Discover Public Health

RESEARCH Open Access

Impact of the first COVID-19 lockdown period on diet and health-related behaviours of Maltese adults

Claire Copperstone[1*], Stuart W. Flint[2,3], Adrian Brown[4,5,6] and Fiona Sammut[7]

*Correspondence:
Claire Copperstone
claire.copperstone@um.edu.mt
[1]Department of Food Sciences and Nutrition, Faculty of Health Sciences, University of Malta, Msida, Malta
[2]School of Psychology, University of Leeds, Leeds, UK
[3]Scaled Insights, Nexus, University of Leeds, Leeds, UK
[4]Centre for Obesity Research, University College London (UCL), London, UK
[5]Bariatric Centre for Weight Management and Metabolic Surgery, University College London Hospital NHS Trust (UCLH), London, UK
[6]UCLH NIHR Biomedical Research Unit, London, UK
[7]Department of Statistics and Operations Research, Faculty of Science, University of Malta, Msida, Malta

Abstract

Empirical evidence has highlighted the impact of the Coronavirus (COVID-19) pandemic, specifically examining 'lockdown periods' enforced by Governments globally. These studies have shown that lockdowns had a disproportionate impact on subgroups of the population, which may have exacerbated health inequalities. The primary aim was to explore the impact of the first partial lockdown period (March–June 2020) on health-related behaviours in Maltese adults. A retrospective cross-sectional survey study design was employed and disseminated between September and October 2020 online. The study was approved by the University of Malta's Faculty of Health Sciences Research Ethics Committee. A total of 358 respondents were included in the final analysis in a predominantly female sample (n = 295, 82.9%). Median body mass indices for males and females were 27.4 and 25.5 kg/m^2, respectively. Approximately one third, 139 (38.8%), of respondents, claimed that they had gained weight and similarly, 140 (39.1%) reported trying to lose weight. Over a third (n = 145, 40.5%) reported increased food prices, with 53.1% also reporting moderate or high changes in food shopping behaviours (n = 190). Moderate or high changes in diet were reported by 161 (44.9%) respondents, including increased consumption of confectionery/snacks (n = 132, 62.5%). No changes in alcohol consumption were reported by the majority (n = 231, 64.5%). Nearly half (163, 45.5%) reported less physical activity carried out. These findings show some of the negative impacts the first partial lockdown had on health behaviours, the food environment and body weight in Maltese adults and have important implications for any future pandemics.

Keywords COVID-19, Lockdown, Health behaviours, Food consumption changes

1 Introduction

Empirical evidence demonstrates the wide-ranging effects of the Coronavirus (COVID-19) pandemic and measures to control its spread (i.e. lockdowns) on population groups across the world. For instance, research has highlighted that national and regional lockdown periods had a detrimental impact on health behaviours such as weight gain, reduced physical activity (PA) and changes in food purchasing habits [1]. Another study

also reported increased weight in the longer term with a potential time-lag effect for the post-lockdown period [2].

Evidence also highlights that lockdowns, and the associated impact of these such as reduced social contact, change to employment status and working patterns, as well as changes in health-related behaviour engagement and quality, led to increased reporting of mental health concerns and reduced wellbeing and loneliness [3, 4]. These implications of lockdown restrictions are likely to have impacted prevention and treatment of non-communicable diseases and risk of mortality.

A systematic review reporting on both adults and children during the COVID-19 lockdown period [5] shows mixed results for adherence to the Mediterranean diet (MD), including reduced adherence in an Italian cross-sectional study [6] and increased adherence in Spain [7]. Lockdown restrictions also accentuated the reliance on the home environment and created an unparalleled obesogenic situation caused by more sedentary behaviours, and poorer mental health as has been previously mentioned [8]. The COVID-19 global crisis has also affected the progress in attaining the Sustainable Development Goals (SDGs), particularly SDG 1 (No Poverty) and also SDG 10 (Reduce Inequality) as well as the relationships between the different SDGs in the light of this crisis, with some countries struggling more to recover than others [9].

Malta is a small island nation in the southern Mediterranean with a population of just over half a million according to local national statistics [10]. The first COVID-19 case was locally reported on the 7th March 2020. Consequently, a series of restrictive measures were imposed which included closures of schools and a legal ban applicable for those defined as clinically vulnerable from leaving their homes with stepwise relaxation from May and June 2020. Malta has a high prevalence of non-communicable diseases (NCDs) with one in four adults reported to be living with obesity [11] and Type 2 diabetes, both of which have been identified as risk factors for severe illness from COVID-19 [12]. Understanding the impact of the first partial lockdown period in Malta can therefore help to guide policy makers and public health scientists when planning for future global emergencies and improving preparedness and resilience in the longer term.

There is sparse data covering the COVID-19 period and its impact on specific health behaviours in Malta. One local study retrospectively examined self-reported data collected from Maltese adults ($n = 1034$) over a one-year period, the first year of the pandemic, reporting changes in weight, alcohol consumption, smoking and PA. In this study, half of the respondents reported decreased PA (49.32%) and weight gain (43.23%), with no change in alcohol consumption (88.68%) or smoking (91.30%) for most respondents [13].

Whilst the COVID-19 pandemic has ended, it is an important case study to understand the impact it has had whilst planning for future preparedness for any further global pandemics. Health systems, policymakers and public health officials need a strong understanding of the impact that the pandemic had on the Maltese population to support the longer-term needs and for the management of any future lockdowns or pandemics.

The aim of this local cross-sectional study was therefore to examine the effect of the first partial lockdown on diet and health-related behaviours of Maltese adults. Consequently, we hypothesised that Maltese adults made several changes to their health behaviours during the first lockdown period, including diet, sleep, PA, and use of food

delivery services and which were dependant on age, sex, weight status, salary and education levels.

2 Methodology

2.1 Study design and participants

A retrospective study design methodology was implemented through the dissemination of a 44-question anonymised online survey on Google forms between the period of September and October 2020. The survey explored the impact of the first partial lockdown period (March–June 2020) on health-related behaviours of Maltese adults. Inclusion criteria included being a Maltese resident and aged ≥ 18 years. Participants were recruited online through invitations on social media. Exclusion criteria were: not having availability to the internet and aged < 18 years. Participants were provided with an information letter accompanying the survey explaining that filling in the survey implied consent. Respondents were thus able to change their minds and refrain from completing and submitting the survey. No incentives were provided to the respondents.

The online survey was available in Maltese and English languages. The questions were adapted from two UK questionnaires [3, 4, 14]. It consisted of a combination of both closed and open-ended questions, divided into three main sections: Demographic Characteristics (Section A), Food Costs and Availability (Section B) and Health-related Behaviours (Section C). For diet and PA changes, 5-point Likert type items were utilised. For diet changes: 'no change in diet' up to 'a great deal of change'; for PA changes, a positive outcome was reported with increasing level: from 'much less PA', to 'no change' up to 'much more active than usual'. For food shopping, alcohol consumption, food delivery service utilisation and sleep changes, 3 -point Likert type items were utilised. For food shopping from: 'no change' up to 'a great deal of change'; for alcohol consumption: from 'much less/less' alcohol consumption through 'no change' up to 'more/much more consumption than usual'; for food delivery service utilisation: from 'no utilisation' to 'as usual' and then to ' more than usual utilisation'; for sleep: from 'no change' to 'moderate' up to a 'great deal of change'. A food delivery service typically refers to a courier service by food outlets, such as supermarkets, through which clients could order food products including grocery items, typically by telephone or through the websites or mobile applications.

Prior to the survey launch, piloting of the survey (face validation) was carried out among nine participants. Minor amendments were made, mainly to improve the level of comprehension of some questions.

2.2 Ethics

The study received ethical approval from the University of Malta Faculty Research Ethics Committee (FREC) (ref no. 15062020 5930).

2.3 Statistical analysis

Sample size requirement was calculated according to the method described by Dhand and Khatkar [15] with a random sample size of 385 required for 50% of the subjects to have the factor of interest with a 95% confidence level (such that 45–55% of the subjects in the population would have that factor of interest).

Descriptive variables were first described including age, sex, body mass index (BMI), education level and vulnerability status. Two respondents selected the 'other' and 'prefer not to say' options and were excluded from sex data analysis due to insufficient numbers. Data was inputted in IBM Statistical Package for the Social Science (SPSS, Microsoft Corp, version 27) and analysed. Descriptive variables were first described. The Mann-Whitney test was compiled to check for any significant differences in BMI according to sex after utilising the Shapiro-Wilk normality test.

Chi-squared tests or Fisher-Exact tests (for 2 × 2 tables) or Fisher-Freeman- Halton tests (for larger contingency tables) were carried out to check for associations between the different categorical variables (Food group consumption- decreased, increased; Food prices- increased, did not increase; Weight changes- decreased, increased, no change) and sex, salary or education levels.

Cumulative odds ordinal logistic regression analysis with proportional odds were then conducted to determine the effects of BMI, age, salary, sex and education level on use/change of use of food delivery services, dietary changes, changes in alcohol consumption and PA changes. Multinomial logistic regressions were performed to ascertain the effects of BMI, age, salary, sex and education levels on sleep quality and food shopping changes. Statistical significance was defined at $p < 0.05$.

3 Results

3.1 Demographic results

In total, 361 surveys were received, three were considered invalid and were subsequently removed, such that 358 respondents were included in the final analysis: 301 (84.1%) for the English version (84.1%) and 57(15.9%) for the Maltese version respectively. Most participants were females ($n = 295$, 82.9%). The mean age of respondents was 48.3 years (SD 14.4 years). The most commonly reported education level was post-secondary, for 114 respondents (31.8%).

Three hundred and forty-five respondents had complete data for both their self-reported weight and height status. The median BMI value was 26.0 kg/m^2 (IQR 7.2), with median BMI values of 25.5 kg/m^2 for females and 27.4 kg/m^2 for males ($n = 286$ and 59 respectively). There was no significant difference in median BMI values due to sex ($p = 0.079$); see Table 1.

One hundred seventeen respondents (32.6%) reported that their salary was extremely ($n = 43$, 12%) or somewhat negatively ($n = 74$, 20.6%) impacted during the lockdown. Five (1.4%) and 21 (5.9%) of the respondents believed that their salary was extremely or somewhat positively affected during the partial lockdown period respectively, with 216 (60.1%) not experiencing any changes in their salary. The majority of participants ($n = 205$, 57.3%) reported no vulnerability status, with 123 (34.3%) reporting one or more conditions, or another condition ($n = 82$, 22.9%).

3.2 Food group consumption changes

For those who chose to respond to this non-mandatory question, food consumption changes worth noting were: large increases for confectionery items, eggs, fruits and vegetables, pasta and grains, teas and coffees, notable decreases for red and processed meats and sugary beverages, please see Table 2 for the full breakdown of results.

Table 1 Participant characteristics

Agemean(SD) years ((n=357)	48.3 (14.4)
Sex n (%) (n = 356)	
Male	61 (17.1)
Female	295 (82.9)
Education level n(%)	
Up to secondary	59 (16.2)
Up to post-secondary	93 (26.2)
Up to tertiary	114 (31.8)
Post-tertiary	92 (25.7)
BMI median (IQR) kg/m^2 (n = 345)	
Male (*n* = 59)	27.4 (6.8)
Female (*n* = 286)	25.5 (7.3)
Vulnerability status n(%)	
Pregnant	2 (0.6)
> 65 years	53 (14.8)
Diabetic, taking insulin	4 (1.1)
Chronic respiratory disease	43 (12.0)
Chronic kidney disease	0 (0.0)
Chronic liver disease	0 (0.0)
Chronic heart disease	6 (1.7)
Chronic neurological conditions	2 (0.5)
Immunocompromised conditions	5 (1.4)
Cancer and/or on treatment	3 (0.8)
Oral steroid treatment	5 (1.4)
Other (different from above)	82 (22.9)
None	205 (57.3)

Table 2 Food group consumption reported changes

Food group	Increased *n* (%)	Decreased *n* (%)	Don't know *n* (%)
Red meats	44 (24.9)	77 (50.3)	44 (24.8)
Processed meats	50 (28.1)	84 (47.2)	44 (20.2)
White meats (including fish)	101(55.8)	38 (21.0)	42 (23.2)
Legumes and nuts	95(54.2)	36 (20.6)	44 (25.1)
Eggs	121 (66.8)	18 (9.9)	42 (23.2)
Fruits	132 (68.0)	37 (19.1)	25 (12.9)
Vegetables	136 (71.2)	27 (14.1)	28(14.7)
Dairy products	90 (48.1)	50 (26.7)	47(25.1)
Bread/pasta/grains	125 (63.8)	47 (24.0)	24(12.2)
Oils and spreads	53 (31.2)	56 (32.9)	61 (35.9)
Confectionery, snacks	132 (62.5)	56 (26.5)	23(10.9)
Non-alcoholic drinks	58 (34.1)	58 (34.1)	54(31.8)
Sugary drinks	35 (20.3)	79 (45.9)	58(33.7)
Teas/coffees	133 (68.6)	24 (12.4)	37(19.1)

For food group consumption differences reported for different food groups (increased or decreased), there were significant associations between sex and processed meat consumption changes (p =0.012, Cramer V effect size ϕ = 0.217), fruit and vegetable consumption (p =0.007, and 0.032, Cramer V effect sizes ϕ = 0.207 and 0.187 respectively) changes. For females, processed meats consumption decreased for 66.9% whilst this was reportedly decreased by 36.8% in males. Increased fruit and vegetable consumption was reported more by females than males. For salary, significant associations resulted for legumes (p =0.021, Cramer V effect size, ϕ = 0.347) and sugary drinks (p =0.044 Cramer

Table 3 Food group consumption changes (increased or decreased only) according to sex, education and salary analysis

Food group	Sex p-value	Salary p-value	Education p-value
Red meats	0.448[a]	0.160[c]	0.007[a*]
Processed meats	0.012[a*]	0.262[c]	0.476[a]
White meats	0.760[b]	0.686[c]	0.565[a]
Legumes	0.555[b]	0.021[c*]	0.182[a]
Eggs	1.000[b]	0.557[c]	0.671[a]
Fruits	0.007[a*]	0.214[c]	0.958[a]
Vegetables	0.032[b*]	0.161[c]	0.320[a]
Dairy products	0.840[a]	0.516[c]	0.705[a]
Breads/pasta/grains	0.169[a]	0.174[c]	0.757[a]
Oils and spreads	0.679[a]	0.837[c]	0.422[a]
Confectionery snacks	0.985[a]	0.352[c]	0.167[a]
Non-alcoholic drinks	0.305[a]	0.505[c]	0.456[a]
Sugary drinks	0.772[a]	0.044[c*]	0.057[a]
Teas/coffees	0.532[b]	0.204[c]	0.666[a]

[a]Chi-squared test

[b]Fisher-exact test

[c]Fisher-Freeman-Halton exact test

*Significant at $p<0.05$

V effect size, $\phi = 0.340$), and for education, a significant association resulted for red meats ($p=0.007$ Cramer V effect size, $\phi = 0.301$), refer to Table 3.

3.3 Health-related behaviours and food utilisation results

One hundred forty-five participants (40.5%) thought food prices had increased during the lockdown period. Food shopping habits changed a great deal or a lot for a quarter of respondents ($n = 91$, 25.4%). Food accessibility was reported as changed for 96 (26.8%) of respondents. Food delivery service utilisation increased for 177 respondents (49.4%), see Table 4.

One hundred and thirty-nine (38.8%) of respondents claimed that they had gained weight during the lockdown period. More than a third of the respondents, 140 (39.1%),

reported that they were actively trying to lose weight, with half those respondents (49.4%) who claimed to have gained weight also trying to lose weight actively.

A third of participants ($n = 119$, 33.2%) reported moderate diet changes and 42 (11.7%) reported high diet changes. Nearly half of all respondents (45.5%) replied that their PA was reduced (was less or much less) during the lockdown period ($n = 163$). With respect to alcohol consumption, a majority, 231 (64.5%) of respondents, reported no changes. Sleep quality changed a great deal or a lot for 77 respondents (21.5%).

A total of 19.3% of respondents stated that they consumed tobacco ($n = 69$). From these respondents, 53.6% ($n = 37$) responded that their tobacco consumption increased (more or much more) during the partial lockdown period.

Chi-squared tests for association identified no significant associations between self-reported salary levels, sex, education levels and food price changes ($p=0.740$, 0.970, 0.522 respectively). A statistically significant association was identified between sex and weight changes ($p=0.009$) with a Cramer-V effect size, $\phi = 0.163$, but not for salary and education levels ($p=0.417$ and 0.576 respectively).

Table 4 Food services and health-related behaviour changes

Prices n(%)	
Decreased	2 (0.6)
Increased	145 (40.5)
No change	87 (24.3)
Don't know	124 (34.6)
Shopping n(%)	
Not at all	94 (26.3)
A little	74 (20.7)
Moderate	99 (27.7)
A lot	51 (14.2)
A great deal	40 (11.2)
Delivery n(%)	
More	177 (49.4)
As usual	32 (8.9)
No	149 (41.6)
Weight n(%)	
Increased	139 (38.8)
Decreased	65 (18.2)
No change	154 (43.0)
Diet n(%)	
Not at all	122 (34.1)
A little	75 (20.9)
Moderate	119 (33.2)
A lot	19 (5.3)
A great deal	23 (6.4)
Alcohol n(%)	
Much less	31 (8.7)
Less	14 (3.9)
Same amount	231 (64.5)
More	72 (20.1)
Much more	10 (2.8)
Access n(%)	
Yes	96 (26.8)
No	262 (73.2)
PA n(%)	
Much less	82 (22.9)
Less	81 (22.6)
No change	88 (24.6)
More	81 (22.6)
Much more	26 (7.3)
Sleep quality n(%)	
Not at all	146 (40.8)
A little	62 (17.3)
Moderate	73 (20.4)
A lot	34 (9.5)
A great deal	43 (12.0)

3.4 Predictors for diet and health-related behaviours

Diet changes: There were proportional odds, as assessed by a full likelihood ratio test comparing the fitted model to a model with varying location parameters, $\chi^2(33) = 17.050$, $p = 0.990$. Of the five explanatory variables, three were statistically significant: Sex ($\chi^2(1) = 4.786$, $p = 0.029$), BMI ($\chi^2(1) = 14.628$, $p < 0.001$) and Age ($\chi^2(1) = 6.057$, $p = 0.014$).

Table 5 Ordinal logistic regression analysis predicting diet consumption and physical activity changes

Predictor	Did your diet change during lockdown?			Did the amount of physical activity change during lockdown?		
	β	p-value	OR,95%CI	β	p-value	OR,95%CI
Sex (female)*	0.640	0.029**	1.9 [1.07,3.37]	− 0.055	0.845	0.9 [0.54,1.65]
Age	− 0.021	0.014**	1.0 [0.96,1.00]	− 0.015	0.059	1.0 [0.97,1.00]
BMI	0.072	< 0.001****	1.1 [1.04,1.11]	− 0.085	< 0.001****	0.9 [0.89,0.95]
*Education**		0.474			0.053	
(1)	− 0.559	0.157	0.6 [0.26,1.24]	0.908	0.018	2.5 [1.17,5.28]
(2)	− 0.215	0.497	0.8 [0.43,1.51]	0.265	0.393	1.3 [0.71,2.39]
(3)	− 0.004	0.990	1.0 [0.58,1.72]	− 0.082	0.763	0.9 [0.54,1.57]
*Salary**		0.214			0.049**	
(1)	0.348	0.490	0.7 [0.26,1.90]	− 0.516	0.291	0.6 [0.23,1.56]
(2)	0.372	0.393	1.4 [0.62,3.40]	− 0.735	0.083	0.5 [0.21,1.10]
(3)	0.194	0.658	1.2 [0.51,2.90]	− 0.161	0.706	0.8 [0.37,1.97]
(4)	0.631	0.206	1.9 [0.71,5.00]	− 0.200	0.679	0.8 [0.32,2.11]
(5)	− 0.357	0.618	0.7 [0.17,2.84]	1.103	0.118	3.0 [0.75,12.03]

Ordinal logistic regression; (1)-(5) lowest (Euro 0–9999) to high salary level (Euro 40,000–49,999); (1)-(3) lowest: (up to) secondary to: (up to) tertiary education level

*Reference categories: male; highest education level: (up to) post-tertiary (4); highest salary level: Euro 50,000+(6)

**Significance at: $p<0.05$, ***$p<0.01$, ****$p<0.001$

The odds of female respondents exhibiting greater diet changes was 1.9 times compared to males. An increase in BMI increased the odds of a greater diet change (Supplemental Fig. 1), while for every one-year increase in age there was a decrease in the odds of a greater diet change, see Table 5.

PA changes: There were proportional odds, as assessed by a full likelihood ratio test comparing the fitted model to a model with varying location parameters, $\chi^2(33) = 39.005$, $p = 0.218$. Of the five explanatory variables, two were statistically significant: BMI ($\chi^2(1) = 19.952$, $p < 0.001$) and salary level ($\chi^2(5) = 11.145$, $p = 0.049$), see Table 5. An increase in BMI decreased the odds of a PA change to high levels (Supplemental Fig. 2). The odds of respondents with the lowest salary was 0.6 times that of respondents with a salary of Euro 50,000 or higher, $\chi^2(1) = 1.113$, $p = 0.291$. Conversely, the odds of respondents with a salary between Euro 40,000 and Euro 50,000 was 3.0 times that of respondents with a salary of Euro 50,000 or higher ($\chi^2(1) = 2.440$, $p = 0.118$), see Table 5.

Alcohol consumption changes: There were proportional odds, as assessed by a full likelihood ratio test comparing the fitted model to a model with varying location parameters, $\chi^2(11) = 11.896$, $p = 0.371$, but none of the explanatory variables resulted to be significantly influencing alcohol consumption: Sex ($\chi^2(1) = 0.162$, $p = 0.687$), Education ($\chi^2(3) = 4.784$, $p = 0.188$), Salary ($\chi^2(5) = 7.049$, $p = 0.217$), BMI ($\chi^2(1) = 0.407$, $p = 0.524$) and Age ($\chi^2(1) = 0.045$, $p = 0.832$), see Table 6.

Food delivery utilisation: There were proportional odds, as assessed by a full likelihood ratio test comparing the fitted model to a model with varying location parameters, ($\chi^2(11) = 10.694$, $p = 0.469$). None of the explanatory variables significantly influenced food delivery services: Education ($\chi^2(3) = 2.978$, $p = 0.395$), Sex ($\chi^2(1) = 0.072$, $p = 0.789$), Salary levels ($\chi^2(5) = 3.211$, $p = 0.668$), BMI ($\chi^2(1) = 0.024$, $p = 0.877$) and Age ($\chi^2(1) = 1.021$, $p = 0.312$), see Table 6.

Sleep amount or quality changes: The assumption of proportional odds was violated, as assessed by a full likelihood ratio test comparing the fitted model to a model with

Table 6 Ordinal logistic regression analysis predicting alcohol consumption and food delivery services changes

Predictor	Did your alcohol consumption change during lockdown?			Did you utilise/change food delivery services during lockdown?		
	β	p-value	OR,95%CI	β	p-value	OR,95%CI
*Sex**	0.128	0.687	1.1 [0.61,2.12]	− 0.082	0.789	0.9 [0.51,1.68]
Age	0.002	0.832	1.0 [0.98,1.02]	− 0.009	0.312	1.0 [0.97,1.01]
BMI	0.013	0.524	1.0 [0.97,1.05]	0.003	0.877	1.00 [0.96,1.04]
*Education**		0.188			0.395	
(1)	− 0.453	0.297	0.6 [0.27,1.49]	− 0.470	0.256	0.6 [0.28,1.41]
(2)	− 0.224	0.522	0.8 [0.40,1.59]	− 0.421	0.209	0.7 [0.34,1.27]
(3)	− 0.658	0.035**	0.5 [0.28,0.95]	0.027	0.929	1.0 [0.57,1.84]
*Salary**		0.217			0.668	
(1)	− 0.726	0.191	0.5 [0.16,1.44]	− 0.681	0.208	0.5 [0.17,1.46]
(2)	− 0.354	0.458	0.7 [0.28,1.79]	− 0.279	0.558	0.8 [0.30,1.91]
(3)	− 0.692	0.153	0.5 [0.19,1.29]	− 0.458	0.337	0.3 [0.63,0.25]
(4)	0.232	0.668	1.3 [0.44,3.65]	− 0.507	0.346	0.6 [0.21,1.73]
(5)	− 0.585	0.459	0.6 [0.12,2.62]	0.313	0.704	1.4 [0.27,6.87]

Ordinal logistic regression; (1)-(5) lowest (Euro 0–9,999) to high salary level (Euro 40,000–49,999); (1)-(3) lowest: (up to) secondary to: (up to) tertiary education level

*Reference categories: male; highest education level: (up to) post-tertiary (4); highest salary level: Euro 50,000+(6); ** significance at $p<0.05$, ***$p<0.01$, ****$p<0.001$

Table 7 Multinomial logistic regression analysis predicting sleep and food shopping changes

Predictor	Did the amount or quality of sleep change during lockdown	Did your food shopping change during lockdown?
	p-value	p-value
Sex (female)*	0.128	0.686
Age	0.002***	0.267
BMI	0.002***	0.079
*Education**	0.498	0.163
*Salary**	0.021**	0.110

Multinomial logistic regression; (1)-(5) lowest (Euro 0–9,999) to high salary level (Euro 40,000–49,999); (1)-(3) lowest: (up to) secondary to: (up to) tertiary education level

*Reference categories: male; highest education level: (up to) post-tertiary (4); highest salary level: Euro 50,000+(6)

**Significance at $p<0.05$, ***$p<0.01$, ****$p<0.001$

varying location parameters, $\chi^2(11) = 20.295$, $p = 0.041$. A multinomial logistic regression model was thus fitted (Tables 7 and 8) with the logistic regression model being statistically significant, ($\chi^2(22) = 51.776$, $p < 0.001$). Of the five predictor variables, three were statistically significant: BMI ($\chi^2(2) = 12.028$, $p = 0.002$), age ($\chi^2(2) = 12.177$, $p = 0.002$) and salary levels ($\chi^2(10) = 21.010$, $p = 0.021$). Lower BMI levels were significantly associated with an increased likelihood of exhibiting no change/a little change in sleep relative to a lot/a great deal of change in sleep ($\chi^2(1) = 11.233$, $p < 0.001$), and of exhibiting moderate changes in sleep relative to a lot/a great deal of change in sleep, ($\chi 2(1) = 5.612$, $p = 0.018$). Increasing age was associated with an increased likelihood of exhibiting no change/a little change in sleep relative to a lot/a great deal of change in sleep, ($\chi^2(1) = 10.660$, $p = 0.001$). For salary, the odds of respondents with the second lowest (Euro 10,000–20,000) salary scale exhibiting no/little change in sleep relative to large sleep changes was lower relative to respondents with highest salary levels ($\chi^2(1) = 3.936$, $p = 0.047$).

Table 8 Multinomial logistic regression analysis predicting sleep behaviour changes

Predictor	Category: No change or a little change in sleep*			Category: moderate change in sleep*		
	β	p-value	OR,95%CI	β	p-value	OR,95%CI
*Sex**	0.424	0.276	1.5 [0.71,3.28]	1.008	0.050	2.7 [1.00,7.49]
Age	0.040	0.001***	1.04 [1.02,1.07]	0.018	0.224	1.1 [0.99,1.05]
BMI	− 0.086	< 0.001***	0.9 [0.87,0.96]	− 0.075	0.018**	0.9 [0.87,0.99]
*Education**						
(1)	0.567	0.318	1.80 [0.58,5.35]	− 0.174	0.803	0.8 [0.21,3.30]
(2)	0.681	0.167	2.0 [0.75,5.20]	0.340	0.535	1.4 [0.48,4.11]
(3)	0.245	0.544	1.3 [0.58,2.82]	− 0.427	0.351	0.7 [0.27,1.60]
*Salary**						
(1)	− 0.193	0.815	0.8 [0.16,4.13]	0.063	0.951	1.1 [0.14,8.19]
(2)	−1.403	0.047**	0.2 [0.06,0.98]	− 0.560	0.533	0.60 [0.10,3.32]
(3)	0.089	0.904	1.1 [0.25,4.62]	0.848	0.356	2.3 [0.39,14.14]
(4)	−1.150	0.135	0.3 [0.07,1.42]	0.144	0.879	1.1 [0.19,7.37]
(5)	− 0.027	0.980	1.0 [0.11,8.23]	0.031**	0.982	1.0 [0.07,14.27]

Multinomial logistic regression; (1)-(5) lowest (Euro 0–9,999) to high salary level (Euro 40,000–49,999); (1)-(3) lowest: (up to) secondary to: up to tertiary education level

*Reference categories: male; highest education level: up to post-tertiary (4); highest salary level: Euro 50,000+(6); reference category: a lot/a great deal of change in sleep

**Significance at $p<0.05$, ***$p<0.01$, ****$p<0.001$

Food shopping changes: A cumulative odds ordinal logistic regression with proportional odds was run to determine the effect of BMI, age, salary levels, sex and education level on food shopping labels. The assumption of proportional odds was violated, as assessed by a full likelihood ratio test comparing the fitted model to a model with varying location parameters ($\chi^2(11) = 23.950$, $p = 0.013$). The multinomial logistic regression model was not statistically significant, ($\chi^2(578) = 605.580$, $p = 0.207$). In fact, of the five predictor variables, none were statistically significant: BMI ($\chi^2(2) = 5.078$, $p = .079$), Age ($\chi^2(2) = 2.643$, $p = 0.267$), Sex ($\chi^2(2) = 0.755$, $p = 0.686$), Education ($\chi^2(6) = 9.201$, $p = 0.163$) and salary levels ($\chi^2(10) = 15.640$, $p = 0.110$), see Tables 7 and 9.

Table 9 Multinomial logistic regression analysis predicting food shopping changes

Predictor	Category: No change or a little change in food shopping			Category: Moderate change in food shopping		
	β	p-value	OR,95%CI	β	p-value	OR,95%CI
*Sex**	0.336	0.383	1.4 [0.66,2.98]	0.202	0.639	1.2 [0.52,2.84]
Age	− 0.006	0.620	1.0 [0.97,1.02]	− 0.019	0.125	1.0 [0.96, 1.00]
BMI	− 0.039	0.114	1.0 [0.91,1.00]	− 0.063	0.030**	0.9 [0.89,0.99]
*Education**						
(1)	1.059	0.050	2.9 [1.00,8.33]	0.594	0.368	1.8 [0.50,6.59]
(2)	0.482	0.273	1.6 [0.68,3.84]	0.621	0.211	1.9 [0.70,4.91]
(3)	0.017	0.965	1.0 [0.47,2.18]	0.598	0.155	1.8 [0.80,4.15]
*Salary**						
(1)	0.418	0.529	1.5 [0.41,5.58]	0.038	0.959	1.0 [0.25,4.33]
(2)	0.178	0.757	1.2 [0.39,3.68]	− 0.065	0.915	0.9 [0.28,3.10]
(3)	1.292	0.036	3.6 [1.09,12.16]	1.230	0.056	3.4 [0.97,12.11]
(4)	0.246	0.704	1.3 [0.36,4.55]	−0.170	0.810	0.8 [0.21,3.36]
(5)	1.477	0.240	4.4 [0.37,51.37]	1.986	0.116	7.3 [0.61,86.53]

Multinomial logistic regression; (1)-(5) lowest (Euro 0–9,999) to high salary level (Euro 40,000–49,999); (1)-(3) lowest: (up to) secondary to: up to tertiary education level

*Reference categories: male; highest education level: up to post-tertiary (4); highest salary level: Euro 50,000+(6); *reference category: a lot/a great deal of change in food shopping

**Significance at $p<0.05$, ***$p<0.01$, ****$p<0.001$

4 Discussion

This local study examined the health behaviour impacts during the first lockdown period in Maltese adults, using an online survey methodology. It therefore provides interesting insights about dietary and other health-related behaviours, including sleep, food purchasing and food accessibility during this period.

The findings demonstrate that, for many Maltese adults, the lockdown period led to changes in some health-related behaviours. Nearly half the respondents reported decreased exercise, similar to other studies that reported this change also in the medium and long term [13, 16] suggesting that the reduction in PA could have turned into a more habitual behaviour through time. Reasons could likely be due to the restrictions imposed to going out and could also be related to increased screen time use, although this latter behaviour was not investigated in our local study. Lower affordability for subscribing to online programmes could be another reason for this finding, also corroborated by the regression results showing respondents in the lowest salary brackets to be more likely to reduce their exercise habits. Other reasons such as reduced motivation and reduced mental wellbeing could also have come into play during the lockdown period.

The reported increase in weight for close to 40% of the respondents may also be reflecting the negative impact caused by lower PA experienced by the cohort. These results compare to other international studies [2]. In a country such as Malta which is already experiencing high obesity prevalence [11], these results highlight the potential negative effects similar scenarios can have in future that promise to intensify the risk for increasing obesity prevalence on a population level as well as accentuating obesity-related concerns on a health systems level.

Dietary changes were reported by nearly half the respondents in our local study. Further analysis into which foods were reported to have changed in terms of consumption provided mixed results, with increased consumption of snacks and confectionery items, but also starchy foods being reported. These results have important implications since snacks and confectionery items are calorie dense and are associated with adverse co-morbidities including weight gain and obesity [17]. Similar results are reported in a recent systematic review [18], however, our study also reports an overall majority of respondents consumingmore fruit and vegetables. One reason could be attributed to people paying more attention to the national dietary recommendations to increase fruit and vegetable consumption to avoid infection. This finding also suggests that results need to be interpreted with caution since not all health behaviour changes were necessarily negative changes. Specifically, in our local study, females, people with higher BMIs and younger adults were more likely to report dietary changes. Our results show that unhealthy (processed meats) and healthy (fruit and vegetable) food groups consumption changes were statistically significantly associated with sex with higher percentages for females increasing fruit and vegetable consumption and decreasing processed meats consumption. These results suggest females could be more motivated and more easily influenced by health promotion messages, which were prevalent during lockdown, and could manage the situation by adapting and transforming to healthier diets. Further exploratory work is needed to understand the exact reasons for the variances in food groups consumption changes.

Sleep quality was reported to have changed for nearly half the respondents. There could be multiple reasons for this finding but could include financial insecurity and

stress as contributors. In our study, younger adults were more likely to report changes in sleep patterns which could have been due to irregular sleep schedules that would have intensified during lockdown, exacerbated also by possible work, or social problems. Regular sleep behaviours and duration have an important impact on our health and well-being [19]. Our study did not specifically measure changes in sleep duration, and it is recommended to investigate this outcome in future studies.

Some international studies report education levels as being significant predictors for health behaviours [20], this study did not report the same finding. This could be due to many reasons, particularly that in our study, there was a bias with many respondents predominantly categorised within higher education levels, which are usually attributed to overall better health behaviours [21] and could have therefore not caught the segment of the population where changes in health behaviours were particularly notable. Another reason could be the different settings and varying cultural influences within the different populations in which the different studies were carried out.

Whilst there were no associations noted between self-reported salary levels and food price changes perceptions, a third of the respondents did report negative effects on their salary levels. Food prices were reported to have changed by approximately a quarter of the respondents, highlighting the need for more focused in-depth analysis on the potential detrimental effects, particularly in the light of inequalities, on rising food prices. Changes in the early stages of the pandemic could be, in part, due to labour shortages and disruptions in food supply chains which were present across international levels and would have affected Malta directly because of its reliance on food imports. Households in the lowest salary brackets, in general, would be at higher risk of experiencing economic and food insecurity coupled also with concerns for increase in malnutrition incidence [22]. Food accessibility and utilisation are now acknowledged to have become unstable because of income concerns giving rise to new scenarios and risks for food insecurity that were previously not considered [23]. Food accessibility changes were reported by over a quarter of the respondents in this local study with half reporting using delivery services more. This finding suggests that some respondents managed to adapt to food accessibility issues during lockdown by being more flexible and resorted to new purchasing tactics. The overarching recommendation is to focus on those population subgroups who are more vulnerable (economically or medically, for example) and provide support structures to avoid the risk of malnutrition and other concomitant concerns such as depression and ill-health.

An overall majority of smokers reported an increase in tobacco consumption with a minority also increasing alcohol consumption during the lockdown period. Other international studies also reported changes in tobacco consumption during the lockdown periods. Whilst the increased alcohol consumption could not be attributable to specific age groups, sex, salary or education level, increased alcohol drinking due to stress, and boredom when confined to non- social settings could have negatively affected some of the respondents who reported increased consumption. Reported international results are mixed and the need for a further detailed understanding for the reasons behind lifestyle changes, the specific population in context and implications for these changes are needed to create more targeted interventions [24, 25].

This study looked at a vast range of diet and health-related behaviour changes during the first lockdown, in Maltese residents. Whilst the lockdown period referred to in

this study was a short finite time period, the two-year pandemic scenario which Malta experienced could potentially have caused longer and more chronic dietary and other lifestyle behaviour changes. There are some data available in another study which details this scenario [13] by reporting on some lifestyle changes for the first pandemic year. This consideration, together with the ongoing new threats and challenges the global world is experiencing, which further threaten food supply chains and food systems, calls for ongoing surveillance and adaptation.

The study does contain some limitations. The data are self- reported and retrospective in design with the use of an adapted survey using only face validation in the pilot study. The time restrictions for disseminating the survey meant that content validation and reliability testing were not carried out. A limited sample size was achieved, and stratification of the population sample would have ideally been carried out. Therefore generalisability of the findings needs to be interpreted with caution. Of particular note, an overrepresentation of females and of participants in higher education levels was achieved in this study sample. Nutrient intake data was not collected, this would have generated more detailed information on dietary behaviours. Retrospective studies tend to have recall and self-reporting biases which could reduce the accuracy of reporting [26]. However, these studies also collect useful data and do not have follow-up issues as the data collection is only carried out once.

Other data such as sedentary behaviours, and further details on the change in direction for some health behaviours would have captured a more detailed picture, but the current results can provide useful baseline data for comparison purposes with any more recent data collected in future. This could include studies on children, focusing particularly on diet and sedentary behaviours.

5 Conclusions

The COVID-19 lockdown period is known to have caused widespread disruptions to health behaviours in different populations worldwide. This local study presents comparable findings. Specifically for Malta, the partial lockdown period is noted to have driven mixed results, some negative, but also a few positive changes, into the traditional ways Maltese people shop, eat and utilise food delivery services, as well as making some lifestyle behaviour modifications. This period could therefore potentially have driven longer-term changes into the way people purchase and consume food or practice health behaviours in the future.

This study adds to the existing evidence-base on the COVID-19 pandemic lockdown and the disruptions this has caused to populations in the Mediterranean region, specifically in Malta. Whilst previous European studies have looked at particular behaviours, fewer have provided an integrated overview linking health behaviours, dietary intakes and food accessibility considerations. Consequently, the approach taken in this study broadens our knowledge on changes in health behaviours and examines other concerns such as the potential vulnerability of small islands towards experiencing food insecurity during pandemics or similar public health scenarios.

Considerations on encouraging more sustainable and practical dietary and PA habits, and supporting other healthy behaviours in specific subgroups, such as the younger generations or people living with obesity, are crucial. Ongoing research is needed to ensure

that intervention strategies are well planned, focused and impactful to improve overall health and wellbeing of the population in context.

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12982-025-00741-0.

Supplementary Material 1.

Author contributions

CC conceived the study design, carried out the survey adaptation and was mainly responsible for the writing of the manuscript. FS carried out the statistical analysis and interpretations of the data and contributed to the writing of the manuscript. AB and SWF contributed to the development of the adapted survey, data analysis, and review of the paper. All authors approved the final manuscript.

Funding

No funding was provided for this study.

Data availability

Data availability statement: The datasets generated during and/or analysed during the current study are not publicly available due to participants' consents according to the terms in the information letter including data accessibility and use of research data but could be available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

Ethics approval was received from the Faculty of Health Sciences Research Ethics Committee, FREC (University of Malta). Ref no. (FREC: 15062020 5930). The research conducted adhered to the Declaration of Helsinki. Informed consent was obtained. Participants were informed through the 'Participants Information' letter accompanying the survey that their consent was provided through submitting the online anonymised survey.

Competing interests

AB declares researcher-led grants from the National Institute for Health Research, Rosetrees Trust, MRC, INNOVATE UK, British Dietetic Association, British Association of Parenteral and Enteral Nutrition, BBRSC, the Office of Health Improvement and Disparities and NovoNordisk. AB reports honoraria from Novo Nordisk, Lilly, Office of Health Improvement and Disparity, Johnson and Johnson and Obesity UK outside the submitted work and is on the Medical Advisory Board and shareholder of Reset Health Clinics Ltd. SWF declares researcher-led grants from the National Institute for Health Research, the Office of Health Improvement and Disparities, Doncaster Council, the West Yorkshire Combined Authority, and Novo Nordisk; and support for attending academic conferences and events from Novo Nordisk, UK Parliament, Welsh Parliament and Safefood.

Received: 14 March 2025 / Accepted: 10 June 2025

Published online: 17 June 2025

References

1. Andreou E, Georgaki E, Vlahoyiannis A, Philippou C, Ntorzi N, Christoforou C, et al. Changes in lifestyle behaviors, shopping habits and body weight among adults in Cyprus and Greece during COVID-19 lockdown: A Cross-Sectional study. Nutrients. 2025;17(2):214.
2. Sung J, Davis W, Qiu Q. The effects of COVID-19 lockdown on the body weight and lifestyle behaviors of US adults. South Econ J. 2024;90(4):900–48.
3. Brown A, Flint SW, Kalea AZ, O'Kane M, Williams S, Batterham RL. Negative impact of the first COVID-19 lockdown upon health-related behaviours and psychological wellbeing in people living with severe and complex obesity in the UK. EClinicalMedicine. 2021:34.
4. Flint SW, Brown A, Tahrani AA, Piotrkowicz A, Joseph AC. Cross-sectional analysis to explore the awareness, attitudes and actions of UK adults at high risk of severe illness from COVID-19. BMJ Open. 2020;10(12):e045309.
5. Farrugia F, Refalo D, Bonello D, Cuschieri S. The impact of the COVID-19 pandemic on mediterranean diet adherence: A narrative systematic review. Nutr Health. 2023;30(2):215–33. https://doi.org/10.1177/02601060231187511.
6. Prete M, Luzzetti A, Augustin LS, Porciello G, Montagnese C, Calabrese I, et al. Changes in lifestyle and dietary habits during COVID-19 lockdown in Italy: results of an online survey. Nutrients. 2021;13(6):1923.
7. Zaragoza-Martí A, Sánchez-SanSegundo M, Ferrer-Cascales R, Gabaldón-Bravo EM, Laguna-Pérez A, Rumbo-Rodríguez L. Effects of the Mediterranean lifestyle during the COVID-19 lockdown in spain: preliminary study. Front Nutr. 2021;8:683261.
8. Storz MA. The COVID-19 pandemic: an unprecedented tragedy in the battle against childhood obesity. Clin Exp Pediatr. 2020;63(12):477.
9. Yuan H, Wang X, Gao L, Wang T, Liu B, Fang D, et al. Progress towards the Sustainable Development Goals has been slowed by indirect effects of the COVID-19 pandemic. Commun Earth Environ. 2023;4(1):184.
10. Malta National Statistics Office World Population. Day-11 July 2024.[cited 2024 Nov 4]. Available from: https://nso.gov.mt/world-population-day-11-july-2024/

11. OECD/European Commission. (2023) Malta: Country Health Profile 2023, OECD Publishing. [cited 2025 May 25]. Available from: https://www.oecd.org/en/publications/malta-country-health-profile-2023_2a821e8a-en.html
12. Smati S, Tramunt B, Wargny M, Caussy C, Gaborit B, Vatier C, et al. Relationship between obesity and severe COVID-19 outcomes in patients with type 2 diabetes: results from the CORONADO study. Diabetes Obes Metab. 2021;23(2):391–403.
13. Cuschieri S, Grech S, Grech VA. Year of COVID-19 Pandemic Roller-Coaster: the Malta experience, lessons learnt, and the future. Disaster Med Public Health Prep. 2022;17: e153. https://doi.org/10.1017/dmp.2022.100.
14. Flint SW, Piotrkowicz A, Watts K. Use of artificial intelligence to understand adults' thoughts and behaviours relating to COVID-19. Perspect Public Health. 2022;142(3):167–74.
15. Dhand NK, Khatkar MS. 2014. Statulator: An online statistical calculator. Sample Size Calculator for Estimating a Single Proportion. [cited 2025 May 24]. Available from: http://statulator.com/SampleSize/ss1P.html
16. Bifolco G, Cardinali L, Mocini E, Duradoni M, Baldari C, Ciampi M, et al. Long-term effects of COVID-19 pandemic on physical activity and eating behaviour of the Italian population: a longitudinal study. Endocrine. 2024;86(3):1003–13.
17. Crimarco A, Landry M, Gardner CD. Ultra-processed foods, weight gain, and co- morbidity risk. Curr Obes Rep. 2021; 1–13.
18. González-Monroy C, Gómez-Gómez I, Olarte-Sánchez CM, Motrico E. I. Eating behaviour changes during the COVID-19 pandemic: A systematic review of longitudinal studies. Int J Env1iron Res Public Health. 2021;18(21):11130. https://doi.org/10.3390/ijerph182111130.
19. Chaput JP, Dutil C, Featherstone R, Ross R, Giangregorio L, Saunders TJ, et al. Sleep timing, sleep consistency, and health in adults: a systematic review. Appl Physiol Nutr Metab. 2020;45(10):S232–47.
20. Zhuo J, Harrigan N. How low education increases COVID-19 mortality: the mediating role of vaccination, distrust in science, and lack of preventative health behavior. J Public Health. 2025;18:fdae318.
21. Brunello G, Fort M, Schneeweis N, Winter-Ebmer R. The causal effect of education on health: what is the role of health behaviors? Health Econ. 2016;25(3):314–36.
22. Otten JJ, Averill MM, Spiker ML. Food security and food access during the COVID-19 pandemic: impacts, adaptations, and looking ahead. JPEN. 2023;47:S11–5.
23. Canwat V. Food security effects of COVID-19 lockdown: causal pathways and vulnerability. Risk Hazards Crisis Public Policy. 2025;16(2):e70010.
24. Reynolds CM, Purdy, Rodriguez L, McAvoy H. Factors associated with changes in consumption among smokers and alcohol drinkers during the COVID-19 'lockdown' period. Eur J Public Health. 2021;31(5):1084–9.
25. Kinouani S, Macalli M, Arsandaux J, Montagni I, Texier N, Schück S, et al. Factors related to increased alcohol misuse by students compared to non-students during the first COVID-19 lockdown in france: the confins study. BMC Public Health. 2024;24(1):646.
26. McCabe EM, Luk JW, Stangl BL, Schwandt ML, Ziausyte U, Kim H, et al. Exercising healthy behaviors: A latent class analysis of positive coping during the COVID-19 pandemic and associations with alcohol-related and mental health outcomes. PLoS ONE. 2024;19(2):e0297060.

Publisher's note