendations in normal times"

Fig. 5 shows the relative frequencies of the response options of Item 1, "Governmental recommendations known"; Item 2, "Food stocks"; and Item 3, "Beverage stocks" for Class 3.

Class 3 represents the largest class, with a share of 51.0% within the total population. For about one half of the respondents (48.4%), food stocks were below the recommendations. In the case of beverages, 89.3% of the respondents indicated that their stocks were below recommendations. Within Class 3, most respondents (60.4%) had been unaware of the governmental recommendations before the COVID-19 pandemic, and 17.1% were only aware of them since the beginning of the pandemic. Only 22.5% of the respondents in Class 3 had been aware of the recommendations before COVID-19. Accordingly, compared with the other two classes, Class 3 indicates the lowest knowledge level. As a result, the class is referred to as *"Uninformed and rarely following stockpiling recommendations in normal times."*

Table 3
Comparative model fit criteria of the latent class analysis.

Number of Classes	Akaike Information Criterion	Bayesian Information Criterion	Log-Likelihood
2	4,650	4,711	−2,313
3	4,612	4,704	−2,286
4	Convergence not achieved		

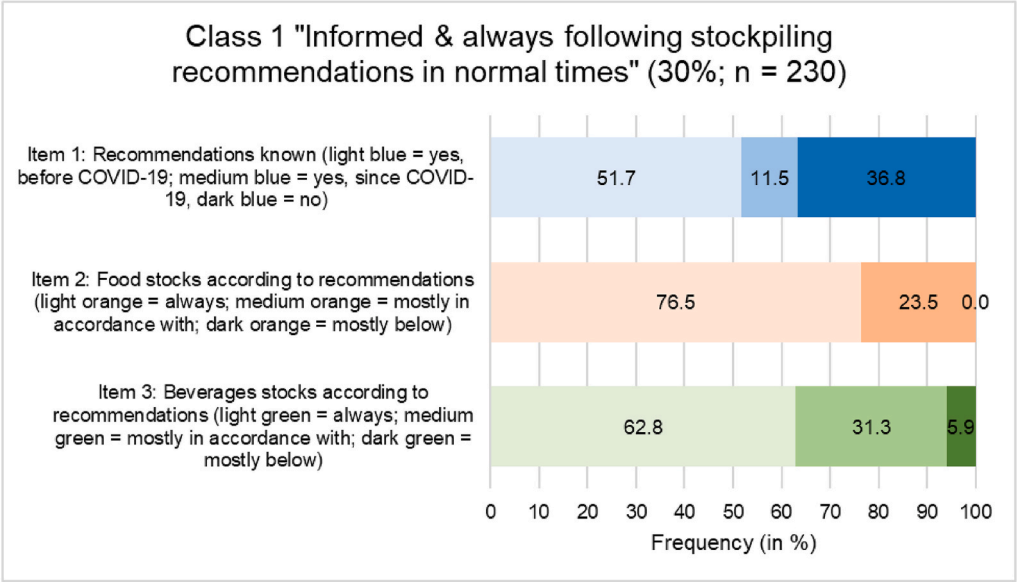

Fig. 3. Relative frequencies of the response options for Item 1, "Governmental recommendations known"; Item 2, "Food stocks"; and Item 3, "Beverage stocks" for Class 1.

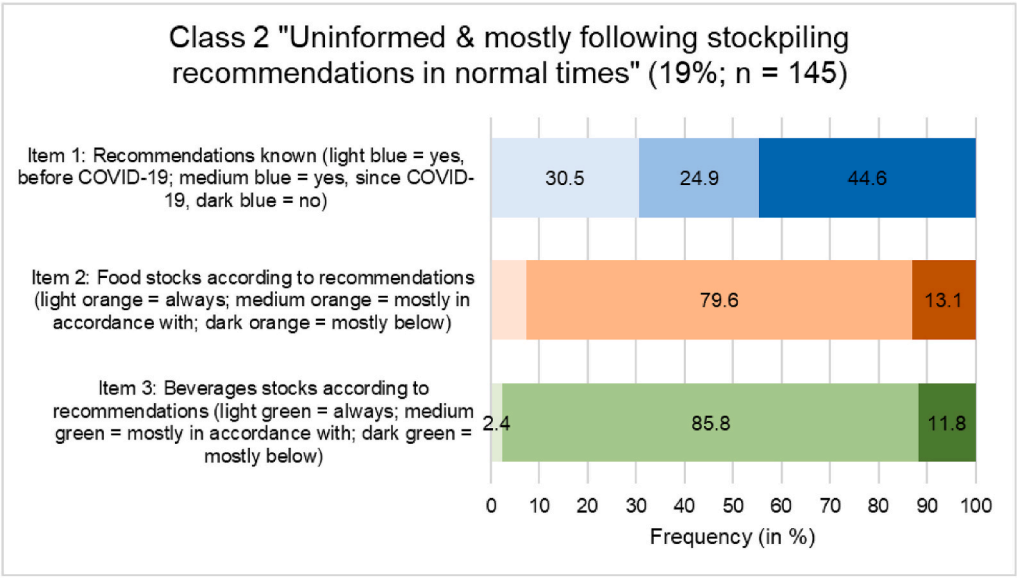

Fig. 4. Relative frequencies of the response options for Item 1, "Governmental recommendations known"; Item 2, "Food stocks"; and Item 3, "Beverage stocks" for Class 2.

4.2. Logistic regression

Table 4 shows the results of the logistic regression with the binary dependent variable that takes the value of 1 if a respondent built up more food stocks than usual during the first lockdown in 2020 and 0 otherwise. For the interpretation of the model estimates, we report the average marginal effect of an independent variable. The average marginal effect represents the average change in the probability when an explanatory variable increases by one unit.

Regarding our variable of interest, "class membership," the regression results reveal that the fear-based stockpiling behaviour in normal times was reinforced during the COVID-19 lockdown when supermarket shelves for certain products were temporarily empty. In this context, findings indicate that respondents belonging to Class 3, "Uninformed and rarely following stockpiling recommendations in normal times," showed a 7.6 percentage points lower probability of building up excessive food stocks during the first lockdown in 2020 than respondents belonging to Class 1, "Informed and always following stockpiling recommendations in normal times." This result suggests that even though Class 1 exhibited the highest knowledge level, and stocks were always in line with the governmental recommendations in normal times, respondents from this class were likely responsible for the phenomenon of panic buying, resulting in empty supermarket shelves. Thus, H1 cannot be rejected.

Compared with women, men showed a 13.9 percentage points lower probability of stockpiling more food than usual between March 13 and April 26, 2020. This finding is in line with data collected in Germany, which found that stockpiling behaviour during the pandemic was correlated with gender, indicating that women were more likely to build up stocks (Ammann & Casagrande, 2021). In this respect, H2 cannot be

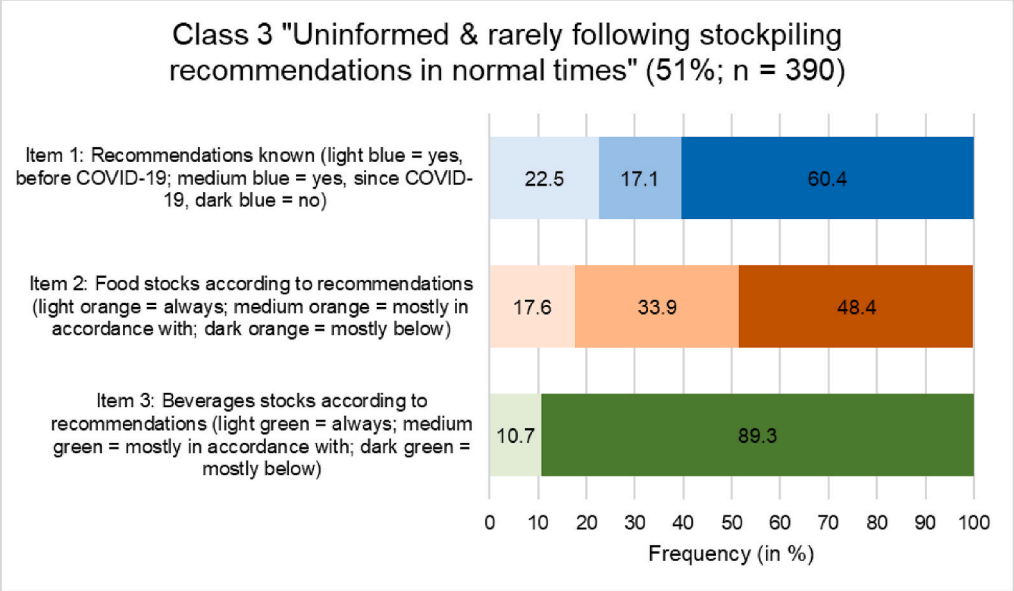

Fig. 5. Relative frequencies of the response options for Item 1, "Governmental recommendations known"; Item 2, "Food stocks"; and Item 3, "Beverage stocks" for Class 3.

rejected.

We found that neither "urban or rural life", "number of persons in the household," nor "household income" influenced the decision to excessively stockpile food during the first lockdown. These results led us to reject H3, H4, and H5.

In comparison with people with a low educational level (i.e., compulsory education), people with higher educational levels showed a lower probability to build up more food stocks than usual. Our results contradict studies conducted by Dammeyer (2020) and Wang et al. (2020), who found a positive relationship between education and excessive food stockpiling in a crisis. Therefore, we must reject H6.

People living in the Italian- and French-speaking regions of Switzerland showed a higher likelihood of excessively stockpiling food compared with people form the German-speaking region. However, the positive effect was not statistically significantly different from zero. Thus, we must reject H7.

Surprisingly, the positive effect of the variable "risk group" was statistically non-significant. Schmidt et al.'s (2021) findings likewise indicate that belonging to a risk group was not a significant predictor of change in purchasing quantity. Consequently, we must reject H8.

Stockpiling above the usual level seems to be motivated by concerns that certain foods were temporarily not available during the first lockdown in 2020. For instance, people who were not worried that they would no longer be able to buy certain foods showed a 22.6 percentage points lower probability of building up unusually high stocks than those who were very worried. Therefore, concerns that certain foods are temporarily not available might cause panic buying and hoarding. Similarly, studies conducted in Germany (Ammann & Casagrande, 2021; Lehberger et al., 2021; Schiller et al., 2021) found that stockpiling behaviours were positively associated with worries about future food unavailability. Thus, H9 cannot be rejected.

Even though home delivery and take-away sales have increased since the beginning of the pandemic, neither variable had a significant influence on the decision to build up more food stocks than usual during the lockdown. Consequently, H10 must be rejected.

The regression results furthermore indicate that respondents with a lower shopping frequency showed a higher probability of excessively stockpiling food during the first lockdown than respondents who maintained their shopping frequency. At the beginning of the pandemic, Cranfield (2020) hypothesised that consumers would stockpile more food than usual to reduce the number of shopping trips. Buying more on each trip should reduce the risk of exposure to COVID-19. Our findings are in line with qualitative evidence from Germany (Lehberger et al., 2021) and quantitative evidence from Russia (Hassen et al., 2021). Therefore, H11 cannot be rejected. Interestingly, our results further indicate that respondents who increased their shopping frequency exhibited a lower probability of excessively stockpiling food than respondents who maintained their shopping frequency.

5. Conclusions

Panic buying and excessive stockpiling behaviour due to the first lockdown of economies caused by the COVID-19 pandemic was a globally observed phenomenon. Understanding the underlying drivers is crucial for policymakers in affected countries to ensure food security and thereby prevent panic among the population, especially in the beginning of a future crisis. A large body of literature has already investigated the sociodemographic and psychological determinants of food stockpiling behaviour during the COVID-19 lockdown. Our study provides an additional contribution by exclusively addressing the relationship between governmental food and beverage stockpiling recommendations and the decision to build up more food stocks than usual during the first Swiss lockdown in 2020. Although the French- and Italian-speaking regions are overrepresented in our sample, we believe that our findings reflect the general tendency regarding excessive food stockpiling of Swiss inhabitants during the first lockdown.

By applying an LCA, we were able to depict the heterogeneity within the Swiss population regarding food and beverage stockpiling knowledge level and behaviour according to the governmental recommendations in normal times. Compared with Class 2, "Uninformed and mostly following stockpiling recommendations in normal times," and Class 3, "Uninformed and rarely following stockpiling recommendations in normal times," Class 1, "Informed and always following stockpiling recommendations in normal times," had the highest knowledge level. Respondents belonging to Class 1 always had food and beverage stocks according to the governmental recommendations in normal times. In contrast, respondents belonging to Class 3 had the lowest knowledge level, and their food and beverages stocks were below the governmental recommendations in normal times. Furthermore, the LCA results show that with a share of 51% of the total population, Class 3 was the largest

Table 4
Results of the logistic regression with the binary dependent variable that takes the value of 1 if a respondent built up more food stocks than usual during the first lockdown in 2020 and 0 otherwise.

Independent variable	Coefficient (Standard error)	Average marginal effect (Standard error)
Class membership (Reference: 1 = Informed & always following recommendations in normal times)		
2 = Uninformed & mostly following stockpiling recommendations in normal times	0.054 (0.259)	0.010 (0.048)
3 = Uninformed & rarely following stockpiling recommendations in normal times	−0.407** (0.200)	−0.076** (0.037)
Gender (1 = Men; 0 = Women)	−0.729*** (0.171)	−0.139*** (0.032)
Urban or rural life (Reference: 1 = Large city)		
2 = Small or medium-sized city	0.140 (0.244)	0.026 (0.046)
3 = Village	−0.303 (0.239)	−0.057 (0.045)
Number of persons in household	0.100 (0.083)	0.019 (0.016)
Household income (Reference: 1 = less than CHF 4,500)		
2 = CHF 4,500 to CHF 6,000	−0.114 (0.289)	−0.021 (0.054)
3 = CHF 6,001 to CHF 7,500	0.156 (0.316)	0.029 (0.059)
4 = CHF 7,501 to CHF 9,000	0.107 (0.324)	0.020 (0.060)
5 = CHF 9,001 to CHF 12,000	−0.101 (0.331)	−0.018 (0.062)
6 = CHF 12,001 to CHF 15,000	0.013 (0.392)	0.002 (0.073)
7 = More than CHF 15,000	0.102 (0.428)	0.019 (0.080)
Education (Reference: 1 = Compulsory education)		
2 = Basic vocational education	−1.334*** (0.482)	−0.240*** (0.078)
3 = Secondary school	−1.309*** (0.508)	−0.235*** (0.083)
4 = Higher vocational education	−1.326*** (0.511)	−0.238*** (0.084)
5 = University	−1.221** (0.500)	−0.218** (0.081)
Language region (Reference: 1 = German CH)		
2 = French CH	0.252 (0.196)	0.047 (0.037)
3 = Italian CH	0.402 (0.266)	0.075 (0.050)
Risk group (1 = Yes; 0 = No)	0.069 (0.206)	0.013 (0.038)
Worried to not find food (Reference: 1 = Yes, very)		
2 = Yes, a little bit	−0.014 (0.354)	−0.003 (0.067)
3 = No	−1.145*** (0.350)	−0.226*** (0.067)
Take-away (1 = Yes; 0 = No)	−0.153 (0.202)	−0.028 (0.038)
Home delivery (1 = Yes; 0 = No)	0.264 (0.200)	0.049 (0.037)
Changed shopping frequency (Reference: 1 = No, the same frequency)		
2 = Yes, more frequently	−0.909*** (0.294)	−0.177*** (0.061)
3 = Yes, lower frequency	0.872*** (0.283)	0.184*** (0.060)
4 = Someone else shops for me	0.078 (0.515)	0.017 (0.111)
Number of observations	765	
Pseudo R^2	0.200	

***p ≤ 0.01, **p ≤ 0.05, *p ≤ 0.10.

class. Against the background of future crises such as the climate crisis, which could at least temporarily influence the food supply negatively, the results of the LCA highlight the importance of raising awareness among the Swiss population to build up stocks according to governmental recommendations.

However, the results of the logistic regression indicate that compared with Class 1, "Informed and always following stockpiling recommendations of the government in normal times," Class 3, "Uninformed and rarely following stockpiling recommendation by the government in normal times," showed a lower probability of building up more food stocks than usual during the first lockdown in 2020. This finding implies that respondents belonging to Class 1 acted in a crisis such as the COVID-19 lockdown contrary to their knowledge and to their stockpiling habits in normal times. The fear-based stockpiling behaviour of Class 1 was reinforced during the first lockdown, causing food stockpiling to occur above the recommended level. Therefore, Class 1 might be at least partially responsible for the phenomenon of panic buying and the resulting empty supermarket shelves. However, our findings do not imply that governmental stockpiling recommendations should be abolished. Building up food and beverage stocks to be prepared for an emergency situation, such as a one-week power outage, is still necessary and important. Governmental information on stockpiling, especially targeting people who do not stockpile in normal times, is therefore indispensable.

The regression results further reveal that sociodemographic characteristics were only partly able to explain the decision of whether to stockpile food to a greater extent than usual during the first lockdown in 2020. Excessive stockpiling seems additionally to have been driven by psychological and purchasing-related factors. In particular, respondents who were very worried that certain food products would disappear off supermarket shelves entirely or would be in short supply stockpiled more food than usual, more so than respondents who were not worried. Moreover, respondents who decreased their shopping frequency during the first lockdown in 2020 showed a higher probability of building up more food stocks than usual as compared with respondents who maintained their shopping frequency.

In Switzerland and in many other developed countries, the food supply was at no time in danger during the first lockdown. Therefore, excessive food stockpiling can be considered an irrational and fear-based behaviour. Against this background, our findings highlight the necessity of intensified communication by policymakers and retailers, especially at the beginning of a crisis, to prevent panic buying of food and excessive stockpiling. In particular, communication in the beginning of a crisis should emphasise that stockpiling food and beverages according to governmental recommendations is sufficient. In this context, communication should additionally highlight that panic buying is an irrational and fear-based behaviour that should be avoided because it temporarily jeopardises food supply chains and food availability. Additionally, and maybe even more important and effective, governments should invest in education about the nature and drivers of panic buying in normal times to mitigate this phenomenon in a future crisis.

Future research should investigate why people follow governmental stockpiling recommendations in normal times. Furthermore, future research should analyse what kind of food is stockpiled in normal times and to which extent food stockpiling in normal times contributes to food waste. In addition, it would be interesting to investigate whether excessive food stockpiling in times of a crisis such as the COVID-19 pandemic led to additional food waste. Limitations of our study are the missing information on what kind of foods were excessively stockpiled and how much. Moreover, additional determinants of excessive stockpiling such as the existence of a storage room, the motivation of (excessive) stockpiling and whether a person was in quarantine during the first lockdown are missing in our regression model.

Declaration of competing interest

The authors declare that they have no conflict of interest.

Appendix

Table 5
Frequency distributions for variables used in the LCA including answer options with value = 98 and value = 99

	Description	Item values	Frequency
Item			
1	Do you know the recommendations of the FONES regarding stockpiling (per person: food stockpiling for one week and 9 L [one sixpack] of water or further non-alcoholic beverages)?	1 = Yes, already before the pandemic	314 (30.5%)
		2 = Yes, since the pandemic	165 (16.1%)
		3 = No	549 (53.4%)
2	Did you already build up household stocks of *food* according to the recommendations of the FONES before March 13?	1 = Yes, always	330 (32.1%)
		2 = Yes, mostly	391 (38.4%)
		3 = No	263 (25.6%)
		98 = I do not know	41 (4.0%)
		99 = I do not want to answer	3 (0.3%)
3	Did you already build up household stocks of *beverages* according to the recommendations of the FONES before March 13?	1 = Yes, always	250 (24.3%)
		2 = Yes, mostly	254 (24.7%)
		3 = No	480 (46.7%)
		98 = I do not know	40 (3.9%)
		99 = I do not want to answer	4 (0.4%)

Table 6
Frequency distributions for variables used in the regression analysis including answer options with value = 98 and value = 99

	Frequency
Binary dependent variable: Did you stockpile more food than usual between March 13 and April 26?	
1 = Yes, more stockpiling than usual	505 (49.1%)
0 = No, not more stockpiling than usual	523 (50.9%)
Gender (binary)	
1 = Men	502 (48.8%)
0 = Women	526 (51.2%)
Living environment (nominal)	
1 = Large city	203 (19.8%)
2 = Small or medium-sized city	381 (37.1%)
3 = Village	444 (43.2%)
Number of persons in household (min. = 1; max. = 5)	1,026 (99.8%)
99 = I do not want to answer	2 (0.2%)
Household income (ordinal)	
1 = Less than CHF 4,500	140 (13.6%)
2 = CHF 4,500 to CHF 6,000	189 (18.4%)
3 = CHF 6,001 to CHF 7,500	128 (12.5%)
4 = CHF 7,501 to CHF 9,000	130 (12.7%)
5 = CHF 9,001 to CHF 12,000	142 (13.8%)
6 = CHF 12,001 to CHF 15,000	82 (8.0%)
7 = More than CHF 15,000	52 (5.1%)
98 = I do not know	31 (3.0%)
99 = I do not want to answer	134 (13.0%)
Education (ordinal)	
1 = Compulsory education	39 (4.1%)
2 = Basic vocational education	360 (33.9%)
3 = Secondary school	178 (16.6%)
4 = Higher vocational education	168 (17.3%)
5 = University	275 (28.2%)
99 = I do not want to answer	8 (0.8%)
Language region (nominal)	
1 = German-speaking Switzerland	370 (37.0%)
2 = French-speaking Switzerland	455 (47.3%)
3 = Italian-speaking Switzerland	203 (15.7%)
Risk group (binary)	
1 = Yes	288 (28.0%)
2 = No	673 (65.5%)
98 = I do not know	63 (6.1%)
99 = I do not want to answer	4 (0.4%)
I was worried about not finding certain food (nominal)	
1 = Yes, very	79 (7.7%)

(*continued on next page*)

Table 6 (*continued*)

Binary dependent variable: Did you stockpile more food than usual between March 13 and April 26?	Frequency
2 = Yes, a little bit	369 (35.9%)
3 = No	577 (56.1%)
99 = I do not want to answer	3 (0.3%)
Utilisation take-away (binary)	
1 = Yes	576 (56.0%)
0 = No	452 (44.0%)
Utilisation home delivery service (binary)	
1 = Yes	399 (38.8%)
0 = No	629 (61.2%)
Changed shopping frequency (nominal)	
1 = No, the same frequency	393 (38.2%)
2 = Yes, more frequently	109 (10.6%)
3 = Yes, lower frequency	466 (45.3%)
4 = Someone else shops for me	47 (4.6%)
98 = I do not know	11 (1.1%)
99 = I do not want to answer	2 (0.2%)

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