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Moroccan eating habits during COVID-19 lockdown: a preliminary analysis

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Abstract
The present study investigated the impact of the COVID-19 pandemic on dietary habits. Data were collected from an online survey (n = 171, out of 315 initial respondents) during the lockdown period from April to June 2020. The questionnaire was provided in Arabic, French, and English language and divided into five sections: sociodemographic and socioeconomic information, eating motivations, food consumption frequency, food-related behaviors, and purchase priorities. The results showed that health and pleasure were the primary perceived changes in eating motivations caused by the pandemic. The results of cluster analysis exhibited that individuals from cluster 1 with "Good Habits" had not changed their consumption frequency of food during the lockdown. In contrast, cluster 2 with "Bad Habits" showed higher consumption of salty snacks, chocolates, cakes, cookies, and processed foods ($p < 0.001$) than the period before the pandemic. On the other hand, the priority to purchase frozen vegetables, chocolates, and canned beans and legumes was observed to increase in cluster 2 during the lockdown period ($p = 0.02$, $p = 0.005$, and $p = 0.001$, respectively). The COVID-19 pandemic had a discernible impact on Moroccan dietary habits, emphasizing the need to fully understand the long-term effects. The observed changes highlight the importance of promoting healthy eating habits, especially during times of crisis. By analyzing the shifts in food consumption and the underlying motivations, policymakers can develop targeted interventions to support healthier dietary choices among the Moroccan population, contributing to improved public health outcomes.

Keywords COVID-19 · Food habits · Food behavior · Food consumption · Morocco

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1 Introduction

After South Africa, Morocco is the second country most affected by Coronavirus Disease 2019 (COVID-19) in Africa and one of the most affected in the Near East and North Africa region [1]. On 2 March 2020, Morocco declared its first confirmed case of COVID-19, and on March 19, 2020, the government declared a state of health emergency, responding to the evolution of the epidemic, for 30 days, which was later expanded until May 20 and later until June 10, 2020 [1]. To mitigate the rapid spread of the virus, the Moroccan population had to obey several measures and restrictions imposed by the government, such as 14-day mandatory quarantine, facemask wearing, online work, restriction of movement and gatherings, curfew, closure of all non-essential shops and entertainment venues, closure of kindergartens and schools, restaurants, cafes, and non-food stores.

Social distancing has negatively affected the daily life of the population. An unprecedented change in the lifestyles of the population has been documented, particularly the distance from family and friends, the loss of freedom, concern for their state of health, and boredom [2, 3]. Many people were forced to work/study at home, and others have lost their jobs [2, 4, 5]. This has had significant effects at both the socio-economic and the behavioral levels. Psychological symptoms have been reported, including emotional exhaustion, stress, insomnia, irritability, and feelings of anger [3]. These changes in the emotional state have potentially modified lifestyle habits, including eating habits (food buying and consumption behavior) [4]. In addition, the constant exposure to daily information on the pandemic has caused uncontrollable stress that worsened the individual's food situation. Most people usually change their eating behaviors when they are stressed, which leads to undernourishment or overeating, depending on the severity of the stress factor [5].

A healthy diet has been associated with a lower risk of various diseases and mortality [6, 7]. As one of the most beneficial diets known in the world, the Mediterranean diet (MD) has shown antiviral, anti-inflammatory, immunomodulatory, antioxidant, antimicrobial, or neuroprotective beneficial properties [8–10]. Many consumers have turned to a healthier and balanced diet during the COVID-19 lockdown period to maintain a correct diet and reduce health risks [11, 12], while others have become more aware of their diet. To improve their immune system to fight against SARS-CoV-2, health has become a concern for individuals throughout the Mediterranean region. For example, in Spain, which is a country where MD is the traditional food pattern, consumers tended to have healthier eating habits during the COVID-19 pandemic [13]. Morocco, another Mediterranean country with different socio-economic characteristics compared to European Mediterranean countries, experienced changes due to measurements of restrictions imposed by the pandemic.

In light of these data, this study specifically aims to investigate changes in food consumption patterns, eating motivations, and purchasing behaviors among Moroccan individuals during the COVID-19 lockdown. By examining these aspects, we seek to understand how the pandemic has influenced dietary habits and food-related decision-making in this context. The data collected for this study were part of a larger international research initiative, "The International Consortium for Changes in Food Behavior—COVID-19 [14]." However, this analysis focuses specifically on the case of Morocco. This allows us to gain insights into the unique food-related behaviors and changes experienced by the Moroccan population during the COVID-19 lockdown.

2 Materials and methods

2.1 Study design

The study was designed as a prospective observational study to investigate the impact of the COVID-19 lockdown on dietary habits and food-related behaviors. Data were collected through an online questionnaire administered from April to June 2020, specifically focusing on participants' experiences and behaviors during the lockdown period, which lasted from March to October 2020. The study was conducted as part of an international study led by the University of Evora, Portugal [14]. It is an online survey conducted by LimeSurvey (LimeSurvey GmbH, Germany) (Supplementary data).

The questionnaire was specifically designed to assess changes in dietary habits, food consumption patterns, and motivations during the lockdown period. Each section of the questionnaire included questions that prompted respondents to reflect on their eating behaviors and food-related decisions while under lockdown.

2.2 Participants

Our target sample included the adult population aged 18 years and older residing in Morocco who agreed to voluntarily participate in this study. Participants were recruited through social media platforms such as Facebook and WhatsApp, as well as academic websites. Respondents were asked to share the online survey with their friends, family, coworkers, and other contacts utilizing a snowball sampling technique to enhance reach and diversity. All participants gave their informed agreement regarding privacy and information management policies at the start of the survey after being informed of the research purpose and context. Personal information and domain data were anonymized, and participants were not compensated for completing the questionnaire. The study was approved by the Ethical Committee of the University of Evora (Ref-GD/14849/2020) and conducted following the Helsinki Declaration. Informed consent for study participation was obtained through the online questionnaire (first page).

Out of the 315 adult respondents who initially participated in the survey, 171 completed the entire questionnaire and were included in the analysis. Participants who did not complete all sections of the survey were excluded to ensure the integrity and reliability of the data. This exclusion criterion was necessary to maintain analysis quality and to draw valid conclusions regarding dietary habits during the lockdown.

2.3 Questionnaire

The survey covered a variety of aspects of eating behavior and typically took between 15 and 20 min to complete. For the benefit of the participants, the questionnaire was provided in French and English in addition to the local Arabic tongue. To ensure consistency across languages, the translation verification of the questionnaire was conducted using a back-translation method.

The questionnaire used in this study was adapted from an existing instrument developed for an international study on eating habits during the COVID-19 lockdown [14]. The original questionnaire was designed to be used across multiple countries, and we made modifications to ensure its suitability for the Moroccan context. The questionnaire included 21 questions in total and was divided into five main sections: the first Sect. (15 questions) aimed to collect sociodemographic and socioeconomic information (Age, sex, height, and weight, educational level, household size and composition, monthly income, and body mass index (BMI) (m^2). The questions in the second Sect. (30 questions) were mainly about eating motivations (liking, habits, need and hunger, health, convenience, pleasure, natural concerns, price, weight control, and affect regulation). The third Sect. (21 questions) was about food consumption frequency (dairy products, red and white meat, fish, eggs, vegetables, potatoes, grains, bread, breakfast cereals, fresh fruits, legumes, nuts, cakes and cookies, chocolates, sweet and salty snacks, processed foods, and coffee and tea). The fourth section of the questionnaire (19 questions) included questions designed to determine food-related behaviors (to purchase products from organic farming, to acquire locally produced foods, to grow or produce your foods, to purchase food from markets or supermarkets close to home, from large supermarkets or superstores, from apps and/or online stores, to purchase food in large quantities, trying not to waste food; planning shopping and meals; being aware of product expiration dates or shelf lives; paying attention to food waste, dedicating time to prepare meals; trying new dishes or recipes; ordering take-out meals, to feel hungry or the desire to eat; to control both the type and amount of food consumed, to ensure a balanced and varied diet; to search for foods providing comfort feeling; to have meals at fixed, predictable times; to include snacks between meals). The last section of the questionnaire (20 questions) included questions about purchase priorities (Fresh meat and fish, Frozen meat and fish, Canned fish, Dairy products, Fresh fruits, Fresh vegetables, Frozen vegetables, Dried beans and legumes, Canned beans and legumes, Nuts, Salty snacks, sweet snacks, Chocolates, Sugar, Bread, Cereals and potatoes, Eggs, Pre-cooked meals, Coffee or tea). A 7-point rating scale, between 1 (never) and 7 (always), was used to evaluate each of the three elements on each scale. Participants were also asked for each item to indicate whether it was greater than, less than, or similar to their usual behavior before the pandemic.

The questionnaire was pre-tested with a sample of 20 participants to assess clarity and relevance. Feedback was incorporated to refine the questions. Additionally, to ensure the appropriateness for the target population, the questionnaire was validated through expert review by nutritionists and public health professionals. The reliability of our questionnaire was assessed using Cronbach's alpha for ordinal variables and Cohen's kappa for nominal variables. The Cronbach's alpha value exceeded 0.7, indicating strong internal consistency among the questionnaire items suggesting that the questionnaire measures a single underlying construct. Cohen's kappa values, while moderate (between 0.3 and 0.6), are considered acceptable given the categorical nature of the nominal variables, reflecting adequate agreement beyond chance.

2.4 Statistical analysis

Statistical analysis was conducted using SPSS software version 26.0. For descriptive statistics, the continuous variables were presented as mean with standard deviation (SD) or as median with interquartile range (IQR), depending on data distribution. Numbers and percentages (%) were used for categorical variables. The BMI was classified based on the classification ranges defined by the World Health Organization (WHO). Mann–Whitney test (for non-normally distributed data) or Chi-squared test (for categorical data) were used for comparisons. Results were significant for p-value < 0.05. The Bonferroni test was applied as a post-hoc test to compare differences in case of significance.

Cluster analysis based on K-means clustering was performed to classify respondents on similar food habits. The cluster variables referred to intake frequency (second section). Based on the interpretability and reliability of the cluster solution, the final number of clusters was taken into consideration. For interpretation purposes, the F statistics were assessed. The clusters were compared in terms of perceived changes in food habits for each variable individually using the Mann–Whitney test. The variables used for this analysis were obtained from the items of our questionnaire regarding the level of change in food consumption frequency, food-related behavior, and purchase priorities comparatively to the usual behavior prior the pandemic. The responses taken into consideration were the ordinal variables ("less than before," "equal," and "more than before").

3 Results

3.1 Sociodemographic and socioeconomic characteristics of the participants

A total of 315 participants answered the sociodemographic and socioeconomic characteristics. Almost two-thirds (62.5%) of the respondents were women compared to 37.5% of men, and 68.6% had no children living with them. The majority of the participants (90.5%) were graduates or had recently completed their degrees (bachelor's, master's, or Ph.D. degree). More than half (50.8%) of the participants were confined, with the majority being women, and 45.4% had high monthly income (Table 1).

Men were significantly older ($p = 0.002$) and had a higher BMI ($p = 0.026$) than women. Whereas women were more likely to be confined ($p = 0.000$), have physical activity ($p = 0.000$), and profession ($p = 0.037$) (Table 1). Among 315 participants, only 171 had completed the survey and were included in subsequent analyses.

3.2 Consumption habits before the pandemic

Our results showed that before the pandemic, participants often consumed their main meals at home (mean score of 5.7 ± 1.76), while fewer individuals frequented the canteen (mean score of 1.5 ± 1.18) (Table 2).

3.3 Impact of COVID-19 lockdown on dietary habits

3.3.1 Eating motivations

The most reported eating motivations were health, followed by liking, pleasure, and natural concerns, the most often reported (mean score of 5.1 ± 1.82, 4.9 ± 1.75, 4.8 ± 1.70, and 4.8 ± 1.81, respectively), while affective regulation factors had a weak influence on eating habits (mean score of 3 ± 1.82). Regarding the perceived changes caused by the pandemic crisis, a higher frequency of participants claimed that "health" and "pleasure" were the most important motivations (Supplementary Table 1).

3.3.2 Food frequency consumption

During the pandemic situation, foods such as bread, coffee/ tea, vegetables, olive oil, beans and legumes, and fresh fruit were consumed 5–6 times per week by participants. An important frequency of respondents reported higher

Table 1 Sociodemographic and socioeconomic characteristics of the 315 participants

Parameters	Total (n = 315)	Women (197)	Men (118)	*p*-value
Gender (%)		62.5%	37.5%	
Age (Mean ± SD)	30.3 ± 12.06	28.2 ± 10.06[a]	33.6 ± 14.22[b]	0.002
BMI (Kg/m^2) (median IQR)		23.1 (15.06—208.09)[a]	24.1 (16.33 -145.33)[b]	0.026
Confinement, n (%)				
Yes	158 (50.8%)	126 (40.5%)[a]	32 (10.3%) [b]	0.000
No	153 (49.2%)	70 (22.5%)[a]	83 (26.7%) [b]	
Type of confinement's Residence, n (%)				
Apartment	203 (65.1%)	131 (42%)	72 (23.1%)	> 0.05
Shared apartment	10 (3.2%)	6 (1.9%)	4 (1.3%)	
Villa with outdoor space	16 (5.1%)	10 (3.2%)	6 (1.9%)	
Own home	83 (26.6%)	48 (15.4%)	35 (11.2%)	
Living during confinement with, n (%)				
1 or 2 persons	73 (23.2%)	45 (14.3%)	28 (8.9%)	> 0.05
3 or 4 persons	150 (47.6%)	97 (30.8%)	53 (16.8%)	
More than 4 persons	92 (29.2%)	55 (17.5%)	37 (11.7%)	
With children, n (%)				
Yes	99 (31.4%)	56 (17.8%)	43 (13.7%)	> 0.05
No	216 (68.6%)	141 (44.8%)	75 (23.8%)	
With eldered, n (%)				
Yes	81 (26%)	54 (17.4%)	27 (8.7%)	> 0.05
No	230 (74%)	142 (45.7%)	88 (28.3%)	
PA, n (%)				
Yes	170 (54.3%)	90 (28.8%)[a]	80 (25.6%)[b]	0.000
No	143 (45.7%)	106 (33.9%)[a]	37 (11.8%)[b]	
Frequency of PA per week (45–60 min or more), n (%)				
1–2 times	124 (39.6%)	66 (21.1%)[a]	58 (18.5%)[b]	0.001
3–4 times	33 (10.5%)	15 (4.8%)[a]	18 (5.8%)[b]	
> 4 times	8 (2.6%)	6 (1.9%)	2 (0.6%)	
Education, n (%)				
Elementary school	13 (4.1%)	9 (2.9%)	4 (1.3%)	> 0.05
High school	9 (2.9%)	5 (1.6%)	4 (1.3)	
Graduate/post graduate	285 (90.5%)	176 (55.9%)	109 (34.6%)	
Other	8 (2.5%)	7 (2.2%)	1 (0.3%)	
Monthly income, n (%)				
Low	63 (20%)	44 (14%)	19 (6%)	> 0.05
Medium	47 (14.9%)	24 (7.6%)	23 (7.3%)	
High	143 (45.4%)	90 (28.6%)	53 (16.8%)	
Other	62 (19.7%)	39 (12.4%)	23 (7.3%)	
Percentage of monthly income dedicated for food, n (%)				
< 25%	106 (33.7%)	60 (19%)	46 (14.6%)	> 0.05
25–50%	131 (41.6%)	82 (26%)	49 (15.6%)	
> 50%	66 (21%)	45 (14.3%)	21 (6.7%)	
Other	12 (3.8%)	10 (3.2%)	2 (0.6%)	
Current employment status, n (%)				
Employee	128 (40.8%)	68 (21.7%)[a]	60 (19.1%)[b]	0.037
Retired	7 (2.2%)	4 (1.3%)	3 (1%)	
Student	152 (48.4%)	106 (33.8%)[a]	46 (14.6%) [b]	
Unemployed	27 (8.6%)	18 (5.7%)	9 (2.9%)	

Table 1 (continued)

Parameters	Total (n = 315)	Women (197)	Men (118)	*p*-value
Nutritional status (kg/m^2)*				
Underweight	22 (7.1%)	14 (4.5%)	8 (2.6%)	0.021
Normal	186 (60.4%)	128 (41.6%)[a]	58 (18.8) [b]	
Overweight	76 (24.7%)	41 (13.3%)	35 (11.4%)	
Obesity	23 (7.5%)	9 (2.9%)[a]	14 (4.5%) [b]	
Morbid obesity	1 (0.3%)	1 (0.3)	0	

Differences in gender were evaluated by the Mann–Whitney test for continuous variables (age and BMI) and the Chi-square-test for categorical variables ($p < 0.05$)

*Nutritional status expressed in kg/m^2, using WHO classification

[a] and [b] mean significant differences between gender (p-value < 0.05), *PA* physical activity

Table 2 Consumption of main meals before pandemic

Variable	Mean	± SD
Conventional restaurants	1.9	1.21
Fast food	2.2	1.4
Canteen	1.5	1.18
Home food	5.7	1.76

Table 3 Cluster analysis of food variables (n = 171)

Variable	Means		F statistics
	Cluster 1 "Good habits" (n = 141)	Cluster 2 "Bad habits" (n = 30)	
Dairy products	4.69	5.86	12.20
Red meat	3.22	4.12	8.77
White meat	3.87	4.50	5.54
Fish	3.26	4.21	11.20
Eggs	4.58	5.81	18.52
Vegetables	5.75	5.89	0.29
Complex glucids	3.94	4.27	0.46
Bread	6.17	6.56	1.42
Breakfast cereals	2.21	4.11	24.77
Fresh fruits	5.25	5.96	4.47
Butter or Margarine	2.97	4.82	22.70
Olive oil	5.48	0.88	2.20
Beans and Legumes	5,63	5.13	1.50
Nuts	2.86	5.36	54.92
Cakes and Cookies	3.51	5.71	49.23
Chocolates	2.80	5.61	91.29
Salty snacks	2.14	5.04	104.70
Processed foods/fast food	1.70	3.68	41.06
Coffee and/or Tea	5.82	6.21	1.30

consumption of vegetables (40.7%), followed by fresh fruits, olive oil, beans, and legumes (33.3%, 24.2%, and 23.8%, respectively) during this period (Supplementary Table 1).

The results of cluster analysis provided two different groups that we identified as Cluster 1, "Good Habits," and Cluster 2, "Bad Habits" (Table 3). The first cluster accounted for 82.46% of individuals who did not change their food consumption frequency during the pandemic. Compared to cluster 1, cluster 2 represented 17.54% of participants with increased food consumption frequency, especially salty snacks, chocolate, nuts, cakes and cookies, and processed food (Table 3).

Table 4 Food frequency consumption during the lockdown period compared with clusters

	Cluster 1 *"Good habits"* (n = 141)				Cluster 2 *"Bad habits"* (n = 30)				*p*-value
	Mean (± SD)	Perceived change due to COVID-19 lockdown (% of participants)			Mean (± SD)	Perceived change due to COVID-19 lockdown (% of participants)			
		Lower	Equal	Higher		Lower	Equal	Higher	
Dairy products (milk, yogurts, cheese)	4.7[a] (1.68)	17.1	60	22.9	5.9[b] (1.17)	10.7	57.1	23.1	$p = 0.000$
Red meat (beef, pork)	3.2[a] (1.4)	29.2	63.5	7.3	4.1[b] (1.45)	37	63	0	$p = 0.004$
White meat (chicken, turkey)	3.9[a] (1.22)	15.3	70.8	13.9	4.5[b] (1.55)	19.2	61.5	19.2	$p = 0.019$
Fish	3.2[a] (1.32)	29.2	54	16.8	4.2[b] (1.59)	26.9	65.4	7.7	$p = 0.002$
Eggs	4.6[a] (1.32)	10.9	60.6	28.5	5.8[b] (1.49)	11.5	57.7	30.8	$p = 0.000$
Vegetables (cabbage, carrots, broccoli, etc.)	5.7 (1.16)	3.6	53.3	43.1	5.9 (1.45)	7.4	59.3	33.3	
Complex glucids (potatoes + rice, pasta)	3.9 (1.58)	13.9	63.5	22.6	4.3 (2.37)	14.8	70.4	14.8	
Bread	6.2 (1.56)	12.4	68.6	19	6.6 (1.28)	7.4	59.3	33.3	
Breakfast cereals	2.2[a] (1.76)	28.6	63.2	8.3	4.1[b] (2.02)	26.9	57.7	15.4	$p = 0.000$
Fresh fruits (apples, oranges, bananas, strawberries, …)	5.2[a] (1.64)	15.9	50	34.1	5.9[b] (1.55)	7.7	61.5	30.8	$p = 0.02$
Butter or Margarine	2.9[a] (1.86)	25	63.3	11.7	4.8[b] (1.90)	23.1	57.7	19.2	$p = 0.000$
Olive oil	5.5 (1.64)	6.6	69.1	24.3	0.9 (1.20)	11.5	65.4	23.1	
Beans and Legumes (beans, lentils, etc.)	5.6 (1.25)	16.9	58.1	25	5.1 (1.92)	7.7	76.9	15.4	
Nuts (almonds, nuts, hazelnuts, cashew, etc.… without salt)	2.9[a] (1.56)	24.6	57.4	18	5.4[b] (1.87)	13.3	53.3	33.3	$p = 0.000$
Cakes and Cookies (cake, cookies, brownies, pie, doughnuts)	3.5[a] (1.54)	23.9	48.5	27.6	5.7[b] (1.30)	15.4	46.2	38.5	$p = 0.000$
Chocolates	2.8[a] (1.37)	30.6	53.7	15.7	5.6[b] (1.59)	23.1	46.2	30.8	$p = 0.000$
Salty snacks (chips, pretzels, crackers, salted nuts etc. …)	2.1[a] (1.23)	44.5	38.7	18.8	5[b] (1.87)	11.5	61.5	26.9	$p = 0.000$
Processed foods/fast food (sausages, pizza, hamburger, etc.)	1.7[a] (1.13)	66.2	25.6	8.3	3.7[b] (2.62)	46.2	34.6	19.2	$p = 0.000$
Coffee and/or Tea	5.8 (1.76)	8.8	67.9	23.4	6.2 (1.03)	15.4	69.2	15.4	

Different upper letters mean significant differences between clusters (p-value < 0.05; Mann–Whitney test)

In order to analyze how lockdown affected the dietary behavior of our population, the clusters were compared in terms of perceived changes in food habits for each variable individually. Table 4 showed a significant difference between clusters, with cluster 2 reporting a higher consumption of salty snacks, chocolates, cakes and cookies, and processed foods ($p < 0.001$) than the period before the pandemic (Table 4).

3.3.3 Food-related behaviors

The main food-related behaviors observed by the participants were "to be aware of products' expiration dates/shelf life" (mean 5.7 ± 1.66), followed by "to dedicate time to preparing meals" and "to maintain a varied/balanced diet" (mean 5.3 ± 1.74, and 5.1 ± 1.91, respectively). In contrast, "to consume meals prepared outside the home" and "to buy food from apps and/or online stores" were reported as being minor concerns (mean scores of 1.7 ± 1.43 and 1.3 ± 0.97, respectively) (Supplementary Table 1).

During the lockdown period, the perceived changes were higher for those dedicating time to prepare meals and being aware of products' expiration dates/ shelf life (Supplementary Table 1).

Food-related behaviors were compared according to the clusters. On average, no significant differences were observed between the clusters during the lockdown period (Table 5).

3.3.4 Food purchase priorities

Regarding the purchase priorities, more attention was paid to purchasing fresh vegetables, fresh fruit, and coffee or tea (mean scores of 5.8 ± 1.54, 5.7 ± 1.70, and 5.4 ± 1.91, respectively). In contrast, lower priorities were reported for frozen meat and fish and frozen vegetables (mean scores of 1.8 ± 1.19 and 1.8 ± 1.55, respectively) (Supplementary Table 1). Moreover, a higher frequency of participants spent more on fresh vegetables, fresh fruit, and dried beans and legumes during the lockdown (Supplementary Table 1).

On the other hand, the results of cluster analysis showed that participants from cluster 2, with Bad Habits, prioritized canned beans and legumes, chocolates, and frozen vegetables ($p = 0.001$, $p = 0.005$, and $p = 0.02$, respectively) (Table 6). Additionally, the priority to purchase these food items increased among this cluster during the lockdown (Table 6).

4 Discussion

Due to the worldwide spread of COVID-19, governments were forced to make strong restrictive measures and decisions to mitigate this pandemic [15]. The lockdown was a challenging experience for all countries, including Morocco, which is a middle-income developing country. The Moroccan government's priorities changed as the pandemic situation and the related lockdown policy (from March 20 to April 20, 2020) led to economic loss [1].

The present work, which was conducted as part of an international study led by the University of Evora, Portugal [14], showed important results related to the main changes in dietary habits among the Moroccan population during the COVID-19 lockdown.

Our results showed that the majority of participants were younger, graduated, and with higher monthly incomes (Table 1). A significant difference was found between genders regarding age ($p = 0.002$) and BMI ($p = 0.026$), with women being younger and had a normal weight. This seems normal as Moroccan women were used to spending more time on household chores (cooking and preparing meals, and trying various recipes, and cleaning) as entertainment activities that needed time and effort. Half of our respondents were confined (50.8%), which could be related to the restriction measures that faced people to remote work or study.

Being a Mediterranean country, Morocco adopts a healthy MD [16, 17] characterized by a high fiber content, a low caloric intake, a high consumption of plant-based foods, olive oil as a major source of fat, and moderate consumption of animal products [18]. Before the pandemic, we reported higher consumption of main meals at home compared to less frequented canteen and restaurants (Table 2). This is expected, as mothers are still in charge of meal preparation in the Moroccan community, and this may be one of the best indicators of the quality of the family diet.

As a result of the lockdown, eating motivations and emotions related to food consumption were influenced. Our results exhibited that health, followed by liking, pleasure, and natural concerns, were the most motivations often reported by the participants. Moreover, health and pleasure were the highest frequencies of perceived changes. For some participants, 'health" became a priority because of the fear of contracting the disease, which motivated them to take care of their

Table 5 Food-related behaviors during the lockdown period compared with clusters

	Cluster 1 *"Good habits"* (n = 141)				Cluster 2 *"Bad habits"* (n = 30)				*p*-value
	Mean (± SD)	Perceived change due to COVID-19 lockdown (% of participants)			Mean (± SD)	Perceived change due to COVID-19 lockdown (% of participants)			
		Lower	Equal	Higher		Lower	Equal	Higher	
To buy food from grocery stores or markets near home	4.6 (2.06)	26.6	34	39.4	4.7 (2.18)	12.5	56.3	31.3	
To buy food from large superstores or supermarkets	2.7 (1.79)	62.1	24.1	13.8	3.5 (1.88)	31.3	62.5	6.3	
To buy food from apps and / or online stores	1.3 (0.77)	30.4	65.8	3.8	1.6 (1.73)	25	66.7	8.3	
To buy food in large quantities (for periods of longer than 1 week)	3.9 (2.18)	8.9	32.2	58.9	3.8 (2.1)	6.7	46.7	46.7	
To purchase products from organic farming	3.6 (2.19)	7.9	74.1	18	3.7 (2.46)	13.3	53.3	33.4	
To acquire locally produced foods	4.3 (2.11)	9.1	63.6	27.3	3.6 (1.98)	0	76.9	23.1	
To dedicate time to preparing meals	5.2 (1.74)	4.3	43.5	52.2	5.6 (1.77)	6.3	31.3	62.5	
To consume meals prepared outside home (eg, takeout or delivery from restaurants)	1.6 (1.14)	69	21.4	9.5	2.5 (2.5)	54.5	27.3	18.2	
To feel appetite / desire to eat	4.4 (1.87)	17.2	50.5	32.3	5.3 (2.12)	6.3	56.3	37.5	
To maintain control over the type of food and the amount eaten	4.7 (1.95)	15.2	56.5	28.3	5 (1.96)	25	50	25	
To maintain a varied / balanced diet	5.2 (1.85)	11	60.4	28.6	4.8 (2.28)	6.3	62.5	31.3	
To look for foods that provide the sensation of comfort	4.3 (1.82)	15.9	59.1	25	4.8 (2.10)	6.3	56.3	37.5	
To eat meals at fixed / predictable times	4.3 (2.13)	29.2	52.8	18	4.1 (2.21)	25	50	25	
To snack between meals	3.4 (2.08)	22.7	51.1	26.1	4.4 (2.20)	6.7	60	33.3	
To make new dishes or try new recipes	4.4 (1.83)	4.3	34.8	60.9	5.1 (1.79)	0	31.3	68.8	
To try not to waste food	4.7 (2.07)	2.3	62.8	34.9	5 (2)	6.7	40	53.3	
To plan ahead for shopping and meals	4.8 (2.18)	2.2	46.1	51.7	5.4 (1.82)	0	53.3	46.7	
To be aware of products' expiration dates/ shelf life	5.7 (1.64)	2.2	62.6	35.2	5.8 (1.78)	0	37.5	62.5	

Different upper letters mean significant differences between clusters (p-value < 0.05; Mann–Whitney test)

Table 6 Purchase priorities during the lockdown period compared with clusters

	Cluster 1 *"Good habits"* (n = 141)				Cluster 2 *"Bad habits"* (n = 30)				*p*-value
	Mean (± SD)	Perceived change due to COVID-19 lockdown (% of participants)			Mean (± SD)	Perceived change due to COVID-19 lockdown (% of participants)			
		Lower	Equal	Higher		Lower	Equal	Higher	
Fresh meat and fish	4.4 (1.91)	16	62.8	21.3	5.7 (1.97)	12.5	56.3	31.3	
Frozen meat and fish	1.6 (1.14)	22.1	72.1	5.8	2.2 (1.36)	21.4	71.4	7.1	
Canned fish (eg tuna)	3.3 (1.85)	13.3	65.6	21.1	3.6 (1.69)	18.8	50	31.3	
Dairy products (eg cheese, yogurt)	4.6 (1.75)	9.3	65.1	25.6	5 (1.94)	0	58.3	41.7	
Fresh fruit (eg banana, apple)	5.6 (1.69)	8.8	60.4	30.8	6 (1.73)	0	40	60	
Fresh vegetables (eg cabbage, carrots)	5.9 (1.49)	5.4	61.3	33.3	5.8 (1.8)	0	50	50	
Frozen vegetables (e.g. spinach, broccoli)	1.6[a] (1.25)	27.9	68	3.5	3.1[b] (2.28)	14.3	71.4	14.3	$p = 0.02$
Dried beans and legumes (eg grain, beans, lentils)	4.6 (1.83)	6.6	56	37.4	4.6 (1.95)	0	78.6	21.4	
Canned beans and legumes (ex. grain, beans, lentils)	1.8[a] (1.56)	24.4	66.7	8.9	3.3[b] (2.05)	0	69.2	30.8	$p = 0.001$
Nuts (almonds, peanuts, etc., no salt)	3.5[a] (1.75)	28	61.3	10.8	5.1[b] (1.89)	0	60	40	$p = 0.003$
Salty snacks (chips, pretzels, crackers, salted nuts, among others)	2.5 (1.54)	38	53.3	8.7	2.9 (2.09)	6.7	60	33.3	
Sweet snacks (eg candy bars) cereals; cakes and cookies; sweets)	3.2 (1.75)	27.2	54.3	18.5	4.2 (2.14)	13.3	53.3	33.3	
Chocolates	2.9[a] (1.66)	36.6	51.6	11.8	4.5[b] (1.99)	6.3	50	43.8	$p = 0.005$
Sugar	3.4 (1.86)	28.7	60.6	10.6	4.3 (2.32)	0	86.7	13.3	
Bread	5 (2.02)	12.9	69.9	7.2	5.1 (1.88)	0	62.5	37.5	
Eggs	5.1 (1.8)	7.7	69.2	23.1	4.8 (2.02)	0	81.3	18.8	
Coffee or tea	5.4 (1.88)	6	75.8	17.6	4.9 (2.03)	6.3	68.8	25	

Different upper letters mean significant differences between clusters (p-value < 0.05; Mann–Whitney test)

eating habits. They chose to eat more fruits and vegetables as a preventative measure to stay healthy. Other participants chose "pleasure" as comfort food in response to imposed stress and boredom due to the pandemic. These results align with a study conducted in France that reported some changes in food choice motives during the lockdown period, with an increase in mood and health as a food choice motivation [19]. Moreover, an Italian study reported that half of the questioned individuals ate comfort foods and increased their food intake as means to improve their mood [11]. It is well known that emotional eating is linked to the tendency of individuals to overeat in response to negative emotional stimuli. A study conducted by Shen et al. reported that perceived stress during lockdown was correlated with a higher desire to choose food based on mood, convenience, natural content, price, and familiarity [20].

During the lockdown period, an important proportion of respondents declared to make new dishes or try new recipes, dedicating time to preparing meals and planning for food shopping and meals. On the other hand, "to consume meals prepared outside the home" was reported as being a minor concern, whereas "to dedicate time to preparing meals" and "to maintain a varied/balanced diet" were the main food-related behaviors observed by the respondents (Supplementary Table 1). These changes potentially resulted from the fear and anxiety felt about contracting the disease, on the one hand, and the absence of entertainment places due to the closure of restaurants, coffee, and cultural institutions during the lockdown, on the other hand. This may be considered a positive effect of the pandemic as people had more time to cook and organize their meals at home [21]. Our findings are in agreement with those found by Sumalla-Cano et al. who reported that the only increase during the lockdown period was in the frequency of cooking [22].

During the lockdown, many participants kept a healthy food diet, and their food consumption included mainly fruits and vegetables. This may translate the Moroccan habits in general, on the one hand, and their awareness of the importance of good health and well-being during this pandemic situation, on the other hand. This would help individuals strengthen their immunity and improve their mood and physical status. Home-cooked meals may provide a great benefit for health as they permit control of the ingredients of each meal and ensure a healthy diet compared to eating out [23–25]. In addition, preparing meals at home had more advantages than physical health [26].

The majority of respondents did not change their food-related behaviors, as they stated buying food from grocery stores or markets near home, purchasing products from organic farming, acquiring locally produced food, and dedicating time to preparing meals. This seems to be normal in Morocco, which is known by the availability of mini grocery stores in each neighborhood. Our data are in disagreement with those from other countries that reported a lower frequency of grocery shopping compared to increased interest in online grocery shopping. Similar to our results, published studies also reported increased consumption of locally sourced food items due to food safety concerns [1, 4].

Regarding the impact of the lockdown on food frequency consumption, an important proportion of respondents reported consuming bread, coffee/tea, vegetables, olive oil, beans and legumes, and fresh fruit during this period (Supplementary Table 1). In terms of food variety and diversity, the results of this study revealed that the food proportions consumed by the respondents substantially met the updated MD recommendations [27]. Previous studies have created graphical representations of the Moroccan population's diet (adults, women, and men) living in urban and rural areas, taking into account various socio-demographic characteristics as factors likely to influence their eating behaviors, including food consumption [28]. Given the complexity and variety of foods, as well as the lifestyles and social customs, it has been reported that the Moroccan population still follows the MD [29, 30]. This confirms that people did not change their good eating habits during the pandemic because they are already on a rich, varied, and healthy diet and also to take more care of their health. The Moroccan daily food pattern consists of cereals, vegetables, fresh fruit, red meat, fish, legumes, olive oil, and other vegetable oils [31–33]. Our findings are comparable to those reported by Sumalla et al. where most respondents did not change their eating habits during the lockdown [22]. Furthermore, Ben Hassen et al. declared that despite the seriousness of the problem, most participants expressed health concerns by cutting back on unhealthy food, such as sweets and fast food, during the pandemic to boost the immune system [4]. In contrast, Celorio-Sardá et al. found an increase in the consumption of fruit, vegetables, legumes, fish, eggs, and yogurt among participants [34].

As mentioned above, based on the food frequency consumption parameter, the participants were classified into two clusters: "Good Habits" (cluster 1) and "Bad Habits" (cluster 2). Individuals of Cluster 1 declared they had not changed their consumption frequency of food during the pandemic situation compared to those of Cluster 2. A larger frequency of participants in Cluster 2 reported increased consumption related to chocolates, cakes and cookies, processed foods, and salty snacks ($p < 0.001$) during the lockdown. This may be the result of daily stress felt because of the pandemic consequences, such as confinement, fear of disease, and unemployment. In response to this stress, emotional eating has occurred as a form of the consumption of sugary foods and snack food between meals [19]. This is in agreement with data reported by Casas et al. [21], in which some participants have chosen to eat sugary foods to improve their mood. Other studies have shown that foods high in sugar, fat, and salt are overconsumed under these strange living conditions

[26, 35]. It is difficult to establish a relationship between foods and mood even though the results show that liking is one of the eating motivations because companionship is one of the characteristics of the Mediterranean model [36]. The fact that people are still involved in meal preparation and still eat at least two meals a day with their families may have a good effect on their general health. On the other hand, eating meals with others can have a good effect on mood and helps reduce the risks associated with depression.

Similarly, we found that individuals of Cluster 2 had a higher priority for purchasing chocolates, canned beans and legumes, frozen vegetables, and sweet snacks during the lockdown period. Although the participants in the "Bad Habits" group are very few, the negative effect of confinement on their mental state and, consequently, their eating behavior should not be overlooked. The pleasurable feeling of eating sugary and appetizing food can be used as a self-medicating way to cope with daily stress [37] since high-sugar foods stimulate serotonin production [38]. Di Renzo et al. [11] reported an increase in the consumption of sweets during confinement in Italy, a country that was particularly affected during the first wave of the pandemic. These results are consistent with those reported by Bin Zarah et al. [39], who found an increase in the consumption of tasty and processed food during quarantine among the US population.

Our findings suggest that most participants did not change their eating habits or food purchases during the studied period, which is similar to Poelman et al. study confirming the persistence of dietary routines [40].

The findings of this study indicate that the COVID-19 pandemic has led to notable changes in dietary habits among the Moroccan population, with implications for public health interventions. To address these changes, policymakers must develop targeted dietary guidelines that promote healthy eating behaviors, especially during crises. Public health campaigns could focus on educating the population about the importance of balanced nutrition and the risks associated with increased consumption of processed foods. Furthermore, we recommend that future research explore the long-term effects of the pandemic on eating habits through longitudinal studies. Qualitative research could also provide deeper insights into the psychological factors influencing food choices during stressful times. Additionally, future studies should aim to include a more diverse and representative sample, encompassing various socioeconomic backgrounds and geographic regions, to ensure that findings apply to the entire Moroccan population.

5 Strengths and limitations

The present study showed several limitations that should be acknowledged. First, the use of a snowball sampling technique may introduce selection bias. As individuals with higher social connectivity are more likely to participate, this could potentially skew the sample toward those with higher socioeconomic status and education levels. This offers a valuable snapshot of the immediate impacts of the pandemic on dietary behaviors. In fact, this is often the case in surveys with volunteers [41], where individuals with a low education level are frequently underrepresented in these surveys [42]. In addition to the gap in internet usage between rural and urban areas in all Middle East and North Africa (MENA) countries, including Morocco [43]. Second, the reliance on self-reported data can lead to reporting bias, as participants may not accurately recall their food consumption or may respond in a socially desirable manner. These factors limit the generalizability of our findings to the broader Moroccan population. Future studies should consider employing stratified random sampling methods and objective measures of food consumption to enhance the validity and generalizability of the results. Additionally, exploring the long-term impacts of the pandemic on dietary habits and the factors influencing these changes would be valuable for informing public health policies and interventions.

Nevertheless, this limitation could be considered a strength of our study because individuals with a high level of education are supposed to be more careful about what they eat before and during the lockdown and subsequently carefully declare their food consumption [19]. Another strength of our work is that the survey included all ages (≥ 18 years). In addition, to the best of our knowledge, this is the first study that assessed and compared changes in dietary habits during the lockdown among the Moroccan adult population. The findings can guide public health policies to promote healthier eating and address pandemic-related challenges.

6 Conclusion

COVID-19 was painful for all countries, including Morocco. The lockdown negatively and positively impacted Moroccan dietary practices. Our preliminary research indicates that the group of people we studied had healthy habits before the pandemic due to the original MD. The Bad Habits group, which represents a minority of our studied population, had

slightly changed their eating habits as a result of the pandemic situation. At the same time, the large population maintained the same dietary habits, given the impact of good dietary habits on the protection against contamination. People around the world are oriented towards a healthy and balanced diet. At the same time, the MD to which Morocco belongs is rich in the principal source of bioactive compounds that contribute to health and general well-being and could be a therapeutic approach to COVID-19.

The impact of COVID-19 on eating habits cannot go unnoticed, especially since the restriction measures have been in place for a very long time. Future research studies must focus on the long-term effect of COVID-19 pandemics on household and commercial eating habits and the general nutritional status of individuals.

Author contributions Z.Z and A.B: study conception and design, draft of the article, data treatment, analysis and interpretation of the data, writing the main manuscript text. J.B and N.M: critical revision, editing, and final approval. E.L: preparation of the questionnaire, data collection, critical revision, editing, and final approval. A.B, N.GN, M.BM, and E.L: supervision All authors have read and approved the final version of the manuscript.

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Declarations

Competing interests The authors declare no competing interests.

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