ORGINAL ARTICLE

Impact of COVID-19 Pandemic and Lockdown Measures on the Nutrition Plan Service Cohort

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Abstract

Objective: This study analyses the patients' factors can influence the attitude to follow or not the therapeutic weight-loss plan after national lockdown measures adopted from March 2020 to May 2020.

Materials and Methods: Patients that visited a private nutritional center in March 2020 were included in this retrospective observational study. All relevant characteristics were noted. In May 2020, patients who did not attend the follow-up visit were labeled as "abandoned". Variation in Body Mass Index (BMI) was noted in the second visit. Univariate logistic regression was performed to test the influence on dependent variables (lost follow-up). Odds Ratio (OR) was calculated. According to BMI distribution, we performed a Student T-test (α= 0.05) or Wilcoxon test (α= 0.05) to test BMI variation in patients that attended the follow-up visit. A *P*-value< 0.05 was considered statistically significant.

Results: Our population consisted of 77 patients, and 26 patients (33.8%, $CI_{95\%}$ 23.4-45.4%) were labelled as "abandoned". Age≥ 54 years old (OR= 8.9048, $CI_{95\%}$:1.888-41.9822, *P*-value= 0.0057) and suffering from hypertension (OR= 4.8706, $CI_{95\%}$:1.4284-16.6076, *P*-value= 0.0114) were factors associated with the abandon follow-up visits. Wilcoxon test for BMI variation resulted statistically significant (May BMI 29.5 kg/m^2 vs March BMI 29.4 kg/m^2, *P*-value= 0.0094).

Conclusion: Age and hypertension are related to the risk of abandoning healthcare services after ending the national lockdown. The losing follow-up phenomenon could worsen clinical conditions and reduce life expectancy. An increase in BMI during lockdown should be interpreted as a personal difficulty in complying with therapeutic prescriptions.

Keywords: COVID-19, Pandemic, Lockdown, Obesity, Diet

Introduction

In March 2020, the sudden and rapid spread of the Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2), causative agent of Coronavirus Disease 2019 (COVID-19), forced Italy to adopt restrictive measures like social distancing, detection and isolation of the infected tracing, quarantine of exposed people and national lockdown. In May 2020,

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the government lifted the restrictions with a gradual return to a "normal" lifestyle. Since the beginning of the pandemic, the main risk factors related to an adverse outcome were advanced age and comorbidities (arterial hypertension, obesity and diabetes) (1). To avoid health care overload, the elderly and people with comorbidities were educated to self-isolate and stayed at home during the imposed restrictions (2).

As a consequence, access to public health services was reduced during the lockdown period. In a cross-sectional German study, Michalowsky et al. (3) showed that physician consultations and disease recognition decrease slightly before the imposed lockdown, deteriorate enormously during the lockdown, and mitigate at the end of the lockdown.

This phenomenon could represent an unwanted effect of pandemic-phobia, increasing the rate of patients who did not attend the screening, diagnostic and treatment procedures or deciding spontaneously to abandon the healthcare program after the lockdown period, impairing the outcome (4).

Due to lack of studies evaluating the long-term effects of lockdowns on patient-related outcomes, we performed a retrospective observational study to analyze patients' attitude to follow a therapeutic weight-loss plan, based on diet and periodic follow-up, after national lockdown measures adopted in Italy from March 2020 to May 2020.

Materials and Methods

The population enrolled included all patients that visited a private nutritional center before (March 2020) and after (May 2020) national lockdown. Since it is a nutritional private center, the ethics committee's approval was not requested, but written informed consent was obtained for each patient in compliance with current privacy regulations.

Sex, age, degree of education (middle, high school, university), economic status (student, employed, unemployed, retirees), smoking, height, weight and Body Mass Index (BMI) were noted during the last visit in March 2020 before general lockdown.

In addition to obesity (defined as BMI> 30 kg/m^2), other patients' comorbidities, as well as hypertension, smoking, diabetes, hypercholesterolemia, endocrinological diseases (i.e., hypo and hyperthyroidism, insulin resistance), gastrointestinal disorders (i.e., coeliac disease), gynecological disorders (i.e. polycystic ovary syndrome) and malignancy history, were noted. Likewise, the number of patients without comorbidities was reported.

On post lockdown follow-up in May 2020, variation in BMI was registered. Patients who did not attend the follow-up visit in May were contacted by phone and were labeled as "abandoned" if they declared a willingness to discontinue the nutritional plan. The number of patients who discontinued the program was recorded.

Statistical analysis was performed with MedCalc® Statistical Software version 19.5.3 (MedCalc Software Ltd, Ostend, Belgium; https://www.medcalc.org; 2020). A *P*-value< 0.05 was considered statistically significant. For its retrospective nature, no statistical sample size assessment was performed a priori, and the sample size was the number of patients treated during the study period.

Categorical variables and frequencies were reported as absolute numbers, and percentages (%) and 95% confidence interval ($CI_{95\%}$) were calculated. Continuous variables were tested for normal distribution with the Shapiro-Wilk test (α= 0.05). Normally distributed data were presented as mean ± standard deviation (SD). On the contrary case, data were reported as a median and interquartile range [IQR]. For mean and median, $CI_{95\%}$ was calculated.

In this observational retrospective study, the primary scope was to analyze the patients' factors (demographic, medical, cultural and social characteristics) that could influence the attitude to follow the therapeutic weight-loss plan. The therapeutic weight loss plan was based on diet and periodic follow-up and the evaluation was performed after national

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lockdown measures adopted in Italy from March 2020 to May 2020. For this scope, univariate logistic regression was performed for every variable to test the influence on dependent variables (lost follow-up). Continuous variables (age and BMI) were divided according to their quartile distribution and were used for univariate logistic regression. The regression coefficient was calculated, and the Wald statistic was performed. Moreover, we calculated the Odds Ratio (OR) and $CI_{95\%}$.

The second endpoint was to test if national lockdown restrictions influenced BMI in patients that did not abandon the follow-up plan between March 2020 and May 2020. BMI variation was noted, and the percentages of increase, equal, or decrease BMI patients, with $CI_{95\%}$ were calculated. Student T-test for paired samples (α= 0.05) or Wilcoxon test (α= 0.05) if normally or not distributed, were used, respectively. Data were reported in tables and plots.

Ethical considerations

In accordance with national legislation (artt. 13, 23 of D.L.gs. n. 196/2003), by signing the consent, patients also signed the processing of personal data.

Results

Our population consisted in 77 patients, 22 (28.6%, $CI_{95\%}$: 18.4-40.0%) male and 55 (71.4%, $CI_{95\%}$: 60.0-81.2%) female. 26 patients (33.8%, $CI_{95\%}$: 23.4-45.4%) did not attend the follow-up visit in May 2020, when national lock-down measures stopped. Table 1 reports the main population characteristics, while the results of univariate logistic regression are reported in Table 2.

The median age of the considered population was 39.0 years ($CI_{95\%}$: 34.0-47.1, IQR: 26.0-53.0 years), and univariate logistic regression based on quartile distribution showed that patients with age≥ 54 years old presented an increased risk to abandon nutritional follow-up plan (OR=8.9048, $CI_{95\%}$:1.888-41.9822, *P*-value= 0.0057).

BMI in March 2020 was reported as median of 29.8 kg/m^2 ($CI_{95\%}$:27.7-31.1, IQR: 25.5-32.9 kg/m^2). Quartile distribution showed no correlation with the main outcome in univariate logistic regression. Sex showed no correlation with main outcome (*P*-value=

Table 1. The demographic, medical, social, and economic characteristics of the population

Variables	Results	$CI_{95\%}$
Sex, Male (%)	22 (28.6%)	18.4-40.0%
Age (years)	39.0 (26.0-53.0)	34.0-47.1
BMI March 2020 (kg/m^2)	29.8 (25.5-32.9)	27.7-31.1
Comorbidities		
No comorbidities (%)	18 (23.4%)	14.5-34.4%
Hypertension (%)	14 (18.2%)	10.3-28.6%
Smoking (%)	21 (27.3%)	17.7-38.6%
Diabetes (%)	4 (5.2%)	1.4-12.8%
Obesity (%)	37 (48.1%)	36.5-59.7%
Hypercholesterolemia (%)	9 (11.7%)	5.5-21.0%
Endocrinological disorder (%)	7 (9.1%)	3.7-17.8%
Gastrointestinal disease (%)	7 (9.1%)	3.7-17.8%
Gynecological disorders	3 (3.9%)	0.8-11.0%
Malignance history (%)	2 (2.6%)	0.03-9.1%
Education		
Middle school (%)	21 (27.3%)	17.7-38.6%
High school (%)	38 (49.4%)	37.8-61.0%
University (%)	18 (23.4%)	14.5-34.4%
Economic Status		
Student (%)	9 (11.7%)	5.5-21.0%
Employed (%)	40 (51.9%)	40.3-63.5%
Unemployed (%)	21 (27.3%)	17.7-38.6%
Pensioned (%)	7 (9.1%)	3.7-17.8%

Data have been reported as frequencies (numbers and percentages), mean ± standard deviation (SD), or median and interquartile range [IQR], with 95% confidence interval (CI95%).

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Table 2. The univariate logistic regression of demographic, medical, social, and economic characteristics of the considered population (77 patients), with Wald statistic

Variables	Coefficient	Standard Error	Wald	*P*-value	Odds ratio	$CI_{95\%}$ Odds ratio
Sex, Male	0.1609	0.5282	0.0928	0.7606	1.1746	0.4171-3.3076
Age, quartile (years)						
Q_1 (≤26)	Ref.	-	-	-	-	-
Q_2 (27-39)	0.7050	0.8146	0.7490	0.3868	2.0238	0.4100-9.9903
Q_3 (40-53)	1.1156	0.7823	2.0337	0.1538	3.0513	0.6586-14.1371
Q_4 (≥54)	2.1866	0.7911	7.6386	0.0057	8.9048	1.888-41.9822
BMI March 2020, quartile (kg/m^2)						
Q_1 (≤25.5)	Ref.	-	-	-	-	-
Q_2 (25.6-29.8)	-0.5137	0.6564	0.6124	0.4339	0.5983	0.1653-2.1661
Q_3 (29.9-32.8)	-2.1972	1.1450	3.6822	0.0550	0.1111	0.0118-1.0482
Q_4 (≥32.9)	-0.5878	0.6146	0.9145	0.3389	0.5556	0.1665-1.8532
Comorbidities						
Hypertension, "yes"	1.5832	0.6258	6.3996	0.0114	4.8706	1.4284-16.6076
Smoking, "yes"	0.2617	0.5327	0.2413	0.6232	1.2991	0.4573-3.6908
Diabetes, "yes"	1.8751	1.1819	2.5173	0.1126	6.5217	0.6432-66.1286
Obesity, "yes"	0.3509	0.4837	0.5262	0.4682	1.4203	0.5504-3.6652
Hypercholesterolemia, "yes"	1.0288	0.7203	2.0396	0.1532	2.7976	0.6817-11.4804
Endocrinological disorder, "yes"	-0.2657	0.8737	0.0925	0.7611	0.7667	0.1383-4.2495
Gastrointestinal disease, "yes"	0.4270	0.8050	0.2813	0.5959	1.5326	0.3164-7.4250
Gynecological disorders, "yes"	-0.0202	1.2491	0.0003	0.9871	0.9800	0.0847-11.3377
Malignance history, "yes"	19.8665	6061.9099	0.00001	0.9974	-	-
Degree of education						
Middle school	Ref.	-	-	-	-	-
High school	-0.2513	0.5546	0.2054	0.6504	0.7778	0.2623-2.3063
University	-1.3218	0.7710	2.9389	0.0865	0.2667	0.0588- 1.2085
Economic Status						
Student	Ref.	-	-	-	-	-
Employed	0.1541	0.8810	0.0306	0.8611	1.1667	0.2075-6.5597
Unemployed	1.1574	0.9131	1.6068	0.2049	3.1818	0.5314-19.0515
Pensioned	1.5404	1.1073	1.9352	0.1642	4.6667	0.5326-40.8874

The odds ratio (OR) and 95% confidence interval ($CI_{95\%}$) were calculated. A *P*-value< 0.05 was considered statistically significant. Age and BMI noted in March 2020 are divided into quartile (from Q_1 to Q_4), and Q_1 was selected as the reference.

0.7606).

18 patients (23.4%, $CI_{95\%}$: 14.5-34.4%) had no comorbidity and the most frequent pathological conditions were obesity (37 patients, 48.1%, $CI_{95\%}$: 36.5-59.7%), smoking (21 patients, 27.3%, $CI_{95\%}$: 17.7-38.6%) and hypertension (14 patients, 18.2%, $CI_{95\%}$:10.3-28.6%). Univariate logistic regression showed that the presence of hypertension increases the risk to abandon nutritional follow-up plan (OR= 4.8706, $CI_{95\%}$:1.4284-16.6076, *P*-value= 0.0114). No other comorbidities resulted statistically related to main outcome.

38 patients (49.4%, $CI_{95\%}$: 37.8-61.0%) were graduated at high school and 40 patients (51.9%, $CI_{95\%}$: 40.3-63.5%) were employed. Univariate logistic regression showed no correlation between the main outcome and degree of education and economic status.

51 patients presented in May 2020 follow-up visit.Median of BMI reported in March 2020 and May 2020 was 29.4 kg/m2 (IQR:24.9-32.7 kg/m2) and 29.5 kg/m^2 (IQR: 25.6-33.6 kg/m^2) respectively. Two patients (3.9%, $CI_{95\%}$: 0.5-13.5%) had no BMI variation, 14 patients (27.5%, $CI_{95\%}$: 15.9-41.7%) had reduction in BMI, and 35 patients (68.6%, $CI_{95\%}$: 54.1-80.9%) presented an increase in BMI. Wilcoxon test showed that the variation was statistically significant (median differences in BMI 0.5 kg/m^2, $CI_{95\%}$:0.1-0.7 kg/m^2, *P*-value= 0.0094, Figure 1).

Discussion

COVID-19 represents a severe crisis for both economy and public health. According to its high morbidity and mortality, it can be described as the worst pandemic of the last century (5). Due to the lack of herd immunity

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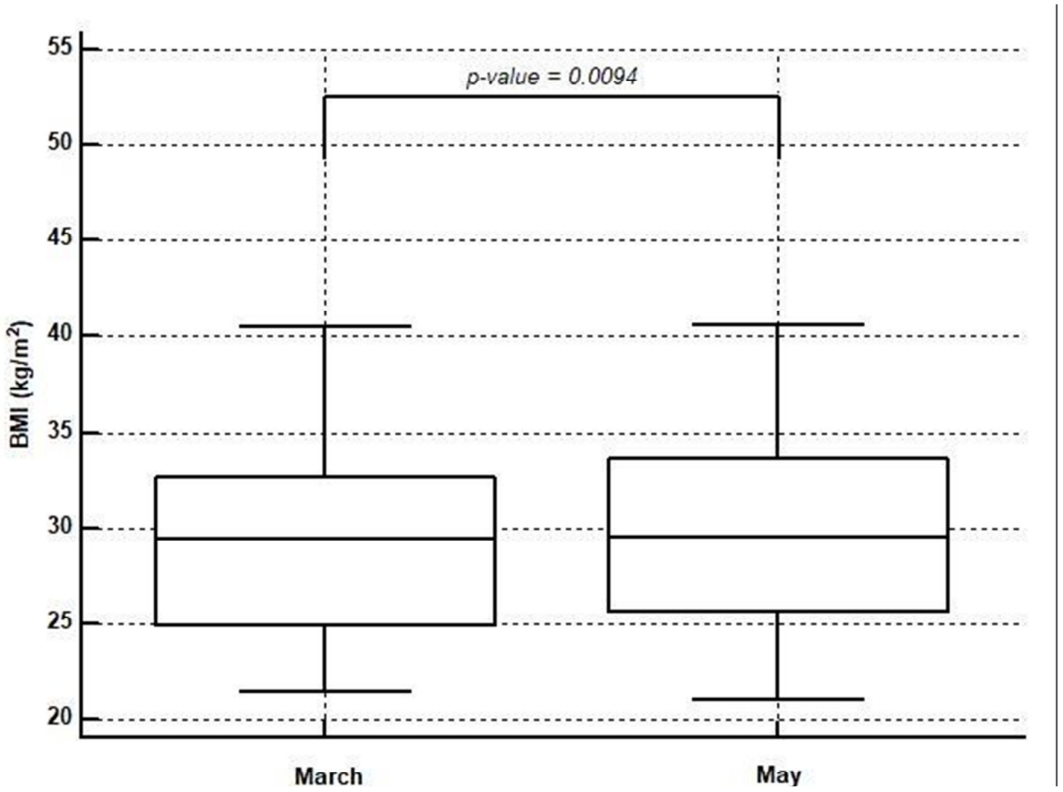

Figure 1. The Box-and-Wiskers-Plot showed BMI distribution in patients that attended the follow-up visit in May 2020 (51 patients). Wilcoxon test (α= 0.05) showed that the variation resulted statistically significant (median differences in BMI 0.5 kg/m^2, $CI_{95\%}$ 0.1-0.7 kg/m^2, *P*-value= 0.0094).

in the population and the highly contagious nature of the virus, industrialized countries have adopted restrictive measures and general lockdown to reduce and control the infection spreading.

In Italy, restrictive measures ended in May 2020, but the fear of contagion was still perceived high in the elderly and patients suffering from chronic cardiovascular conditions. Indeed, advanced age and chronic cardiovascular conditions have often been shown as factors related to COVID-19 mortality (6). Therefore, these categories may be especially prudent about minimizing in-person healthcare visits during the COVID-19 pandemic.

According to this evidence, results of our primary scope showed that the abandoning nutritional plan rate was high (33.8%). Specifically, univariate logistic regression analysis revealed that age ≥ 54 years old and suffering from hypertension represented factors able to increase the risk to abandon follow-up visits and, as they preferred to reduce compliance to a nutritional plan rather than expose themselves to infective risk. No relations with BMI, cultural and economic characteristics were noted by univariate logistic regression. In these categories of patients, the post-lockdown effects on outpatient health services and follow-up consultations are still unknown and further well-designed studies are needed to betterclarify the effects of both pandemic and stay-at-homeorder on the health status of the population.

The second endpoint was to test if national lockdown restrictions influenced BMI in patients that did not abandon the follow-up plan. In our cohort, we found a statistical difference in BMI in patients who attended the follow-up visit in May 2020 (51 patients)

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compared to March 2020, and 35 patients presented an increase in BMI. The issue is not of secondary importance if we consider that an increasing body of evidence points out that outcomes with COVID-19 are worse for those suffering from obesity, representing an urgent global challenge (7-9). Indeed, obese COVID-19 patients have a significant risk and worse clinical progression of infectious disease with greater complications, prolonged hospitalization and high critical illness with a dramatic influence on COVID-19 severity and mortality (1,10,11). Obesity could promote the occurrence of the whole course of COVID-19, and a higher degree of obesity may predict a higher risk (11). Obese patients were more likely to have positive SARS-CoV-2 test results, higher incidence of hospitalization, higher incidence of ICU admission, invasive mechanical ventilation, and in-hospital mortality.

Several different aspects could explain the strong and bad relationship between obesity and SARS-CoV-2 infection. First, obesity is connected with numerous comorbidities such as hypertension, insulin resistance, type 2 diabetes, cardiovascular disease, fatty liver disease, respiratory disease and neoplasia (12-14). Second, obesity is characterized by chronic subclinical systemic inflammatory, which negatively impairs immune response (15-18). In overweight and obese people, the adipose tissue reduces the production of anti-inflammatory adiponectin and induces the release of pro-inflammatory mediators such as tumour necrosis factor α (TNF-α) and interleukin 6 (IL-6), thus leading to the development of a chronic and systemic inflammatory state, oxidative stress damage and defect in the innate immunity (19-21). Severe complications of COVID-19 are characterized by uncontrolled secretion of inflammatory cytokines like IL-6 (22). Hence obesity share with COVID-19 both metabolic and inflammatory hallmarks.

National lockdown measures implied a greater risk of sedentarism and exercise reduction on one side, but on the other, an increased possibility to eat almost every meal at home, the impossibility to consume restaurant/ cafeteria meals, and the availability of more time to cook, with a lower need for ready meals, usually rich in fats, sugars, and salt. Flanagan et al. (23) performed an online survey in April 2020 and collected information on dietary behaviors, physical activity, and mental health. During the pandemic, overall scores for healthy eating increased due to less eating out and increased cooking. Leisure-time sedentary behaviors increased, while time spent in physical activity (absolute time and intensity-adjusted) declined. Anxiety scores increased during the pandemic, and the magnitude of increase was significantly greater in people with obesity. Weight gain was reported in 27.5% of the total sample compared to 33.4% in participants with obesity.

These data are congruent with our results, and sedentary lifestyle and psychological stress exerted adverse effects on the patients' capacity to respect the nutritional plan. Stress conditions induced by lockdown and social restrictions increase the energetic intake and reduce physical activity. Marchitelli et al. (24) reported that weight gain during lockdown was by 31 of the 63 participants affected by overweight/obesity without a psychiatric diagnosis and by 31 of the 47 patients with a psychiatric diagnosis. Weight gain predictors were stress and low depression for patients without a psychiatric diagnosis and binge eating behaviors for patients with a psychiatric diagnosis. About the second aspect, as reported by Robinson et al. (25), a large number of participants to a national survey reported negative changes in eating and physical activity behavior (e.g. 56% reported snacking more frequently) and experiencing barriers to weight management (e.g. problems with motivation and control around food) compared to before lockdown. These trends were particularly pronounced among participants with higher BMI. Higher BMI was associated with lower physical activity levels, and diet quality during the lockdown and a

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greater reported overeating frequency. Rogers et al. (26) showed that 25.0% changed toward less intensive physical activity. Doing less intensive physical activity was associated with obesity, hypertension, lung disease, depression, and disability.

All these considered factors could contribute to the spread of the "silent" obesity pandemic. Governments should pay attention, promote a healthy lifestyle, encourage regular physical activity, and ensure access to health service to stop obesity incidence, especially in emergency conditions, as the current pandemic.

Strengths and limitation

The present study's main limitation is its retrospective observational nature, and due to the small sample size, we did not perform multivariate logistic regression analysis. Moreover, we did not investigate the psychological aspect and psychiatric conditions in our cohort, during the lockdown. Further studies are needed to elucidate the impact of stressful events in patients suffering from comorbidities on attitude to take care of themselves health status.

Conclusions

Age and hypertension are factors related to the risk of abandoning healthcare services after ending national lockdown measures in May 2020. The phenomenon of lost follow-up patients should not be underestimated because it could worsen clinical conditions, with a deterioration of life expectancy in the next year. Moreover, an increase in BMI during stay-at-home order should be interpreted as a personal difficulty in complying with a plan or a therapeutic prescription, contributing to the spread of the "silent" obesity pandemic.

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