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Eating behavior and food purchases during the COVID-19 lockdown: A cross-sectional study among adults in the Netherlands

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ABSTRACT

On March 15, 2020, the Dutch Government implemented COVID-19 lockdown measures. Although self-quarantine and social-distancing measures were implemented, restrictions were less severe compared to several other countries. The aim of this study was to assess changes in eating behavior and food purchases among a representative adult sample in the Netherlands (n = 1030), five weeks into lockdown. The results show that most participants did not change their eating behaviors (83.0%) or food purchases (73.3%). However, socio-demographic differences were observed among those that reported changes during lockdown. For example, participants with overweight (OR = 2.26, 95%CI = 1.24–4.11) and obesity (OR = 4.21, 95%CI = 2.13–8.32) were more likely to indicate to eat unhealthier during lockdown compared to participants with a healthy weight. Those with a high educational level (OR = 2.25, 95%-CI = 1.03–4.93) were also more likely to indicate to eat unhealthier during lockdown compared to those with a low educational level. Older participants were more likely to indicate to experience no differences in their eating behaviors compared to those of younger age, who were more likely to indicate that they ate healthier (OR = 1.03, 95%CI = 1.01–1.04) as well as unhealthier (OR = 1.04, 95%CI = 1.02–1.06) during lockdown. Participants with obesity were more likely to indicate to purchase more chips/snacks (OR = 2.79, 95%CI = 1.43–5.45) and more nonalcoholic beverages (OR = 2.74, 95%CI = 1.36–5.50) during lockdown in comparison with those with a healthy weight. Of those that used meal delivery services before, 174 (29.5%) indicated to use meal delivery services more frequently during lockdown. Although the results confirm the persistence of dietary routines, profound socio-demographic differences were observed for those that did report changes. Especially for individuals with overweight and obesity, the lockdown has taken its toll on healthy dietary choices. Further research should unravel underlying mechanisms for these observations.

1. Introduction

In 2020, the world has become a different place as COVID-19 (Coronavirus disease 2019) evolved from an isolated disease in the Wuhan region of China to a global pandemic (*AMJC, A Timeline of COVID-19 Developments in 2020*, 2020). Five weeks after confirmation that COVID-19 is transmittable from person to person, the first positive test for COVID-19 was confirmed in the Netherlands on February 27, 2020. On March 11, 2020, the WHO declared COVID-19 a pandemic, and not long after, many countries implemented measures to flatten the curve. On March 15, the Dutch Government implemented lockdown measures that were first in place for only a few weeks (until April 6, 2020). Not long after, these measures were extended until June 1st 2020 because number of deaths and hospitalizations of patients with

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COVID-19 remained increasing.

During the COVID-19 lockdown in the Netherlands, people were requested to work from home if possible, to avoid busy places, travel outside peak hours, stay at home and get tested when having symptoms of the virus (*Dutch Government, Approach and measures against the coronavirus*, 2020). Although self-quarantine and social-distancing measures were in place, restrictions were less severe compared to other countries. While Dutch participants were requested to stay at home as much as possible, they were allowed to go out for a walk or run while other citizens (e.g. Italy) were only allowed to go out for essential movement (groceries, healthcare, work) (*Italian Government, Coronavirus Covid-19 Italy*, 2020) or had to stay within their local area (*New Zealand Government, Alert system overview, Unite against COVID-19*, 2020). By means of their lockdown strategy, the Dutch government wanted to cushion the psychological, social and economic costs of social isolation, while containing the spread of the virus. Within this context, pubs and restaurants closed their doors while supermarkets and meal delivery services improved revenue (e.g. kantar.com) and local food shops like the butcher or bakery also remained open.

Already early in the pandemic, it was recognized that diet-related chronic conditions, such as cardiovascular disease, diabetes type 2, and obesity are major risk factors for being hospitalized for COVID-19, severe complications and mortality (Killerby et al., 2020; Li et al., 2020; Yadav et al., 2020). Primary measures taken by national governments during the pandemic aimed to eliminate the virus by transmission reduction via social distancing and hygiene measures. Less attention however has been directed to the potential lockdown side-effects such as unhealthy lifestyle behaviors that could even further increase those at risk. Nevertheless, prior studies indicated that self-quarantine has been associated with negative psychological effects such as psychological distress (Brooks et al., 2020). The COVID-19 lockdown has also been associated with more direct lifestyle behavior changes including increased smoking frequency (45%) among smokers (Sidor & Rzymski, 2020), both increased and decreased alcohol consumption (Anne et al., 2020; Kim et al., 2020) self-reported weight-gain in adults (e.g. due to snacking in response to food cues, stress or little sleep) (Zachary et al., 2020) and in younger adults (Sidor & Rzymski, 2020), increased consumption of unhealthy food, uncontrolled eating, snacking between meals and overall higher number of main meals (Ammar et al., 2020; Carroll et al., 2020; Sidor & Rzymski, 2020). Furthermore, it was observed that having a higher Body Mass Index (BMI) and lower age were associated with an increase in junk food consumption (Ashby, 2020; Di Renzo et al., 2020; Sidor & Rzymski, 2020) and that children with obesity increased their snack intake and sugary drinks during lockdown (Pietrobelli et al., 2020). In contrast, a Spanish study indicated that the lockdown measures led to the adoption of a healthier diet in an adult study population (Rodríguez-Pérez et al., 2020).

Whereas prior studies revealed mixed effects of the COVID-19 lockdown on eating behaviors, the impact on individual food purchase behaviors, including meal delivery, have been less frequently investigated. Zhao and colleagues indicated that most individuals in main land China continued purchasing food products (e.g. 80.1% of fruits and 77.2% of vegetables) via in-person grocery shopping (Zhao et al., 2020) and it was observed that online food shopping increased in Taiwan; every additional confirmed case of COVID-19 increased online sales by 5.7% and the number of customers by 4.9%. (Chang & Meyerhoefer, 2020). Italian insights indicated that the minority of participants used online delivery during lockdown (9%) although it was not observed how this changed compared to pre-lockdown (Di Renzo et al., 2020). Moreover, food purchasing trends indicated that households are stocking up energy dense, ultra-processed groceries (e.g. nielsen.com). However, less research is conducted on individual level changes and socio-demographic differences in food purchases during the lockdown.

To add to the literature and better understand the impact of the lockdown on changes in dietary behaviors and individual differences, the aim of this study was to examine self-reported eating behavior and food purchases during five weeks into the COVID-19 lockdown among a representative adult Dutch sample, and to assess socio-demographic differences in eating and food purchase behaviors.

2. Methods

2.1. Study design

In the present paper, secondary data analyses were conducted using cross-sectional online panel data collected by a panel agency (Flycatcher.eu) that has been performed in accordance with the declaration of Helsinki. The initial study was commissioned by the Netherlands Nutrition Centre, an independent organization funded by the Ministry of Economic Affairs and the Ministry of Public Health, Welfare & Sport. Descriptive outcomes (in Dutch) have been reported previously (Flycatcher, 2020). Members of the Flycatcher Panel registered voluntarily and gave explicit consent to be included in the Flycatcher Panel. Their participation in any survey is voluntary and panel members may terminate their panel membership at any time. After explaining the study details, participants could participate in the online survey which was not invasive and anonymous.

2.2. Procedure and data-collection

A nationwide representative sample living across the Netherlands was recruited by the panel agency. Based on the budget available while allowing a representative study sample at the same time, the aim was to reach a minimum sample size of 1000 respondents. Taken into account an expected response rate of 60–65%, an initial sample of 1598 respondents were randomly selected from the participant database of the panel agency (based on socio-demographic representativeness, e.g. age, sex, educational level) and invited by e-mail to take part in the survey. This email message included detailed information about the purpose of the study (e.g. aim, client, estimated time required for completion, number of points awarded upon completion of the entire questionnaire, information about anonymity). Respondents were invited between April 22–28, 2020 and were given seven days to complete the survey. A reminder email was sent to non-responders two days after the initial invitation. Inclusion criteria were being aged 18 years or older and currently living in the Netherlands. A final number of 1030 respondents completed the survey (response rate = 64%).

2.3. Measures

2.3.1. Socio-demographic characteristics

Age, sex, highest level of education, weight and height were assessed. Based on the Dutch educational system (Statistics Netherlands, 2018) three educational levels were defined high (university, college, higher vocational, general secondary, and intermediate vocational education), middle (general intermediate, and lower vocational education), and low (elementary education or less). Based on height and weight, BMI (weight (kg)/height $(m)^2$) and weight-status (healthy weight (BMI=<25), overweight (BMI = 25 < 30), obesity (BMI=>30)) were calculated.

2.3.2. Eating behavior

First, we assessed if participants indicated to eat healthy pre-lockdown on a five-point Likert scale (fully agree - full disagree). By means of three multiple choice questions, we assessed 1) if individuals found it *easier* or *more difficult than usual* to make healthy food choices, 2) if they ate *healthier* or *less healthy than usual* and 3) if they ate *less* or *more than usual,* during lockdown. Individuals could also indicate if they had *not* changed their eating behavior during lockdown in respect of these topics.

Among those participants that indicated to eat healthier or less healthy than usual, reasons for eating either healthier or less healthy

during lockdown were assessed by asking participants to indicate the two most important reasons from a pre-defined list (e.g., fewer temptations, being bored, see Table 2 for full list). Participants were also asked to indicate if they ate *in a different way than usual* during lockdown (with more awareness, taking more time, during different occasions, more often and snacking more frequently) using a five-point Likert scale, ranging from fully disagree (1) to fully agree (5). We calculated the number of participants that (fully) agreed on each of the items (score 4 or 5).

2.3.3. Food purchase behavior

First, we asked participants if they did the groceries for their household (being the gatekeeper) in the past weeks. If not at all (n = 156, 15.1%), participants were excluded from the analyses concerning food purchase behavior. Second, by means of a multiple-choice question we assessed if participants did groceries *more often* or *less often than usual* or if they did *not change* this frequency compared to pre-lockdown. We also assessed if participants ordered groceries online more frequently (yes/no) compared to pre-lockdown. Third, we assessed if participants more frequently purchased (yes/no) shelf-stable (e.g. preserved); frozen or ready-to-eat products compared to pre-lockdown. Also, it was assessed if participants changed the type of foods purchased by examining if they purchased *less* or *more* fruit, vegetables, fish, pastry/cake, candy/chocolate, chips/snacks, non-alcoholic drinks and alcoholic drinks during lockdown or if this was *as usual*. Lastly we assessed if participants used meal delivery services more often (yes/no) compared to pre-lockdown (including take-a-way), and if so, which products were *ordered more often than usual* deep-fried food (e.g., fries, deep-fried snacks); pizza; salad; sushi/poke bowl, wok-meals (e.g. rice, noodles), hamburgers or meals (unspecified) from local restaurants (yes/no).

2.4. Statistical analyses

Descriptive statistics were used to describe socio-demographic characteristics and eating and food purchase behavior. Multivariate multinomial logistic regression models were used to assess socio-demographic differences in eating and purchasing behavior were '*no change in eating or purchase behavior*' was included as reference category. Multivariate binary logistic regression models were used to assess differences in meals ordered for delivery. Odds Ratio's (OR) and their 95% confidence intervals were presented. Age, sex (male/female), educational level (low, mid, high) and weight-status (healthy-weight, overweight, obesity) were included as covariates in all models. Analyses were conducted using SPSS V 26.0. Statistical significance was defined as a two-tailed $P < 0.05$.

3. Results

3.1. Participants

Participants that completed the online survey (n = 1030) were on average 49.9 (SD 17.0) years old (range = 18-87y), almost half of the participants were men (49.5%) and the majority had a middle educational level (41.8%). In total 44.4% of the participants had a healthy weight and 55.6% of the participants had either overweight or obesity (Table 1).

Table 1
Descriptive statistics of socio-demographic characteristics of the study sample (n = 1030).

	N = 1030
Age (M, SD)	49.9 (17.0)
Sex, N (%).	
Female	520 (50.5)
Male	510 (49.5)
Educational level, N (%)	
Low	229 (29.0)
Middle	431 (41.8)
High	300 (29.1)
Body Mass Index, M (SD)	26.2 (5.0)
Weight status* N (%)	
Healthy weight	454 (44.4)
Overweight	392 (38.4)
Obesity	176 (17.2)
Difficulty of eating healthy during lockdown, N (%)	
No difference during lockdown	852 (82.7)
Easier to eat healthy during lockdown	67 (6.5)
More difficult to eat healthy during lockdown	111 (10.8)
Eating healthier or unhealthier during lockdown, N (%)	
No difference during lockdown	858 (83.3)
Eating healthier during lockdown	99 (9.6)
Eating unhealthier during lockdown	73 (7.1)
Eating more or less during lockdown, N (%)	
No difference during lockdown	854 (82.9)
Eating less during lockdown	84 (8.2)
Eating more during lockdown	92 (8.9)
Changes in eating style during lockdown ((fully) agree), N (%)[a]	
Ate on different times	174 (16.9)
Ate more frequently	146 (14.2)
Took more time for eating	196 (19.0)
Ate more sweets and snacks	228 (22.1)
Being more conscious of diet	155 (15.0)
Changes in frequency of doing groceries during lockdown, N (%)	
No change during lockdown	392 (44.9)
Less frequent during lockdown	440 (50.3)
More frequent during lockdown	42 (4.8)

*n = 8 missing.
M = mean, SD = standard deviation.
[a] number of participants that scored a 4 or 5 on a five-point Likert scale ranging from 1 to 5.

3.2. Eating behavior

Most of the participants perceived their regular food consumption (pre-lockdown) healthy (n = 834, 81.0%) whereas the smallest group (n = 30, 2.9%) indicated to eat unhealthily. A total of 166 participants (16.1%) were neutral about this.

3.2.1. The difficulty of making healthy food choices during lockdown

Most of the participants (82.7%) indicated that they did not find it *more difficult or easier than usual* to make healthier choices during lockdown, although a total of 111 participants (10.8%) indicated that they found it *more difficult than usual* to make healthy choices. Participants with overweight (OR = 2.13, 95%CI = 1.31–3.47) and obesity (OR = 3.23, 95%CI = 1.80–5.81) were more likely to indicate that they found it *more difficult than usual to make healthy food choices* during lockdown compared to those with a normal weight, Fig. 1. Also women were more likely to indicate to find it *more difficult than usual to make healthy choices* during lockdown (OR = 2.07, 95%CI = 1.33–3.23) compared to men. Older participants were more likely to indicate to experience *no differences* compared to those of younger age, that were more likely to indicate that they found it *easier than usual* (OR = 1.06, 95%CI = 1.04–1.08) as well as *more difficult than usual* (OR = 1.04, 95% CI = 1.03–1.06) to make healthy choices during lockdown than those of older age. No differences for educational level were observed.

3.2.2. Eating (un)healthier during lockdown

Most participants indicated that they did not change their diet during lockdown (83.3%) whereas 7.1% of the participants indicated that they ate more unhealthily during lockdown. Facing more unhealthy temptations at home (35.6%), more leisure time (31.5%) and being bored (21.9%) were the most frequently mentioned reasons for *eating unhealthier than usual* during lockdown. A total of 99 (9.6%) participants indicated that they ate healthier during lockdown. Most frequently mentioned reasons for *eating healthier than usual* during lockdown were a need to improve resistance (30.3%), more time/head space to prepare a healthy meal (30.3%) and more time/head space to be conscious about

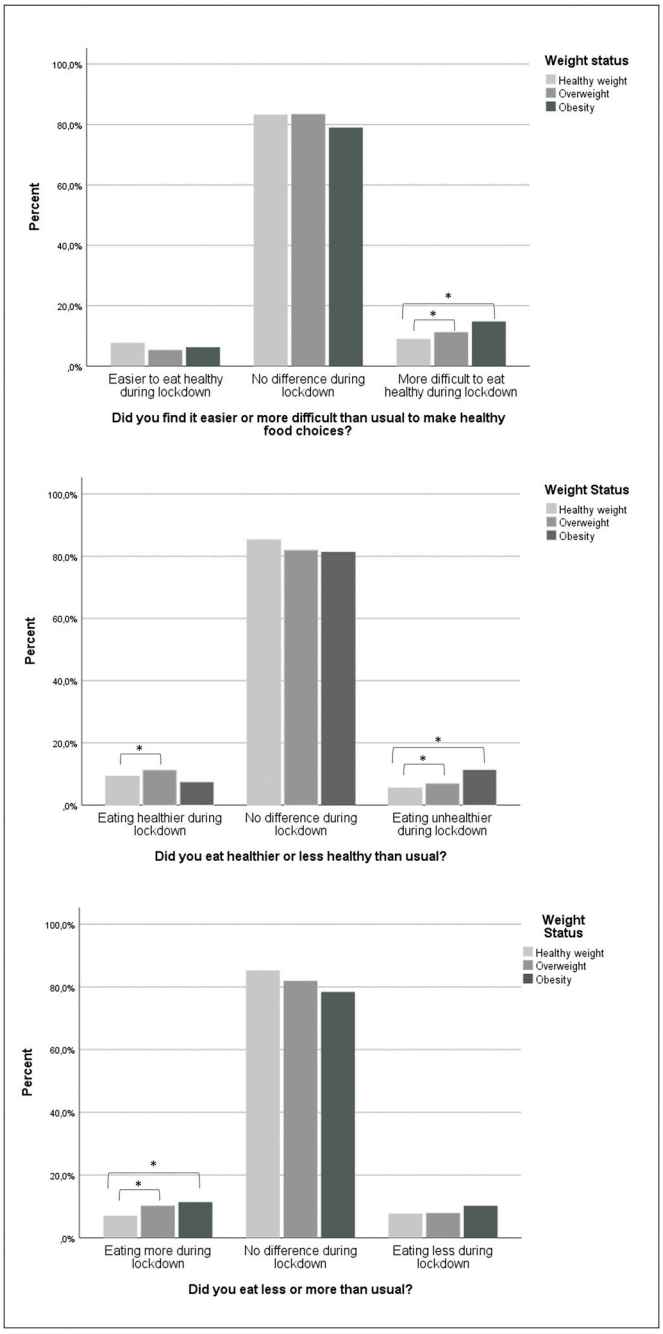

Fig. 1. Changes in eating behavior during lockdown, separated by weight status.

healthy nutrition (26.3%), Table 2.

Participants with overweight (OR = 2.26, 95%CI = 1.24–4.11) and obesity (OR = 4.21, 95%CI = 2.13–8.32) were more likely to indicate to *eat unhealthier than usual* during lockdown compared to participants with a healthy weight. However, participants with overweight were also more likely to indicate that they *ate healthier than usual* during lockdown (OR = 1,77, 95%CI = 1.09 = 2.86) compared to those with a healthy weight, Fig. 1.

Older participants were more likely to indicate to experience *no differences* compared to those of younger age, who were more likely to indicate that they *ate healthier than usual* (OR = 1.03, 95%CI = 1.01–1.04) as well as *unhealthier than usual* (OR = 1.04, 95%CI = 1.02–1.06) during lockdown.

Those with a high educational level (OR = 2.25, 95%-CI = 1.03–4.93) were more likely to indicate to *eat unhealthier than usual* during lockdown compared to those with a low educational level. Yet, participants with a high educational level (OR = 1.68, 95%CI = 1.02–2.74) were more likely to indicate that they *ate healthier than usual* during lockdown compared to those with a middle educational level. No differences between men and women were observed.

Table 2
Reasons for eating healthier or unhealthier during the COVID-19 lockdown.

Factors contributed to eating healthier during lockdown (n = 99)	*N*	%
Facing less unhealthy temptations at work (e.g. birthday treats)	17	17.2
Facing less unhealthy temptations at social events (e.g. cake at morning tea)	25	25.3
Facing less unhealthy temptations when going out for dinner (e.g. desert)	24	24.2
More time/head space to prepare a healthy meal	30	30.3
More time/head space to be conscious about healthy nutrition	26	26.3
Need to improve resistance	30	30.3
Media attention on the relationship between overweight and COVID-19 complications	6	6.1
Other reason	8	8.1
Factors contributed to eating unhealthier during lockdown (n = 73)	***N***	**%**
Facing more unhealthy temptations at home	26	35.6
More time/head space to prepare an extensive meal	4	5.5
More time/head space and opportunities to bake	14	19.2
More leisure time	23	31.5
More stress	14	19.2
Less social control	4	5.5
Less social contacts/feeling lonely	13	17.8
Being bored	16	21.9
Other reason	9	12.3

3.2.3. Eating more or less during lockdown

Most of the participants (82.9%) did not change the amount of food they consumed during lockdown, whereas 92 (8.9%) indicated *to eat more than usual* during lockdown. Participants with overweight (OR = 2.24, 95%CI = 1.34–3.76) and obesity (OR = 2.73, 95%CI = 1.45–5.15) were more likely to indicate that they *ate more than usual* during lockdown compared to participants with a healthy weight, Fig. 1. Older participants were more likely to indicate to experience *no differences* in the amount they ate during lockdown compared to younger participants, whereas those of younger age were more likely to indicate that they *ate more than usual* (OR = 1.61, 95%CI = 1.01–2.57) as well *as less than usual* (OR = 1.02, 95%CI = 1.01–1.04) during lockdown. Women (OR = 1.61, 95%CI = 1.01–2.57) also were more likely to indicate to *eat more than usual* during lockdown compared to men. Lastly, those with a lower educational level (OR = 2.17, 95%CI = 1.08–4.36) were more likely to indicate to *eat less than usual* during lockdown compared to those with a high educational level.

3.3. Purchase behavior

3.3.1. Frequency of food purchases during lockdown

A total number of 874 (84.9%) participants indicated to get groceries either in-store or online during lockdown and were included in the analyses. Of those participants, the majority indicated to *get groceries less often than usual* during lockdown (n = 440, 50.3%), Table 1. Younger participants (OR = 1.03, 95%CI = 1.00–1.05) were slightly more likely to *get groceries more often than usual* during lockdown than those being older. Women (OR = 1.45, 95%CI = 1.09–1.93) were more likely to indicate to *get groceries less often than usual* during lockdown than men. Participants with a high educational level were more likely to do groceries *less frequent than usual* during lockdown compared to those with a low (OR = 1.77, 95%CI = 1.17–2.67) and middle educational level (OR = 1.83, 95%CI = 1.30–2.58). No significant differences in the frequency of getting groceries for weight-status were observed. Only a small number of participants (n = 59, 6.8%) indicated that they got online groceries more often than usual, but no socio-demographic differences were observed.

3.3.2. Type of products purchased during lockdown

As presented in Table 3, the minority of participants indicated that they more frequently purchased shelf-stable products (17.7%) and frozen products (11.1%). The increased frequency was even lower for ready-to-eat products (3.1%). No socio-demographic differences were observed.

3.3.2.1. Healthy food purchases. Most participants indicated that they did not change the purchases of fruit, vegetables and fish during lockdown (Table 3). Yet, 15% of the participants indicated to purchase *more fruit than usual* during lockdown, whereas this was lower for vegetables (9.6%) and fish (6.3%). We observed no socio-demographic differences in fruit and vegetable purchases during lockdown. For fish purchases we observed that those of older age were more likely to indicate to purchase *more fish than usual* during lockdown (OR = 1.03, 95%CI = 1.01–1.05) compared to those that were younger. Those with a low (OR = 2.37, 95%CI = 1.11–5.04) and middle (OR = 2.35, 95%CI = 1.22–4.53) educational level were more likely to indicate to purchase *less fish than usual* during lockdown compared to those with a high educational level.

3.3.2.2. Unhealthy food purchases. Most participants did not change the purchases of sweets, snacks and beverages during lockdown (Table 3). Among those that did, participants with a high (OR = 2.93, 95%CI = 1.13–7.57) and middle educational level (OR = 3.33, 95%CI = 1.40–7.94)) were more likely to indicate to purchase *more pastry/cake than usual* compared those with a low educational level during lockdown. In line, participants with a high (OR = 4.83, 95%CI = 1.99–11.73) and middle (OR = 3.22, 95%CI = 1.37–7.58) educational level were also more likely to indicate to purchase *more sweets/chocolate* than usual compared to those with a low educational level during lockdown. Those with a middle educational level were more likely to indicate to purchase *less nonalcoholic beverages than usual* during lockdown (OR = 2.40, 95%CI = 1.06–5.41) compared to those with a high educational level. Those with a high educational level indicated more often to purchase *more alcoholic beverages than usual* (OR = 2.01, 95%CI = 1.01–3.99) during lockdown compared to those with a middle educational level whereas those with a middle educational level were more likely to indicate to purchase *less alcoholic beverages than usual* (OR = 2.37, 95%CI = 1.39–4.06) during lockdown compared to those with a high educational level. Younger participants were more likely to indicate to purchase *more* non-alcoholic beverages (OR = 1.02, 95%CI = 1.00–1.04) and alcoholic beverages (OR = 1.04, 95%CI = 1.01–1.06) during lockdown than usual compared those of older age. Women were more likely to indicate to purchase *more pastry/cake than usual* during lockdown (OR = 2.05, 95%CI = 1.16–3.63) than men. Men were more likely to indicate (OR = 1.53, 95%CI = 1.01–2.31) that they bought *less alcoholic beverages* during lockdown compared to women. Participants with obesity were more likely to indicate to purchase *more chips/snacks* (OR = 2.79, 95%CI = 1.43–5.45) and *more nonalcoholic beverages than usual* (OR = 2.74, 95%CI = 1.36–5.50) during lockdown in comparison with those with a healthy weight. Participants with overweight were also more likely to indicate to purchase *more* nonalcoholic beverages (OR = 2.09, 95%CI = 1.16–3.77) as well as *more alcoholic beverages than usual* (OR = 2.05, 95%CI = 1.02–4.11) during lockdown compared to those with a healthy weight.

Table 3
Food Purchases (n = 875) and meal delivery (n = 174) during the COVID-19 lockdown.

	Less than usual during lockdown	*As usual during lockdown*	More than usual during lockdown
Food Purchases (n = 875)			
Food types N (%)[a]			
Shelf-stable	*n/a*	*n/a*	155 (17.7)
Frozen products	*n/a*	*n/a*	98 (11.2)
Ready-to-eat	*n/a*	*n/a*	27 (3.1)
Healthy food products N (%)			
Fruit	41 (4.7)	702 (80.3)	131 (15.0)
Vegetables	29 (3.3)	762 (87.2)	83 (9.5)
Fish	83 (9.5)	736 (84.2)	55 (6.3)
Unhealthy food products N (%)			
Pastry/cake	131 (15.0)	681 (77.9)	62 (7.1)
Candy/chocolate	116 (13.3)	675 (77.2)	83 (9.5)
Chips/snacks	124 (14.2)	677 (77.5)	73 (8.4)
Non-alcoholic beverages	59 (6.8)	744 (85.1)	71 (8.1)
Alcoholic beverages	116 (13.3)	712 (81.5)	46 (5.3)
Meal delivery (n = 174), N (%)[a]			
Meal from a local restaurant	*n/a*	*n/a*	104 (59.8)
Pizza	*n/a*	*n/a*	61 (35.0)
Deep-fried food	*n/a*	*n/a*	40 (23.0)
Sushi or poke bowl	*n/a*	*n/a*	40 (23.0)
Wok-meal	*n/a*	*n/a*	30 (17.2)
Hamburgers	*n/a*	*n/a*	12 (6.9)
Salad	*n/a*	*n/a*	5 (2.9)

[a] N (%) participants that answered 'yes' on the question if this was more often purchased.

3.3.3. Meal delivery during lockdown

A total of 362 participants (41.4%) never used meal delivery pre-lockdown (incl. take-a-way) nor did during lockdown. Of those that used meal delivery services pre-lockdown, 174 (29.5%) indicated to use meal delivery services more *frequently than usual* during lockdown, whereas 122 (20.7%) used it *less frequently than usual* during lockdown. Most participants (n = 293, 49.7%) used meal-delivery services as usual during lockdown. Participants with a high educational level were more likely to indicate to use meal delivery *more frequently than usual* during lockdown (OR = 2.51, 95%CI = 1.34–4.67) than those with a lower educational level. Also, those of younger age were more likely to indicate to used meal delivery *more often than usual* than those participants of older age (OR = 1.02, 95%CI = 1.00–1.04). Further, no socio-demographic differences in meal delivery were observed.

Of the 174 participants that indicated to use meal delivery services more frequently, meals from local restaurants (n = 104, 59.8%) were most often ordered, followed by pizza (n = 61, 35.0%, Table 3). Participants with overweight (OR = 5.23, 95%CI = 1.82–15.0) and a healthy weight (OR = 3.57, 95%CI = 1.28–9.91) were more likely to indicate to order meals from a local restaurant *more often than usual* during lockdown than those with obesity. Participants with obesity were more likely to indicate to order pizza (OR = 2.88, 95%CI = 1.09–7.60) as well as deep-fried food (OR = 3.29, 95%CI = 1.15–9.46) *more often than usual* compared to those with a healthy weight. Younger participants (OR = 1.03, 95%CI = 1.00–1.06) were more likely to indicate to order deep-fried food *more often than usual* compared to older participants whereas older participants were more likely to indicate to order a meal from a local restaurant *more often than usual* (1.04, 95%CI = 1.02–1.07) than the younger participants. Participants with a low (OR = 7.55, 95%CI = 2.26–25.2) and middle (OR = 2.47, 95%CI = 1.04–5.87) educational level were more likely to indicate to order deep-fried food *more often than usual* compared to those with a high educational level. Women were more likely to indicate to order meals from a local restaurant *more often than usual* than men (OR = 2.38, 95%CI = 1.15–4.93). No socio-demographic differences were observed in the frequency of the delivery of sushi/poke-bowl and wok-meals. (Salad and hamburgers excluded from analyses due to small numbers, Table 3).

4. Discussion

The aim of the present research was to examine changes in eating behavior and food purchases during the COVID-19 lockdown among Dutch adults and to examine socio-demographic differences. Most participants indicated to not have changed their eating behavior or food purchases during the lockdown. However, substantial socio-

demographic differences were observed among those that did report changes. Younger participants more often indicated to change their eating behavior during lockdown compared to older participants. Especially participants with overweight and obesity indicated more often to find it harder than usual to make healthy choices, indicated that they ate more food in general, ate less healthy food and purchased more savory snacks and (non-)alcoholic beverages. Also, those with a higher educational level indicated more often to buy more sweets than usual during lockdown. Finally, women also indicated more often that they found it harder than usual to make healthy food choices compared to men.

4.1. The persistence of dietary routines

Most participants did not indicate to have changed their eating behaviors and food purchases five weeks into the COVID-19 lockdown. This stresses the perseverance of dietary routines (healthy or unhealthy) that are hard to change. Prior research showed that habits are strong predictors of eating behavior (van't Riet et al., 2011; Verhoeven et al., 2012) and can explain approximately 20% of the variation in dietary behaviors (Gardner et al., 2011). The current study shows that despite the changes in daily life and pandemic stressors, most people retained their routinized dietary behaviors. Also, earlier studies showed limited effects of individual attempts (e.g., educational interventions) to change dietary behavior (de Ridder et al., 2017). In the current study sample, the pandemic 'only' encouraged 30 participants (2.9%) to eat healthier during lockdown to improve their resilience, and 6 participants (0.60%) to eat healthier due to the relationship between overweight and COVID-19 complications. Yet, despite the finding that most participants did not change their behavior, general population level intake of high-processed energy dense products is still too high and the intake of fresh nutritious foods too low (National Institute for Public Health and the Environment, 2016). To illustrate, the average Dutch population currently consumes 113 g fruit and 131 g vegetables instead of the recommended 200 g and 250 g successively, per day (Netherlands Nutrition Centre, 2017). Also, approximately half of the Dutch adult population is overweight or obese (National Institute for Public Health and the Environment, 2019). As diet-related conditions like obesity are a major risk factor for being hospitalized for COVID-19, changing dietary patterns would benefit the resilience of the population in future. Attempts supporting individuals to eat healthier as well as wider food system changes to promote healthy diets are urgently needed (Swinburn et al., 2019).

4.2. Nationwide consequences of dietary changes during lockdown

A considerable number of participnats changed their eating behavior and food purchases during lockdown. To illustrate, 7.1% of the participants indicated to eat less healthy during the lockdown. Translating this figure to a nation-wide sample of 18–87 year in the Netherlands (Statistics Netherlands, 2020), this would result in 950.000 adults eating less healthy because of the lockdown. This would have severe potential public health consequences including weight gain and increased risk for non-communicable diseases like diabetes type 2 or cardiovascular diseases. It should however be acknowledged that a slightly larger part of the participants indicated to improve their food intake during the lockdown (9.6%) which would have positive public health consequences. Nevertheless, predominantly among those that ate less healthy during lockdown, substantial socio-demographic differences were observed.

Approximately 7% of the sample that was responsible for doing groceries indicated to that they ordered their groceries more frequently online than usual. This is slightly lower than the figure observed in Italy (9%) (Di Renzo et al., 2020) but much lower than the online food ordering figures during the pandemic observed in Asia (Chang & Meyerhoefer, 2020; Zhao et al., 2020). These increases in online food ordering may on the one hand related with the request to stay at home as much as possible (for which food delivery is extremely suitable) but it may also be related with fears for being infected in places like shops (Gerhold, 2020). While globally online shopping grew extensively, future trends will show how the current pandemic will change our way of shopping permanently.

4.3. Age differences and daily routine

We observed that eating behaviors of older participants were less likely to be impacted by the lockdown compared to younger participants, which is in line with earlier observations during the COVID-19 pandemic (Di Renzo et al., 2020). Since 23% of the participants was 65 years and older (up to 87 years old) it is reasonable to assume that their daily routines during lockdown were less divergent than usual compared those in the studying or working age group (The Netherlands Institute for Social Research, 2019). A recent study in the Netherlands indicated that 80% reduced outdoor activities and 44% worked from home during the lockdown (de Haas et al., 2020). Those in the studying and working age group (18–65) suddenly had to combine work activities with homeschooling or other caring task (e.g., causing time-stress, risk for parental burn-out (Griffith, 2020)), were faced with job losses (e.g., causing financial insecurity and mental stress), were not able to go to school/university whereas some of the working group also obtained more leisure time (e.g. inability to work, no commuting time), all of which deviates from usual routines. We observed that 17% of the participants ate at different times and 14% indicated to eat more frequently, demonstrating some participants also differentiate their daily dietary routines during lockdown. Such deviations from daily routines are also a common during vacation and holidays, which have been found related to weight gain in adults (Cooper & Tokar, 2016; Stevenson et al., 2013).

4.4. Overweight and obesity differences

Most noticeable was that participants with overweight and obesity were more likely to indicate to find it more difficult to make healthy choices, ate unhealthier, ate more and purchased or ordered more unhealthy products and meals than usual during lockdown, compared to those with a healthy weight. To illustrate, participants with obesity were more likely to indicate to purchase chips and snacks, non-alcoholic beverages and ordered pizza or deep-fried foods more often than usual compared to those with a healthy weight. Our findings are in line with other research during the COVID-19 pandemic that found a positive relationship between obesity and weight gain after one month of self-quarantine (Pellegrini et al., 2020). A psychological explanation for the association between obesity and unhealthy eating during lockdown could be that it is moderated by stress. Indeed, stress is a common psychological reaction to the pandemic (Rajkumar, 2020). Stress is also associated with obesity, and the neurobiology of stress overlaps significantly with that of appetite and energy regulation (Sinha & Jastreboff, 2013). Moreover, people with obesity are more prone to stress-induced eating, compared to healthy controls (Cotter & Kelly, 2018). Elevated stress levels due to the pandemic may therefore translate into more unhealthy eating engagement among this group. It could also be speculated that people with overweight and obesity are more concerned about their dietary intake due to overweight preoccupation (Annis et al., 2004) and therefore be more sensitive to notice changes in their eating behavior than those with a healthy weight and be quicker to self-report to find it more difficult to eat healthy due to changed daily routines.

However, it was also observed that a group of participants with overweight were significantly more likely to indicate to eat healthier during lockdown than those with a healthy weight. Although one could speculate that improving resilience or the attention on the relationship between overweight and COVID-19 and complications could explain these outcomes, we could not support this based on additional explorative analyses; 33.3% of individuals with a healthy weight indicated to

eat healthier to improve resilience, whereas this was 27.3% of those with overweight. Yet, facing less food temptations at work (58.8% vs 29.4%), on-the-go (53.3% vs. 33.3%) and at social events (60.0% vs. 36.0%) were more often indicated as one of the two main reason for eating healthier during lockdown by this group of participants with overweight. These assumptions should however be interpreted with caution and follow-up studies are needed to better understand underlying mechanisms why some individuals with overweight eat healthier while some others unhealthier under lockdown circumstances.

4.5. Educational level differences

It was noticeable that those with a high educational level more frequently reported to eat less healthy and to purchase more sweet snacks (pastries, chocolate) during lockdown compared to those with a low educational level, and to purchase more alcoholic beverages during lockdown compared to those with a middle educational level. In general, those with a higher educational level eat healthier and drink more alcoholic beverages than individuals with a lower educational level (Dijkstra et al., 2018). A recent cluster-analysis study from France indicated that participants with a high educational level were more likely to work from home as a result of the lockdown and were more likely to change their eating behaviors (Deschasaux-Tanguy et al., 2020) whereas those that kept working outside of their home (including less qualified jobs) or those with no professional activity were less likely to change their dietary behaviors. We observed a similar pattern in our sample (data not reported), where approximately 9% of the participants with both a high and low educational level worked '(almost) always from home' pre-lockdown, whereas this proportion increased to 56.5% for those with a high educational level and to 13.9% for those with a low educational level during lockdown. Therefore, the likelihood of eating unhealthier due to changed daily routines (as outlined in 4.3) is higher for those with a high educational level than for participants with a low educational level.

Those with a high educational also indicated to use meal delivery services more frequently during lockdown than those with a low educational level. As those with a higher educational level are more likely to go out for dinner usually (Lachat et al., 2012), the lockdown might have reinforced to get the restaurant "at home", especially due to online campaigns supporting local restaurants and food services during the lockdown. Yet, when using meal delivery services, participants with a higher educational level were less likely than those with a low and middle educational level to order more deep-fried food during lockdown.

Those with a low educational level were more likely to indicate to eat less than usual compared to participants with a high educational level. Prior research indicates that food-insecurity increased since the corona crisis (Loopstra, 2020; Wolfson & Leung, 2020). A UK study found that especially those with a drop in income were more likely to experience food insecurity during the corona crisis (Loopstra, 2020) which includes eating less by skipping meals or not eating for a whole day. As individuals with low educational levels are more likely to experience larger employment losses due to the corona crisis than those with high educational levels (Cho & Winters, 2020), this could be a potential mechanism explaining this outcome.

4.6. International comparisons

Compared to other countries, the Dutch lockdown was less constraining. For example, in comparison with the Italy where individual movement was restricted except for the necessity, health or work, Dutch citizens were requested to stay at home as much as possible, but were able to go out for a walk or run (*Dutch Government, Approach and measures against the coronavirus*, 2020; *Italian Government, Coronavirus Covid-19 Italy*, 2020). In an Italian study, Di Renzo et al. indicated that 46.1% of the participants not changed their lifestyle behaviors and 37.4% and 35.8% of the Italian participants declared to eat more or less healthy food (Di Renzo et al., 2020). These figures are much higher than the observations in our Dutch sample, with for example 15.0% and 4.5% of the participants indicating to eat more or less fruits, subsequently. In addition, where we observed that the majority of Dutch participants did not eat (un)healthier or more during lockdown, over half of the participants in a Canadian study indicated to change their eating behavior; e.g. 57% of woman indicated to eat more during lockdown and 67% women indicated to eat more snack foods (Carroll et al., 2020). Sidor and Rzymski indicated that over 43% and more than 50% of participants in Poland reported to eat and snack more. These figures are also higher than that we observed in our Dutch sample (e.g. 8.9% indicated to eat more). Ruiz-Roso and colleagues observed that adolescents in Spain Chile Colombia and Brazil increased fruit (+7.7 percent point (pp)) and vegetable (+7.8 pp) intake as well as increased fried (1.4 pp) and sweet food intake (+6.7 pp). While we did not include adolescents, we observed that 15% indicated to have purchased more fruit, 9.5% more vegetables, 9.5% more candy/chocolate. 23% indicated to order deep-fried food more often. These figures are slightly more in line with our findings than those of the Italian, Canadian and Polish study findings. Nevertheless, our observation that the lockdown was more likely to take a toll on healthy dietary choices of participants with obesity has been observed in a variety of international studies (Ashby, 2020; Di Renzo et al., 2020; Sidor & Rzymski, 2020). All together these findings suggest that different lockdown strategies implemented in different countries have influenced eating behaviors differently. Further research should unravel how different lockdown measures impacted these supposed differences, taking both socio-cultural factors and the severity of the coronavirus in the country of concern into account.

4.7. Strengths and limitations of the study

Strengths of the study include the large study sample, generalizability of the study sample, the included survey items explicitly asking for differences in eating and purchase behavior as compared to pre-lockdown and that the study was timed in week five of the lockdown (and thus not retrospective). Limitations of the study include the cross-sectional character and the use of unvalidated measures to assess eating and food purchasing behavior. Also, all outcome measures were self-reported. This may have caused bias by expressing participants' ideas rather than their actual behavior. For example, the participants may have had different perceptions of healthy food and a healthy diet rather than their actual behavior, which may have caused bias as well. While 81% of the participants of this study indicated that they ate rather healthy pre-lockdown, national studies into food consumption using 24h recalls indicate that this percentage is much lower (e.g. only 6% of the population meats daily vegetable recommendations (*Institute for Health and Environment, Food consumption compared to the wheel of five 2012/14–2016*, 2017). Moreover, using self-reported BMI as proxy for weight status may have bias the outcomes (Dekkers et al., 2008). This is however a common limitation in the field of behavioral nutrition research which uses surveys that measures dietary behavior and will be common in comparable COVID-19 related studies that predominantly relied on self-reported survey studies.

4.8. Recommendations for practice and future research

Parallel to fighting the coronavirus and eliminating the COVID-19 pandemic it is important to implement actions and interventions encouraging a healthy diet to support individuals to get into a healthy lifestyle routine, especially among vulnerable groups (e.g. individuals with obesity). Not only are diet related non-communicable diseases like obesity associated with increased risk for severe illness or death from COVID-19, our study also indicates a higher risk for unhealthy eating behavior for the same group under lockdown circumstances. Besides, the pandemic has confronted us with the fragility of the food system (e.g.

disruptions of the global food chains and empty supermarket shelves) (Hobbs, 2020). Supporting a healthy diet should be approached from a socio-ecological perspective by not only encouraging individuals to eat well-balanced meals but also improving the food system on the global, national and community level, also addressed in the multi-level framework of action to support nutrition and food security during the COVID-19 pandemic (Naja & Hamadeh, 2020). For example, the COVID-19 pandemic provides urban planners with the opportunity to support the development of rebalanced and healthier local food systems, reducing reliance on national supermarkets (Cummins et al., 2020). The increase upsurge of online food purchases during the pandemic also observed in the current study may reassure retailers to improve web shops to encourage customers to get healthier groceries (Jilcott Pitts et al., 2018) or boost local restaurants to offer healthier meal delivery options, especially since the current meal delivery scape is not supportive in this (Poelman et al., 2020). Such community environmental improvements, together with global, national and individual efforts could support healthy eating behaviours needed to improve resilience of the population during the current crisis, but also in the future. In the upcoming months or years (depending on the course of the virus and its impact on society) it is important to monitor the consequences of the virus and the lockdown on peoples' eating and food behaviors as well as health status, especially among the most vulnerable groups. In addition, underlying mechanisms of the impact of the lockdown on diet should be further understood. At last, actions that support a sustained and healthier food system and environmentshould be studied and implemented.

5. Conclusion

Most participants did not change their eating behavior or food purchases during lockdown, confirming the persistence of dietary routines. However, profound socio-demographic differences were observed for those that did report changes. Especially for individuals with overweight and obesity, the lockdown has taken its toll on healthy dietary choices. Because diet-related conditions are a major risk factor for being hospitalized for COVID-19, this study indicates that the pandemic may even further challenge public health. More research should unravel underlying mechanisms for these observations while at the same time sustained and healthier food systems are needed to improve resilience of the population in the current and future pandemics.

Author contributions

MP analysed the data and wrote the manuscript. FM, ED, PA designed the online survey and ED and PA collected the data. All authors read and provided input and critical feedback on the manuscript before approving.

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Ethical statement

As this study involved secondary data analyses of data that was initially collected by the Netherlands Nutrition Centre, no approval from an ethics committee prior to the reported study was obtained. However, the data collection was not invasive (online survey about eating behavior) and is in line with the ethical standards of the involved universities. Therefore, we report the following in the manuscript:

Data collection has been performed in accordance with the declaration of Helsinki. After explaining the study details, participants could participate in the online survey which was not invasive and anonymous, but signed informed consent was not obtained.

Declarations of competing interest

None.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.appet.2020.105002.

References

AMJC. (2020). *A timeline of COVID-19 developments in 2020*. https://www.ajmc.com/view/a-timeline-of-covid19-developments-in-2020.

Ammar, A., Brach, M., Trabelsi, K., Chtourou, H., Boukhris, O., Masmoudi, L., Bouaziz, B., Bentlage, E., How, D., Ahmed, M., Müller, P., Müller, N., Aloui, A., Hammouda, O., Paineiras-Domingos, L. L., Braakman-Jansen, A., Wrede, C., Bastoni, S., Pernambuco, C. S., & Hoekelmann, A. (2020). Effects of COVID-19 home confinement on eating behaviour and physical activity: Results of the ECLB-COVID19 international online survey. *Nutrients, 12*(6), 1583. https://doi.org/10.3390/nu12061583

Anne, K., Ekaterini, G., Falk, K., & Thomas, H. (2020). Did the general population in Germany drink more alcohol during the COVID-19 pandemic lockdown? *Alcohol and Alcoholism, 2020*, 1–2. https://doi.org/10.1093/alcalc/agaa058

Annis, N. M., Cash, T. F., & Hrabosky, J. I. (2004). Body image and psychosocial diffrences among stable average weight, currently overweight, and formerly overweight women: The role of stigmatizing experiences. *Body Image, 1*(2), 155–167. https://doi.org/10.1016/j.bodyim.2003.12.001

Ashby, N. J. S. (2020). Impact of the COVID-19 pandemic on unhealthy eating in populations with obesity. *Obesity, oby, 22940*. https://doi.org/10.1002/oby.22940

Brooks, S. K., Webster, R. K., Smith, L. E., Woodland, L., Wessely, S., Greenberg, N., & Rubin, G. J. (2020). The psychological impact of quarantine and how to reduce it: Rapid review of the evidence. *The lancet* (Vol. 395,(10227), 912–920. https://doi.org/10.1016/S0140-6736(20)30460-8. Lancet Publishing Group.

Carroll, N., Sadowski, A., Laila, A., Hruska, V., Nixon, M., Ma, D. W. L., & Haines, J. (2020). The impact of COVID-19 on health behavior, stress, financial and food security among middle to high income Canadian families with young children. *Nutrients, 12*(8), 2352. https://doi.org/10.3390/nu12082352

Centre, N. N. (2017). *The Wheel of Five is the practical information tool used by The Netherlands Nutrition Centre to*.

Chang, H.-H., & Meyerhoefer, C. (2020). COVID-19 and the demand for online food shopping services: Empirical evidence from taiwan. *NBER Working Paper No. 27427*. https://doi.org/10.3386/w27427

Cho, S. J., & Winters, J. V. (2020). The distributional impacts of early employment losses from COVID-19. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.3602755

Cooper, J. A., & Tokar, T. (2016). A prospective study on vacation weight gain in adults. *Physiology & Behavior, 156*, 43–47. https://doi.org/10.1016/j.physbeh.2015.12.028

Cotter, E. W., & Kelly, N. R. (2018). Stress-related eating, mindfulness, and obesity. *Health Psychology, 37*(6), 516–525. https://doi.org/10.1037/hea0000614

Cummins, S., Berger, N., Cornelsen, L., Eling, J., Er, V., Greener, R., Kalbus, A., Karapici, A., Law, C., Ndlovu, D., & Yau, A. (2020). *COVID-19: Impact on the urban food retail system and dietary inequalities in the UK* (Vol. 00). Cities & Health. https://doi.org/10.1080/23748834.2020.1785167

Dekkers, J. C., Van Wier, M. F., Hendriksen, I. J. M., Twisk, J. W. R., & Van Mechelen, W. (2008). Accuracy of self-reported body weight, height and waist circumference in a Dutch overweight working population. *BMC Medical Research Methodology, 8*(1), 1–13. https://doi.org/10.1186/1471-2288-8-69

Deschasaux-Tanguy, M., Druesne-Pecollo, N., Esseddik, Y., Szabo de Edelenyi, F., Alles, B., Andreeva, V. A., Baudry, J., Charreire, H., Deschamps, V., Egnell, M., Fezeu, L. K., Galan, P., Julia, C., Kesse-Guyot, E., Latino-Martel, P., Oppert, J.-M., Peneau, S., Verdot, C., Hercberg, S., & Touvier, M. (2020). *Diet and physical activity during the COVID-19 lockdown period (March-May 2020): Results from the French NutriNet-sante cohort study. MedRxiv, June, preprint.* https://doi.org/10.1101/2020.06.04.20121855

Di Renzo, L., Gualtieri, P., Pivari, F., Soldati, L., Attinà, A., Cinelli, G., Cinelli, G., Leggeri, C., Caparello, G., Barrea, L., Scerbo, F., Esposito, E., & De Lorenzo, A. (2020). Eating habits and lifestyle changes during COVID-19 lockdown: An Italian survey. *Journal of Translational Medicine, 18*(1), 229. https://doi.org/10.1186/s12967-020-02399-5

Dijkstra, S. C., Neter, J. E., Brouwer, I. A., Huisman, M., Visser, M., Van Lenthe, F. J., & Kamphuis, C. B. M. (2018). Socio-economic differences in the change of fruit and vegetable intakes among Dutch adults between 2004 and 2011: The GLOBE study. *Public Health Nutrition, 21*(9), 1704–1716. https://doi.org/10.1017/S1368980017004219

Dutch Government. (2020). *Approach and measures against the coronavirus*. https://www.rijksoverheid.nl/onderwerpen/coronavirus-covid-19/nederlandse-maatregelen-tegen-het-coronavirus.

Flycatcher. (2020). *Eetgedrag en corona*. https://www.voedingscentrum.nl/Assets/Uploads/voedingscentrum/Documents/Professionals/Pers/Persmappen/Rapportage - Eetgedrag en corona (mei 2020).pdf.

Gardner, B., de Bruijn, G.-J., & Lally, P. (2011). A systematic review and meta-analysis of applications of the self-report habit Index to nutrition and physical activity behaviours. *Annals of Behavioral Medicine, 42*(2), 174–187. https://doi.org/10.1007/s12160-011-9282-0

Gerhold, L. (2020). *COVID-19: Risk perception and Coping strategies*. https://doi.org/10.31234/osf.io/xmpk4

Griffith, A. K. (2020). Parental burnout and child maltreatment during the COVID-19 pandemic. In *Journal of family violence* (pp. 1–7). Springer. https://doi.org/10.1007/s10896-020-00172-2.

de Haas, M., Faber, R., & Hamersma, M. (2020). How COVID-19 and the Dutch 'intelligent lockdown' change activities, work and travel behaviour: Evidence from longitudinal data in The Netherlands. *Transportation Research Interdisciplinary Perspectives, 6*, 100150. https://doi.org/10.1016/j.trip.2020.100150

Hobbs, J. E. (2020). Food supply chains during the COVID-19 pandemic. *Canadian Journal of Agricultural Economics/Revue Canadienne d'agroeconomie, 68*(2), 171–176. https://doi.org/10.1111/cjag.12237

Institute for Health and Environment. (2017). *Food consumption compared to the wheel of five 2012/14 -2016*. https://www.rivm.nl/documenten/voedselconsumptie-in-2012-2014-vergeleken-met-schijf-van-vijf-2016.

Italian Government. (2020). *Coronavirus covid-19 Italy*. http://www.governo.it/it/coronavirus.

Jilcott Pitts, S. B., Ng, S. W., Blitstein, J. L., Gustafson, A., & Niculescu, M. (2018). Online grocery shopping: Promise and pitfalls for healthier food and beverage purchases. *Public health nutrition* (Vol. 21,(18), 3360–3376. https://doi.org/10.1017/S1368980018002409. Cambridge University Press.

Killerby, M. E., Link-Gelles, R., Haight, S. C., Schrodt, C. A., England, L., Gomes, D. J., Shamout, M., Pettrone, K., O'Laughlin, K., Kimball, A., Blau, E. F., Burnett, E., Ladva, C. N., Szablewski, C. M., Tobin-D'Angelo, M., Oosmanally, N., Drenzek, C., Murphy, D. J., Blum, J. M., & Wong, K. K. (2020). Characteristics associated with hospitalization among patients with COVID-19 — metropolitan atlanta, Georgia, march–april 2020. *MMWR. Morbidity and Mortality Weekly Report, 69*(25), 790–794. https://doi.org/10.15585/mmwr.mm6925e1

Kim, J. U., Majid, A., Judge, R., Crook, P., Nathwani, R., Selvapatt, N., Lovendoski, J., Manousou, P., Thursz, M., Dhar, A., Lewis, H., Vergis, N., & Lemoine, M. (2020). Effect of COVID-19 lockdown on alcohol consumption in patients with pre-existing alcohol use disorder. *The lancet gastroenterology and hepatology* (Vol. 5,(10), 886–887. https://doi.org/10.1016/S2468-1253(20)30251-X. Elsevier Ltd.

Lachat, C., Nago, E., Verstraeten, R., Roberfroid, D., Van Camp, J., & Kolsteren, P. (2012). Eating out of home and its association with dietary intake: A systematic review of the evidence. *Obesity reviews* (Vol. 13,(4), 329–346. https://doi.org/10.1111/j.1467-789X.2011.00953.x. John Wiley & Sons, Ltd.

Li, X., Guan, B., Su, T., Liu, W., Chen, M., Bin Waleed, K., Guan, X., Gary, T., & Zhu, Z. (2020). Impact of cardiovascular disease and cardiac injury on in-hospital mortality in patients with COVID-19: A systematic review and meta-analysis. *Heart, 106*(15), 1142–1147. https://doi.org/10.1136/heartjnl-2020-317062

Loopstra, R. (2020). *Vulnerability to food insecurity since the COVID-19 lockdown Preliminary report*. https://ukdataservice.ac.uk/.

Naja, F., & Hamadeh, R. (2020). Nutrition amid the COVID-19 pandemic: A multi-level framework for action. In *European journal of clinical nutrition* (pp. 1–5). Springer Nature. https://doi.org/10.1038/s41430-020-0634-3.

National Institute for Public Health and the Environment. (2016). *VCP 2012-2016, 1-79 jaar - RIVM*. http://www.rivm.nl/Onderwerpen/V/Voedselconsumptiepeiling/Overzicht_voedselconsumptiepeilingen/VCP_Basis_1_79_jaar_2012_2016.

National Institute for Public Health and the Environment. (2019). *Overgewicht | cijfers & context | huidige situatie | Volksgezondheidenzorg.info*. https://www.volksgezondheidenzorg.info/onderwerp/overgewicht/cijfers-context/huidige-situatie#!node-overgewicht-volwassenen.

New Zealand Government. (2020). *Alert system overview, Unite against COVID-19*. https://covid19.govt.nz/alert-system/alert-system-overview/#alert-level-4-%97-lockdown.

Pellegrini, M., Ponzo, V., Rosato, R., Scumaci, E., Goitre, I., Benso, A., Belcastro, S., Crespi, C., De Michieli, F., Ghigo, E., Broglio, F., & Bo, S. (2020). Changes in weight and nutritional habits in adults with obesity during the "lockdown" period caused by the COVID-19 virus emergency. *Nutrients, 12*(7). https://doi.org/10.3390/nu12072016, 2016.

Pietrobelli, A., Pecoraro, L., Ferruzzi, A., Heo, M., Faith, M., Zoller, T., Antoniazzi, F., Piacentini, G., Fearnbach, S. N., & Heymsfield, S. B. (2020). Effects of COVID-19 lockdown on lifestyle behaviors in children with obesity living in verona, Italy: A longitudinal study. *Obesity, 28*(8), 1382–1385. https://doi.org/10.1002/oby.22861

Poelman, M. P., Thornton, L., & Zenk, S. N. (2020). A cross-sectional comparison of meal delivery options in three international cities. *European Journal of Clinical Nutrition*, 1–9. https://doi.org/10.1038/s41430-020-0630-7

Rajkumar, R. P. (2020). COVID-19 and mental health: A review of the existing literature. *Asian Journal of Psychiatry, 52*, 102066. https://doi.org/10.1016/j.ajp.2020.102066

de Ridder, D., Kroese, F., Evers, C., Adriaanse, M., & Gillebaart, M. (2017). Healthy diet: Health impact, prevalence, correlates, and interventions. *Psychology and Health, 32*(8), 907–941. https://doi.org/10.1080/08870446.2017.1316849

Statistics Netherlands. (2019). Trends in the Netherlands 2018; Education, figures, society. https://longreads.cbs.nl/trends18/maatschappij/cijfers/onderwijs/.

Statistics Netherlands. (2020). Population; sex, age and marital status. January 1st https://opendata.cbs.nl/statline/#/CBS/nl/dataset/7461BEV/table?fromstatweb.

The Netherlands Institute for Social Research. (2019). *Time use in The Netherlands*. The Netherlands Institute for Social Research 2019. edition 2. Publication https://english.scp.nl/publications/publications/2019/07/24/time-use-in-the-netherlands-edition-2.

van't Riet, J., Sijtsema, S. J., Dagevos, H., & de Bruijn, G. J. (2011). The importance of habits in eating behaviour. An overview and recommendations for future research. *Appetite, 57*(3), 585–596. https://doi.org/10.1016/j.appet.2011.07.010

Rodríguez-Pérez, C., Molina-Montes, E., Verardo, V., Artacho, R., García-Villanova, B., Guerra-Hernández, E. J., & Ruíz-López, M. D. (2020). Changes in dietary behaviours during the COVID-19 outbreak confinement in the Spanish COVIDiet study. *Nutrients, 12*(6), 1730. https://doi.org/10.3390/nu12061730

Sidor, A., & Rzymski, P. (2020). Dietary choices and habits during COVID-19 lockdown: Experience from Poland. *Nutrients, 12*(6), 1657. https://doi.org/10.3390/nu12061657

Sinha, R., & Jastreboff, A. M. (2013). Stress as a common risk factor for obesity and addiction. *Biological Psychiatry, 73*(9), 827–835. https://doi.org/10.1016/j.biopsych.2013.01.032. Elsevier.

Stevenson, J. L., Krishnan, S., Stoner, M. A., Goktas, Z., & Cooper, J. A. (2013). Effects of exercise during the holiday season on changes in body weight, body composition and blood pressure. *European Journal of Clinical Nutrition, 67*(9), 944–949. https://doi.org/10.1038/ejcn.2013.98

Swinburn, B. A., Kraak, V. I., Allender, S., Atkins, V. J., Baker, P. I., Bogard, J. R., Brinsden, H., Calvillo, A., De Schutter, O., Devarajan, R., Ezzati, M., Friel, S., Goenka, S., Hammond, R. A., Hastings, G., Hawkes, C., Herrero, M., Hovmand, P. S., Howden, M., & Dietz, W. H. (2019). The global syndemic of obesity, undernutrition, and climate change: The lancet commission report. *The lancet* (Vol. 393,(10173), 791–846. https://doi.org/10.1016/S0140-6736(18)32822-8. Lancet Publishing Group.

Verhoeven, A. A. C., Adriaanse, M. A., Evers, C., & De Ridder, D. T. D. (2012). The power of habits: Unhealthy snacking behaviour is primarily predicted by habit strength. *British Journal of Health Psychology, 17*(4), 758–770. https://doi.org/10.1111/j.2044-8287.2012.02070.x

Wolfson, J. A., & Leung, C. W. (2020). Food insecurity and COVID-19: Disparities in early effects for US adults. *Nutrients, 12*(6), 1648. https://doi.org/10.3390/nu12061648

Yadav, R., Aggarwal, S., & Singh, A. (2020). SARS-CoV-2-host dynamics: Increased risk of adverse outcomes of COVID-19 in obesity. *Diabetes & Metabolic Syndrome: Clinical Research Reviews, 14*(5), 1355–1360. https://doi.org/10.1016/j.dsx.2020.07.030

Zachary, Z., Brianna, F., Brianna, L., Garrett, P., Jade, W., Alyssa, D., & Mikayla, K. (2020). Self-quarantine and weight gain related risk factors during the COVID-19 pandemic. *Obesity Research & Clinical Practice, 14*(3), 210–216. https://doi.org/10.1016/j.orcp.2020.05.004

Zhao, A., Li, Z., Ke, Y., Huo, S., Ma, Y., Zhang, Y., Zhang, J., & Ren, Z. (2020). Dietary diversity among Chinese residents during the COVID-19 outbreak and its associated factors. *Nutrients, 12*(6), 1699. https://doi.org/10.3390/nu12061699