COVID-19, body weight and the neighbourhood: food system dimensions and consumption associated with changes in body weight of Peruvian adults during first wave lockdowns

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ABSTRACT

Objective The objective of this study is to assess changes in the dimensions of the food system and consumption associated with body weight variations during the first month’s lockdown in Peruvian adults in Metropolitan Lima.

Methods A cross-sectional study conducted during the first months of lockdowns in Peru. 694 adults completed a web-based survey about changes experienced in the process of acquiring food during lockdown, changes in their intake and self-perceived body weight. A multinomial logistic regression analysis was conducted to evaluate the factors associated with changes in body weight.

Results Weight gain was perceived in 38% of the participants and 22.8% perceived weight loss. 39.2% did not perceive changes in their weight. Risk factors for body weight gain were increased alcohol consumption (OR=4.510, 95% CI 1.764 to 11.531) and decreased fruit consumption (OR=2.129, 95% CI 1.290 to 3.515), while decreasing cereal intake (OR=0.498, 95% CI 0.269 to 0.922) and choosing nutritious food as a driver for purchase (OR=0.512, 95% CI 0.320 to 0.821) were found to be protective against gaining weight. Decreasing food intake during the pandemic (OR=2.188, 95% CI 1.348 to 3.550) and having to miss important foods (OR=2.354, 95% CI 1.393 to 3.978), were associated with weight loss.

Conclusions During confinement, weight gain was mostly associated with food consumption and personal food system factors. Meanwhile, weight loss was associated with external food system factors.

INTRODUCTION

The COVID-19 is an infectious disease caused by SARS-CoV-2, it is spread through human-to-human transmission mainly by droplets or aerosols. An infected person can manifest mild flu-like symptoms like fever, cough and fatigue. However, in severe and critical conditions, especially among people suffering from non-communicable diseases, it can cause multiple organ dysfunctions and a higher risk of death. It was declared a pandemic by the WHO on 11 March 2020. Ever since, it has caused the saturation of health systems worldwide and the disruption of all human activity, including daily food purchasing behaviours, vendors’ availability, eating habits and income.

To reduce contagion, most territories in the world implemented voluntary or
compulsory social distancing measures. In Peru, after confirming seven cases of COVID-19, the government declared a State of National Emergency on 16 March 2020.1-6 Strict borders closures; suspension of classes and non-essential work; and strict lockdown and curfews lasted until the end of June 2020 and remained moderately strict the following months.

During the first stages of the lockdown, street vendors, who constitute a great proportion of the local food trading in Peru,7 were banned. Capacity limits were imposed in markets, grocery stores and corner shops, where long queues formed the first weeks. Some food providers were indefinitely closed. A few empty shelves were a sign of the coping mechanism adopted in response to the shortage threat.8

The pandemic has impacted the external domains of the food system, food prices and availability of foods, as well as the internal: accessibility, affordability, shelf life, convenience of the food product and desirability. It is not clear if these modifications to food acquisition and consumption practices could lead to deterioration of the nutritional status and health of populations and individuals.9 10 There is evidence that the pandemic and social distancing have negative effects on mental health, stress,11 and physical activity12 which, added to changes in food consumption,13 could lead to weight changes.

In 2019, it was reported that 37.8% of the Peruvian adult population was overweight, 22.3% had obesity14 and 75.8% did little physical activity. The factors associated with greater sedentary lifestyle were being obese, female, to live in an urban area or in the country’s capital.15 The convenience and ubiquity of ultra-processed foods could also contribute to the increase of overweight and obesity11 16 and increase the risk for severe COVID-19 and higher mortality.17

Studies that assess weight variation during the COVID-19 pandemic are emerging. In Spain, 12.8% of adults that completed an online survey reported experiencing weight gain during confinement.18 In Chile, 25.6% of men and 38.1% of women out of a sample of 700 volunteers reported perceiving an increase in their weight.19

In virtual surveys in France20 and Zimbabwe,21 35% and 45.5% adults, respectively, reported an increase in their weight during compulsory social isolation. In Peru, only one study has explored the variation in body weight associated to eating habits and mental health during the pandemic. Authors found that out of 1031 respondents to an online survey, 38.9% reported an increase in their weight, while 29.3% reported having lost weight. Almost all bad habits and stressful scenarios were significantly associated with weight gain.22

In order to design policies and programmes that prevent food insecurity and malnutrition during the evolution of this pandemic, it is necessary to understand the effects of COVID-19 induced lockdown, given that this contention measures promote, either willingly or inadvertently changes in the food system and in the decisions that families make regarding their food consumption. In addition, understanding how these changes affect their health through increases in body weight can create a basis to better manage and understand the complexity of this topic for future similar events. Considering the scarce evidence in these subjects, the present study aims to assess the factors of the food system and consumption associated with the change in body weight in Peruvian adults from Metropolitan Lima after 108 days of mandatory confinement during the first wave of COVID-19 pandemic in Peru.

METHODS

Study design and participants

This cross-sectional observational study was carried out by a team of researchers and expert advisors in nutrition and public health using a web-based survey, which was available throughout from 1 to 26 June 2020, corresponding to weeks 12–16 and days 78–108 of the confinement in Peru. The inclusion criteria were to reside in the city of Lima; to be 18 years old or older; and to have access to internet, an electronic device such as smartphone, tablet or computer.

To determine the sample size, it was used a convenience sampling considering the population of Metropolitan Lima aged 18 years and over who reported using the internet service (6112087 people) during the first quarter of 2020, calculated from the database provided by the National Institute of Statistics and Informatics (INEI) through its National Household Survey (ENAHO). A confidence level of 95%, a variability of 50% and an estimation error of 4% were used to obtain the sample size of 694 participants.

Data collection and tools

Because of the circumstances of lockdown, specific population that could access to the web-based survey was considered for this study to avoid bias. Also, due to the design of the survey that considered required questions, there are no missing data found in this study.

The instrument was digitalised using the Google Forms tool. A pilot test was conducted within 30 participants to evaluate both the clarity of contents and responsiveness of the design. Dissemination was made through social networks such as Facebook, Instagram and WhatsApp groups and individuals based in Lima, and emails. A link to the multiple-choice, 26-question questionnaire was attached within a short greeting message briefly explaining the study.

Socioeconomic characteristics

The first group of questions assessed the place of residence, age, sex, educational level, change in household income before and during the pandemic, number of members of the home, access to drinking water and presence of comorbidities.
Self-perceived body weight

The scale of seven silhouettes of Montero, Morales and Carbajal was used to measure the participants perception of their body weight.23 The male silhouette resembles a height of 1.75 m and weights of 55 kg, 67 kg, 77 kg, 83 kg, 92 kg, 107 kg and 122 kg. For the female figures, the height is 1.65 m and the weights are 50 kg, 60 kg, 68 kg, 74 kg, 82 kg, 95 kg and 109 kg. Participants were asked to select the silhouette that best represented them before and during this stage of confinement. The silhouettes were numbered from 1 to 7.

Food system

In the present study, we considered two dimensions of the food system: external domain and personal domain.

External domain: factors outside the individual that intervene for food choice or consumption in the context of the COVID-19 pandemic, which included: (A) food availability: we asked if in the previous week you noticed if the availability (supply) of 10 food groups had been reduced (yes/no), (B) the characteristics of the place of purchase: if it had order and cleanliness, little influx of people, affordable prices, offered a variety of foods and had adequate location (close to home), all with dichotomous responses yes/no, (C) characteristics of the food that motivated the purchase: being a nutritious food, fresh, having low risk of contamination, quick preparation, low in fat, good taste, easy to prepare, low/moderate amount of sugar and low/moderate amount of salt as multiple choice question and (D) geographic accessibility to the place of purchase: access on foot or access by vehicle.

Personal domain: individual-level factors influencing food consumption included were: (A) affordability of food: asked whether in the previous week, because of low purchasing power, they had to: eat less number of meals in the day, reduce the portion of meals, eat cheaper food or stop eating some important food, all with dichotomous answers yes/no; and (B) convenience: it was inquired if in the previous week he or she prepares for suitability more frequently the following preparations: fried foods, salads, desserts, nutritious and healthy preparations, all with dichotomous responses yes/no.

In this study, we considered two aspects of the food system: external and internal; the questions assessing the impact of the blockage on the external factors of the food system explored the availability of food during the previous week; the quality of the place of purchase that would make it attractive (store looks tidy, cleanliness, capacity compliance and variety of products); food prices; accessibility and characteristics of the food that motivated the purchase (nutritional value and whether fresh or canned); risk of contamination; and how long the product lasts on the shelf. However, the questions on the domestic domain assessed food affordability and food restriction due to lack of resources.

Variation in food consumption

First, we assessed changes in consumption of food groups (section A), where we included three groups: vegetables, fruits and cereals, then preparations (section B) such as: bakery products (sponge cakes and cakes), canned food, bread/crackers, processed meats, snacks, sweets and instant foods. At last, beverages (section C) including sugary and alcoholic beverages were also assessed. For each of the categories, we asked about the increase, decrease or maintenance of consumption of these foods/drinks during the pandemic.

Finally, we assessed variations in the consumption of 20 food groups, whether traditional recipes or tasty fast food were preferred during confinement, if the types of preparation had changed and the motivation behind these changes.

Data analysis and processing

A descriptive analysis was performed on qualitative and quantitative variables. After verification of the normality of the data, a bivariate inferential analysis was performed using Pearson’s $\chi^2$. In the multivariate analysis, a multinomial logistic regression model was used, having the body weight variation as a dependent variable and the variables of the food system and significant consumption in the bivariate analysis as independent. The final model with raw and adjusted OR was selected by evaluating the goodness of fit indicators. A significance level of $p<0.05$ and 95% CIs were considered. Data analysis was performed using SPSS software (Statistical Package for the Social Sciences) V.25.

RESULTS

Descriptive statistics

In total, 696 people accessed the web-based survey but two of them refused the informed consent and could not participate in the study. Figure 1 summarises the participant enrolment and data availability in this study.

Most participants were female (71.8%), aged between 18 and 44 years old (75.6%); 15.0% of participants indicated that they had a comorbidity. A percentage of 41.5 of participants had higher education. A percentage of 45.2 shared their residency with three to four people. A percentage of 68.9 of the volunteers reported a decrease in income. In addition, the majority perceived that their weight had changed (60.8%); weight gain was perceived in 38% of the volunteers and 22.8% perceived weight loss. A percentage of 39.2% did not perceive changes in their weight (table 1). Of the total number of participants who perceived weight gain at the time of filling out the questionnaire, 5.7%, 16.3%, 64% and 14% had perceived that they were underweight, normal, overweight and obesity, respectively, before stage of confinement (see online supplemental table 1).

The changes in the food system affected factors in the external domain such as food availability, so the foods perceived as least available were fish and seafood (30.4%), fruits (24.2%) and vegetables (22.5%). The
characteristics of the place of purchase considered most important were order and cleanliness (71.6%), low influx of people (66.3%) and affordable prices (48.7%). The most important characteristics of the food that motivated the purchase were that the food be nutritious (80.8%), fresh (61.7%) and with low risk of contamination (55.6%). In terms of accessibility, 66.1% of the participants said they preferred vendors within walking distance and 27.8% had to use a vehicle. At the level of internal control, it was found that 10.5% could not afford to eat as many meals as they usually did, 18.6% had to eat less food, 16.3% had to switch to cheaper food alternatives and 21.3% had to stop eating important foods (see online supplemental table 2).

Variation in consumption during the lockdown were observed. An increase of the consumption of vegetables (39.6%), fruits (36.2%) and cereals (31.4%) were reported while the consumption of sweets (40.6%), snacks (39.8%), alcoholic beverages (39.3%), sugary drinks (38.5%) and processed meats (36%) decreased (see online supplemental figure 1).

Bivariate analysis
The bivariate analysis shows that only variation in household income, as a sociodemographic characteristic, was associated with variation in weight (table 2) (p=0.032), while the changes in food consumption associated with variation in perceived body weight were variation in the consumption of fruits (p<0.01), vegetables (p<0.01), processed meats (p=0.001), snacks (p=0.004), cereals (p=0.000), pastries (p<0.01), sugar-sweetened beverages (p<0.01), canned foods (p=0.049), instant food (p=0.047), sweets (p<0.01), sliced bread/biscuits (p=0.002) and alcoholic beverages (p=0.010).

In the external domain level, the food system factors that were associated with weight changes were the following: less availability of food for fruits (p=0.048); food variety as an important characteristic of the place of purchase (p=0.043) and as important characteristics of the food, the nutritional value of the food (p<0.01), quick to spoil (p=0.027) and low or moderate in sugar (p<0.01). However, all the factors of the internal domain were associated with weight changes according to affordability or convenience conditions (table 3).

Factors of the food system and consumption associated with weight variation in the multivariate analysis
Factors associated with weight loss
In the multivariate analysis, the food system factors associated with decreased body weight were consuming less

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**Table 1** Sociodemographic, economic characteristics, presence of comorbidities and perceived weight change

| Variables                          | Category                    | N (%)  |
|------------------------------------|-----------------------------|--------|
| **Sex**                            | Woman                       | 498 (71.8) |
|                                    | Man                         | 196 (28.2)  |
| **Age**                            | 18–44 years                 | 525 (75.6)  |
|                                    | 45–65 years                 | 169 (24.4)  |
| **Educational level**              | Primary education           | 9 (1.3)    |
|                                    | Secondary education         | 150 (21.6) |
|                                    | Higher technical education  | 97 (14.0)  |
|                                    | University higher education | 288 (41.5) |
|                                    | Postgraduate                | 150 (21.6) |
| **Number of household members**    | 1–2 members                 | 229 (33.0) |
|                                    | 3–5 members                 | 314 (45.2) |
|                                    | More than five members      | 151 (21.8) |
| **Change in household income**     | Less money than before      | 478 (68.9) |
|                                    | No change                   | 205 (29.5) |
|                                    | More money than before      | 11 (1.6)   |
| **Number of illnesses suffered**   | 0                           | 574 (82.7) |
|                                    | 1                           | 104 (15.0) |
|                                    | More than 2                 | 16 (2.3)   |
| **Perceived weight change**        | Lost weight                 | 158 (22.8) |
|                                    | Maintained weight           | 272 (39.2) |
|                                    | Gained weight               | 264 (38.0) |

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**Figure 1** Participant enrolment and data available flow diagram.
| Variables                                      | Category          | Lost weight | No change | Gained weight | P value† |
|-----------------------------------------------|-------------------|-------------|-----------|---------------|----------|
| **Sociodemographics, economy and presence of comorbidities** |                   |             |           |               |          |
| Age                                           | 18–44 years old   | 118 (74.7)  | 201 (73.9) | 206 (78)      | 0.653    |
|                                               | 45–60 years old   | 22 (13.9)   | 44 (16.2)  | 38 (14.4)     |          |
|                                               | Over 60 years old | 18 (11.4)   | 27 (9.9)   | 20 (7.6)      |          |
| Gender                                        | Female            | 110 (69.6)  | 199 (73.2) | 189 (71.6)    | 0.732    |
|                                               | Male              | 48 (30.4)   | 73 (26.8)  | 75 (28.4)     |          |
| Education level                               | Primary education | 2 (1.3)     | 4 (1.5)    | 3 (1.1)       | 0.518    |
|                                               | Secondary education| 36 (22.8)  | 52 (19.1)  | 62 (23.5)     |          |
|                                               | Higher technical education | 17 (10.8) | 35 (12.9) | 45 (17)       |          |
|                                               | University higher education | 71 (44.9) | 120 (44.1)| 97 (36.7)     |          |
|                                               | Postgraduate      | 32 (20.3)   | 61 (22.4)  | 57 (21.6)     |          |
| Number of household members                   | 1–2 members       | 46 (29.1)   | 98 (36)    | 85 (32.2)     | 0.242    |
|                                               | 3–5 members       | 82 (51.9)   | 110 (40.4) | 122 (46.2)    |          |
|                                               | More than five members | 30 (19)    | 64 (23.5)  | 57 (21.6)     |          |
| Household income                              | Less money than before | 115 (72.8)| 181 (66.5) | 182 (68.9)    | 0.032    |
|                                               | No changes        | 37 (23.4)   | 87 (32)    | 81 (30.7)     |          |
|                                               | More money than before | 6 (3.8)    | 4 (1.5)    | 1 (0.4)       |          |
| Comorbidity (number of diseases)              | 0                 | 126 (79.7)  | 238 (87.5) | 210 (79.5)    | 0.097    |
|                                               | 1                 | 29 (18.4)   | 29 (10.7)  | 46 (17.4)     |          |
|                                               | 2                 | 3 (1.9)     | 5 (1.8)    | 8 (3)         |          |
| **Change in food consumption before and during the pandemic** |                   |             |           |               |          |
| Fruit consumption                             | No change         | 54 (34.2)   | 123 (45.2)| 87 (33)       | 0.000**  |
|                                               | Less              | 39 (24.7)   | 48 (17.6)  | 92 (34.8)     |          |
|                                               | More              | 65 (41.1)   | 101 (37.1) | 85 (32.2)     |          |
| Consumption of vegetables                     | No change         | 57 (36.1)   | 124 (45.6)| 101 (38.3)    | 0.005**  |
|                                               | Less              | 29 (18.4)   | 39 (14.3)  | 69 (26.1)     |          |
|                                               | More              | 72 (45.6)   | 109 (40.1) | 94 (35.6)     |          |
| Consumption of processed meats                | No change         | 87 (55.1)   | 147 (54)   | 133 (50.4)    | 0.008**  |
|                                               | Less              | 63 (39.9)   | 99 (36.4)  | 88 (33.3)     |          |
|                                               | More              | 8 (5.1)     | 26 (9.6)   | 43 (16.3)     |          |
| Consumption of snacks                         | No change         | 81 (51.3)   | 149 (54.8)| 123 (46.6)    | 0.004**  |
|                                               | Less              | 66 (41.8)   | 108 (39.7) | 102 (38.6)    |          |
|                                               | More              | 11 (7)      | 15 (5.5)   | 39 (14.8)     |          |
| Consumption of cereals                        | No change         | 78 (49.4)   | 164 (60.3)| 133 (50.4)    | 0.000**  |
|                                               | Less              | 35 (22.2)   | 43 (15.8)  | 23 (8.7)      |          |
|                                               | More              | 45 (28.5)   | 65 (23.9)  | 108 (40.9)    |          |
| Consumption of bakery products                | No change         | 61 (38.6)   | 117 (43)   | 89 (33.7)     | 0.000**  |
|                                               | Less              | 61 (38.6)   | 92 (33.8)  | 62 (23.5)     |          |
|                                               | More              | 36 (22.8)   | 63 (23.2)  | 113 (42.8)    |          |
| Consumption of sweetened beverages           | No change         | 83 (52.5)   | 159 (58.5)| 139 (52.7)    | 0.000**  |
|                                               | Less              | 72 (45.6)   | 101 (37.1)| 94 (35.6)     |          |
|                                               | More              | 3 (1.9)     | 12 (4.4)   | 31 (11.7)     |          |

Continued
Factors associated with weight gain

The risk factors for weight gain were lower fruit consumption (OR=2.129; 95% CI 1.290 to 3.515) and higher alcohol consumption (OR=4.510; 95% CI 1.764 to 11.531). While the protective factors against weight gain were preferring nutritious foods to buy (OR=0.512; 95% CI 0.320 to 0.821) and low consumption of cereals (OR=0.498; 95% CI 0.269 to 0.922) (table 4).

**DISCUSSION**

The results of the study show that 60% of the participants perceived changes in their body weight, 38% reported weight gain, and the consumption factors associated with the risk of weight gain were lower consumption of fruit and higher consumption of alcohol, while at the food system level, the following factors that stood out as protective were choosing nutritious foods and lower intake of cereals. However, at the level of the food system, the reduction in self-perceived body weight had as risk factors the reduction of the amount of food and not consuming any important food.

The perceived weight increase found in the study (38%) is consistent with most studies in countries such as Spain, Chile, France, Zimbabwe, Italy and Poland that have reported changes in weight in the adult population due to confinement and the COVID-19 pandemic.13-17,20-22 Studies in Peru, Zimbabwe and France also reported weight loss of 29.3%-31.2% and 23.0%, respectively, similar trends to those found in the present study.20-22

The most important risk factor associated with weight gain was increased alcohol consumption. A similar trend was found in a study in France and Poland, where alcohol consumption was notably increased during the lockdown.20,24 It is worth noting that according to the evidence, alcohol consumption is positively associated with weight gain; hence, heavy drinkers may experience such an effect more commonly than light drinkers.25 Another risk factor for weight gain was decreased consumption of fruits. Other data have previously shown that increased consumption of fruits did not lead to an increase in weight gain; this relationship has multiple factors involved and should be better addressed in future studies.26,27

In the present study, a decrease in cereal consumption during confinement was found to be a protective factor, reducing the risk of weight gain by 51%. The role of cereals for weight gain becomes important in Peru where the consumption of white rice is estimated at 50 kg/year per person.28 Some studies such as that of Pellegrini et al16 in Italy report that increased cereal consumption correlated with significantly higher weight gain during confinement as well as that of Sawada et al29 in Japan where they found that high rice consumption was associated with a higher risk of body weight gain.

Another protective factor against weight gain found in the study was choosing nutritious foods as a purchase driver. A longitudinal study in France reported that people who lost weight reported having stopped eating a food to

**Table 2 Continued**

| Variables                  | Category     | Lost weight | No change | Gained weight | P value† |
|----------------------------|--------------|-------------|-----------|---------------|----------|
|                            |              | n (%)       | n (%)     | n (%)         |          |
| Consumption of canned foods| No change    | 69 (43.7)   | 157 (57.7)| 131 (49.6)    | 0.049    |
|                            | Less         | 40 (25.3)   | 47 (17.3) | 51 (19.3)     |          |
|                            | More         | 49 (31)     | 68 (25)   | 82 (31.1)     |          |
| Consumption of instant foods| No change   | 100 (63.3)  | 181 (66.5)| 156 (59.1)    | 0.047    |
|                            | Less         | 51 (32.3)   | 76 (27.9) | 79 (29.9)     |          |
|                            | More         | 7 (4.4)     | 15 (5.5)  | 29 (11)       |          |
| Consumption of candy       | No change    | 70 (44.3)   | 140 (51.5)| 111 (42)      | 0.000**  |
|                            | Less         | 76 (48.1)   | 107 (39.3)| 99 (37.5)     |          |
|                            | More         | 12 (7.6)    | 25 (9.2)  | 54 (20.5)     |          |
| Consumption of sliced bread and crackers | No change | 78 (49.4)   | 140 (51.5)| 111 (42)      | 0.002**  |
|                            | Less         | 51 (32.3)   | 81 (29.8) | 68 (25.8)     |          |
|                            | More         | 29 (18.4)   | 51 (18.8) | 85 (32.2)     |          |
| Consumption of alcoholic beverages | No change | 90 (57)     | 160 (58.8)| 134 (50.8)    | 0.010    |
|                            | Less         | 62 (39.2)   | 105 (38.6)| 106 (40.2)    |          |
|                            | More         | 6 (3.8)     | 7 (2.6)   | 24 (9.1)      |          |

*Significant at the 0.05 level. **Significant at the 0.01 level. χ² test of independence.
Table 3  Food system factors associated with change in body weight during the pandemic

| Variables                          | Category | Lost weight | No change | Gained weight | P value† |
|-----------------------------------|----------|------------|-----------|---------------|----------|
|                                   |          | n (%)      | n (%)     | n (%)         |          |
| **External domain**               |          |            |           |               |          |
| Reduced food availability         |          |            |           |               |          |
| Fish and seafood                  | Yes      | 77 (29.2)  | 80 (29.4) | 54 (34.2)     | 0.501    |
|                                  | No       | 187 (70.8) | 192 (70.6)| 104 (65.8)    |          |
| Poultry meat                      | Yes      | 11 (4.2)   | 7 (2.6)   | 8 (5.1)       | 0.382    |
|                                  | No       | 253 (95.8) | 265 (97.4)| 150 (94.9)    |          |
| Eggs                              | Yes      | 9 (3.4)    | 5 (1.8)   | 7 (4.4)       | 0.286    |
|                                  | No       | 255 (96.6)| 267 (98.2)| 151 (95.6)    |          |
| Dairy                             | Yes      | 16 (6.1)   | 22 (8.1)  | 14 (8.9)      | 0.51     |
|                                  | No       | 248 (93.9)| 250 (91.9)| 144 (91.1)    |          |
| Cereals                           | Yes      | 11 (4.2)   | 11 (4.0)  | 10 (6.3)      | 0.502    |
|                                  | No       | 253 (95.8)| 261 (96.0)| 148 (93.7)    |          |
| Legumes and vegetables            | Yes      | 22 (8.3)   | 26 (9.6)  | 16 (10.1)     | 0.802    |
|                                  | No       | 242 (91.7)| 246 (90.4)| 142 (89.9)    |          |
| Fruits                            | Yes      | 77 (29.2)  | 55 (20.2) | 36 (22.8)     | 0.048*   |
|                                  | No       | 187 (70.8)| 217 (79.8)| 122 (77.2)    |          |
| Vegetables                        | Yes      | 66 (25.0)  | 54 (19.9) | 36 (22.8)     | 0.359    |
|                                  | No       | 198 (75.0)| 218 (80.1)| 122 (77.2)    |          |
| Tubers                            | Yes      | 8 (3.0)    | 7 (2.6)   | 3 (1.9)       | 0.778    |
|                                  | No       | 256 (97.0)| 155 (98.1)| 155 (98.1)    |          |
| Processed foods                   | Yes      | 24 (9.1)   | 14 (5.1)  | 13 (8.2)      | 0.193    |
|                                  | No       | 240 (90.9)| 258 (94.9)| 145 (91.8)    |          |
| **Important feature of the place of purchase** |          |            |           |               |          |
| Order and cleanliness             | Yes      | 115 (72.8)| 191 (70.2)| 191 (72.3)    | 0.804    |
|                                  | No       | 43 (27.2) | 81 (29.8)| 73 (27.7)     |          |
| Low influx of people              | Yes      | 106 (67.1)| 178 (65.4)| 176 (66.7)    | 0.928    |
|                                  | No       | 176 (66.7)| 94 (34.6)| 88 (33.3)     |          |
| Affordable prices                 | Yes      | 82 (51.9) | 117 (43.0)| 139 (52.7)    | 0.055    |
|                                  | No       | 76 (48.1) | 155 (57.0)| 125 (47.3)    |          |
| Variety of food                   | Yes      | 70 (44.3) | 111 (40.8)| 87 (33.0)     | 0.043*   |
|                                  | No       | 88 (55.7) | 161 (59.2)| 177 (67.0)    |          |
| Good location                     | Yes      | 27 (17.1) | 37 (13.6)| 28 (10.6)     | 0.161    |
|                                  | No       | 131 (82.9)| 235 (86.4)| 236 (89.4)    |          |
| **Important food characteristic** |          |            |           |               |          |
| Nutritious                        | Yes      | 135 (85.4)| 233 (85.7)| 193 (73.1)    | 0.000**  |
|                                  | No       | 23 (14.6) | 39 (14.3)| 71 (26.9)     |          |
| Fresh                             | Yes      | 93 (58.9)| 171 (62.9)| 164 (62.1)    | 0.699    |
|                                  | No       | 65 (41.1) | 101 (37.1)| 100 (37.9)    |          |
| Low risk of contamination         | Yes      | 84 (53.2)| 142 (52.2)| 160 (60.6)    | 0.115    |
|                                  | No       | 74 (46.8)| 130 (47.8)| 104 (39.4)    |          |
| Quick to spoil                    | Yes      | 61 (38.6)| 82 (30.1)| 108 (40.9)    | 0.027*   |
|                                  | No       | 97 (61.4)| 190 (69.9)| 156 (59.1)    |          |
| Low in fat                        | Yes      | 31 (19.6)| 42 (15.4)| 36 (13.6)     | 0.26     |
|                                  | No       | 127 (80.4)| 230 (84.6)| 228 (86.4)    |          |

Continued
avoid weight gain and considered the period of confinement as a great opportunity to better balance their diet, while in Italy it was found that choosing unhealthy foods was significantly associated with weight gain and body mass index in adults during COVID-19 confinement. In a high-income country such as Belgium, 5% of the population experienced not having enough money for food often or eventually and 10% could not afford a healthy diet during confinement.

The factors associated with weight loss during confinement, eating less amount of food and missing important foods belong to the external domain of the food system, meaning they are factors beyond the control of individuals. A study in Peru, carried out during lockdown, found that weight reduction was associated with moderate to severe food insecurity at home. Food insecurity is characterised by survival strategies such as reducing serving size and stop the consumption of foods deemed important. These results are similar to those found in Colombia during confinement, where 35% of families reported lacking money to buy food, while 15.3% reported eating less amounts in main meals. Weight loss was observed in individuals with previous low weight and those who reported eating less. This pattern is seen in low-income

### Table 3

| Variables                        | Category | Lost weight | No change | Gained weight | P value† |
|----------------------------------|----------|-------------|-----------|---------------|----------|
|                                  |          | n (%)       | n (%)     | n (%)         |          |
| Tasty                            | Yes      | 12 (7.6)    | 26 (9.6)  | 37 (14.0)     | 0.084    |
|                                  | No       | 146 (92.4)  | 246 (90.4)| 227 (86.0)    |          |
| Easy to prepare                  | Yes      | 11 (7.0)    | 24 (8.8)  | 30 (11.4)     | 0.3      |
|                                  | No       | 147 (93.0)  | 248 (91.2)| 234 (88.6)    |          |
| Low/moderate in sugar            | Yes      | 21 (13.3)   | 18 (6.6)  | 9 (3.4)       | 0.001**  |
|                                  | No       | 137 (86.7)  | 254 (93.4)| 255 (96.6)    |          |
| Low/moderate in salt             | Yes      | 7 (4.4)     | 10 (3.7)  | 7 (2.7)       | 0.606    |
|                                  | No       | 151 (95.6)  | 262 (96.3)| 257 (97.3)    |          |

#### Accessibility

| Transport                        |          |             |           |               |          |
|----------------------------------|----------|-------------|-----------|---------------|----------|
|                                  |          | On foot     | 106 (67.1)| 188 (69.1)    | 165 (62.5)| 0.259    |
|                                  |          | Vehicular means | 52 (32.9)| 84 (30.9)    | 99 (37.5) |          |

#### Internal domain

**Affordability**

| Eating fewer meals per day       | Yes      | 25 (15.8)   | 27 (9.9)  | 21 (8.0)      | 0.036*   |
|                                  | No       | 133 (84.2)  | 245 (90.1)| 243 (92.0)    |          |
| Eating less food                 | Yes      | 51 (32.3)   | 42 (15.4) | 36 (13.6)     | 0.000**  |
|                                  | No       | 107 (67.7)  | 230 (84.6)| 228 (86.4)    |          |
| Eating cheaper foods             | Yes      | 36 (22.8)   | 32 (11.8) | 45 (17.0)     | 0.011*   |
|                                  | No       | 122 (77.2)  | 240 (88.2)| 219 (83.0)    |          |

| Skipping an important food       | Yes      | 48 (30.4)   | 37 (13.6) | 63 (23.9)     | 0.000**  |
|                                  | No       | 110 (69.6)  | 235 (86.4)| 201 (76.1)    |          |

#### Convenience

| Prepared fried foods more frequently | Yes      | 17 (10.8)   | 32 (11.8) | 56 (21.2)     | 0.002**  |
|                                     | No       | 141 (91.2)  | 240 (88.2)| 208 (78.8)    |          |
| Prepared salads more often          | Yes      | 66 (41.8)   | 96 (35.3) | 59 (22.3)     | 0.000**  |
|                                     | No       | 92 (58.2)   | 176 (64.7)| 205 (77.7)    |          |
| Most frequently prepared desserts   | Yes      | 20 (12.7)   | 51 (18.8) | 67 (25.4)     | 0.006**  |
|                                     | No       | 138 (87.3)  | 221 (81.3)| 197 (74.6)    |          |

#### Reason for choosing preparations

| They are nutritious and healthy    | Yes      | 110 (69.6)  | 186 (68.4)| 129 (48.9)    | 0.000**  |
|                                     | No       | 48 (30.4)   | 86 (31.6) | 135 (51.1)    |          |

*Significant at the 0.05 level.**Significant at the 0.01 level.
†χ² test of independence.
CONCLUSIONS

The results of this study show that 60.8% of respondents noticed variations in their body weight during the lockdown. Body weight gain was mostly associated with changes in food consumption habits such as increased alcohol intake and decreased intake of fruits, while regarding internal factors of the food system, eating less cereals and nutritious value of the food as purchase driver were found as protective habits against weight gain. Finally, body weight loss was associated with external factors of the food system such as having to eat smaller portions and missing important foods.

This study provides information related to the situation of the food system and the perception of body image in an urban area in Peru. Lima is a multicultural city like most Latin American capitals, so the results obtained could be replicated in other Peruvian urban areas and in other major cities in the region where most people can access new methods of data collection such as web-based surveys.

More sedentary and diverse behaviours are evident due to confinement, which increases the risk factors for COVID-19. Given this, it is necessary to promote preventive policies, guidelines, programmes and communications that help mitigate the impact of the pandemic on food systems, consumption habits, physical activity and active rest and aim to promote healthy lifestyles that can adapt to the restrictions that could arise and protect the population.

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Table 4  Multinomial regression model of factors associated with body weight change in adults during the COVID-19 pandemic

| Factors                              | Decrease in body weight* | Increase in body weight* |
|--------------------------------------|--------------------------|--------------------------|
|                                      | β (95% CI)               | P value                  | β (95% CI)†               | P value                  |
| Food system                          |                          |                          |                          |                          |
| Nutritious food                      | −0.084 (0.919 to 1.636)  | 0.775                    | −0.669 (0.512 to 0.821)   | 0.005                    |
| Eating less food                     | 0.783 (2.188 to 3.550)   | 0.002                    | −0.176 (0.838 to 1.413)   | 0.508                    |
| Eating a food that you considered important | 0.856 (2.354 to 3.978)   | 0.001                    | 0.497 (1.644 to 2.741)    | 0.056                    |
| Food consumption                     |                          |                          |                          |                          |
| Lower fruit consumption‡             | 0.231 (1.260 to 2.239)   | 0.431                    | 0.756 (1.219 to 3.515)    | 0.003                    |
| Higher fruit consumption‡            | 0.272 (1.313 to 2.112)   | 0.262                    | 0.004 (1.004 to 1.566)    | 0.985                    |
| Lower consumption of cereals‡        | 0.245 (1.277 to 2.250)   | 0.398                    | −0.698 (0.498 to 0.922)   | 0.262                    |
| Higher consumption of cereals‡       | 0.180 (1.197 to 1.972)   | 0.480                    | 0.329 (1.389 to 2.144)    | 0.138                    |
| Lower alcohol consumption‡           | 0.033 (1.034 to 1.602)   | 0.881                    | 0.283 (1.328 to 1.973)    | 0.161                    |
| Higher alcohol consumption‡          | 0.323 (1.381 to 4.396)   | 0.584                    | 1.506 (4.510 to 11.531)   | 0.002                    |

*Change in body weight. Reference: no change in perceived body weight.
†Change in consumption. Reference: no change in consumption.
‡Models were adjusted for total number of diseases.
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Data availability statement The data that support the findings of this study are available on request from the corresponding author (VMRH).

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## SUPPLEMENTARY MATERIAL

### Supplementary Table 1: Self-perceived weight change before and during the COVID-19 pandemic.

| Nutritional status self-perceived pre-pandemic | Variation in weight perception |       |       |
|-----------------------------------------------|--------------------------------|-------|-------|
|                                               | No change in self-perceived body weight. |
|                                               | (n=694)                        |       |       |
| Thin                                          |                                |       |       |
| Decrease in self-perceived body weight.       |                                |       |       |
| (n=694)                                       |                                |       |       |
| Increase in self-perceived body weight.       |                                |       |       |
| (n=694)                                       |                                |       |       |
| n (%):                                        | n (%)                          |       | n (%) |
| Thin                                          | 18 (6.6)                       | 0 (0.0)| 15 (5.7) |
| Normal weight                                 | 65 (23.9)                      | 14 (8.9)| 43 (16.3) |
| Overweight                                    | 136 (50.0)                     | 68 (43.0)| 169 (64.0) |
| Obesity                                       | 53 (19.5)                      | 76 (48.1)| 37 (14.0) |

### Supplementary Table 2: Characteristics of the food system

| Variables                                   | Category              | Yes n (%) | No n (%) |
|---------------------------------------------|-----------------------|-----------|----------|
| **External domain**                         |                       |           |          |
| Fish and seafood                            | 211 (30.4)            | 483 (69.6)|          |
| Poultry meat                                | 253 (3.7)             | 441 (96.3)|          |
| Eggs                                        | 21 (3.0)              | 673 (97.0)|          |
| Dairy                                       | 52 (7.5)              | 642 (92.5)|          |
| Cereals                                     | 32 (4.6)              | 662 (95.4)|          |
| Legumes and vegetables                      | 64 (9.2)              | 630 (90.8)|          |
| Fruits                                      | 168 (24.2)            | 526 (75.8)|          |
| Vegetables                                  | 156 (22.5)            | 538 (77.5)|          |
| Tubers                                      | 18 (2.6)              | 676 (97.4)|          |
| Processed foods                             | 51 (7.3)              | 643 (92.7)|          |
| **Reduced food availability**               |                       |           |          |
| Order and cleanliness                       | 497 (71.6)            | 197 (28.4)|          |
| Low influx of people                        | 460 (66.3)            | 234 (33.7)|          |
| Good prices                                 | 338 (48.7)            | 356 (51.3)|          |
| Important food characteristic | 268 (38.6) | 426 (61.4) |
|-------------------------------|------------|------------|
| Variety of food              | 78 (13.3)  | 616 (88.7) |
| Good location                | 561 (80.8) | 133 (19.2) |
| Nutritious                   | 428 (61.7) | 266 (38.3) |
| Fresh                        | 386 (55.6) | 308 (44.4) |
| Low risk of contamination    | 251 (36.2) | 443 (63.8) |
| Quick to spoil               | 109 (15.7) | 585 (84.3) |
| Tasty                        | 75 (10.8)  | 619 (89.2) |
| Easy to prepare              | 66 (9.4)   | 628 (90.6) |
| Low in fat                   | 48 (6.9)   | 646 (93.1) |
| Low/moderate in sugar        | 24 (3.5)   | 670 (96.5) |

| Accessibility                | 459 (66.1) | 235 (33.9) |
| On foot                      | 193 (27.8) | 501 (72.2) |
| Vehicular means              | 581 (83.7) | 346 (56.3) |

| Internal domain              | 73 (10.5)  | 621 (89.5) |
| Eating fewer meals per day   | 129 (18.6) | 565 (81.4) |
| Eating less food             | 113 (16.3) | 581 (83.7) |
| Eating cheaper foods         | 148 (21.3) | 546 (78.7) |

| Affordability                | 105 (15.1) | 589 (84.9) |
| Prepared fried foods more frequently | 221 (31.8) | 473 (68.2) |
| Prepared salads more often   | 138 (19.9) | 556 (80.1) |
| Most frequently prepared desserts | 425 (61.2) | 269 (38.8) |

| Convenience                  | 76 (11.1)  | 579 (88.9) |
| Reason for choosing preparations: that they are nutritious and healthy | 22 (3.2) | 638 (96.8) |
**Supplementary Figure 1:** Changes in food consumption before and during the pandemic

![Bar Chart showing changes in food consumption](image-url)