ANKARA MEDICAL JOURNAL

Research Article

Ankara Med J, 2022;(1):104-117 // 10.5505/amj.2022.96729

# AN EXAMINATION OF THE EFFECTIVENESS OF DIGITAL APPLICATIONS FOR OBESE PATIENTS WHOSE FOLLOW-UP AND TREATMENT WERE DISRUPTED DUE TO THE COVID-19 PANDEMIC

**Remziye Nur Eke[1], Yalcin Albayrak[2], Seçil Kuru[1], Hatice Esen[3]**

[1]University of Health Sciences, Antalya Training and Research Hospital, Department of Family Medicine, Antalya, Turkey

[2]Electrical And Electronics Engineering, Akdeniz University, Antalya, Turkey

[3]University of Health Sciences, Antalya Training and Research Hospital, R&D Department, Antalya, Turkey

**Correspondence:**

Remziye Nur Eke (e-mail: drnureke@gmail.com)

Submitted: 01.07.2021 // Accepted: 28.01.2022

Ankara Yıldırım Beyazıt University Faculty of Medicine
Department of Family Medicine

## Abstract

**Objectives:** This study aimed to investigate the effectiveness of digital technologies in the follow-up and treatment of obesity patients during the COVID-19 pandemic.

**Materials and Methods:** Prospective case-control study was carried out at the Obesity Centre of Antalya Training & Research Hospital. While 30 obese patients in the project group were followed and guided 7/24 for three months with smartphones/smart wristbands, 27 control patients were followed up with face-to-face meetings every two weeks as standard. Project group patients were evaluated in terms of calorie consumption, conditions regarding exercises, sleep and stress, and laboratory data in addition to anthropometric measurements at the beginning and end of the project, while control group patients were evaluated only in terms of anthropometric measurements.

**Results:** Mean age of patients in the project group was 42.57 ± 7.57 years, and the control group was 54.63 ± 6.20 years. Of all the patients, 94.74% of them were female, while 5.26% were male. At the end of the project, the weight of the project group patients dropped from 92.25 kg to 89.70 kg, and their BMI from 35.60 kg/m2 to 34.80 kg/m2 ($p<0.001$). In addition, a statistically significant decrease was found in laboratory parameters such as HbA1c and triglyceride levels, as well as systolic and diastolic blood pressures. There was a minimal decline in weight and BMI of the control group, which was not statistically significant.

**Conclusion:** Online and/or smartphone/smart wristband-based follow-up and guidance can be used as an effective method in the treatment of patients with obesity who do not tend to go to the hospital due to pandemics.

**Keywords:** Smart wristbands, smartphones, digital apps, obesity treatment, COVID-19 pandemic.

## Introduction

Obesity and overweight are important public health challenges that concern not only in developed countries but also developing countries in the 21st century, becoming pandemic day by day and causing the death of more than 4 million people every year.[1]

One of the most important systems affected by obesity is the respiratory system. In this regard, obesity is one of the major risk factors for diseases such as asthma, chronic obstructive pulmonary disease, pneumonia, obesity-hypoventilation syndrome, obstructive sleep apnea syndrome, pulmonary hypertension, and acute respiratory distress syndrome.[2,3] Weight gain and increased body mass index (BMI) have been regarded to be associated with a decrease in lung volumes shown by a more restrictive ventilation pattern in spirometry.[4,5] Fat accumulation in the abdominal and thoracic cavity and the mediastinal area directly affects the mechanical properties of the lung and chest wall. It also causes the diaphragm to remain upward, thus restricting its downward movement, increasing pleural pressure, and decreasing functional residual capacity.[6,7] As a result, it can be assumed that the COVID-19-related lung involvement increases in obese patients due to certain reasons such as airway resistance, ventilation-perfusion inequality,[8] decreased diaphragm movement and lung capacity, as well as increased inflammatory cytokines associated with obesity and that obesity, leads to a growing need for intensive care in COVID-19 patients.

As shown in many clinical studies, obesity increases lung involvement, intensive care need, morbidity and mortality in COVID-19 patients, which is why the fight against obesity has once again gained importance during the pandemic.[9-12]

Obesity Centers play an important role in the fight against obesity in Turkey.[13] In addition to individual training, interviews and therapies, interactive training that aim to develop necessary behavior in groups of 12 - 20 people towards healthy nutrition and regular physical activity, that is, lifestyle change, constitute the basis of the service offered in Obesity Centers. In our Obesity Centre, where we achieved successful results with high motivation, online applications via remote access were required for the patients' follow-up to prevent them from losing their motivation and returning to their previous weight during the pandemic. A special project call, namely "COVID-19 and Society: Social, Human and Economic Effects of the Pandemic, Problems and Solutions" opened within the scope of TUBITAK 1001 - Scientific and Technological Research Projects Support Program was applied for this study.

The present study aimed to research the effectiveness of digital applications (smartphone apps and smart wristbands) in the follow-up of patients with obesity who had already been followed up in an Obesity Centre and whose follow-up and treatment process had been disrupted due to the COVID-19 pandemic and to enable

the patients to continue losing weight by minimizing their visits to the Centre during that time in the light of the data to be obtained.

## Materials and Methods

*Sample groups*

The population of this prospective clinical study consisted of 118 patients who were followed up and treated in the Obesity Centre of University of Health Sciences, Antalya Training and Research Hospital between 01.09.2019 and 15.03.2020. The patients whose follow-up and treatment were interrupted due to the COVID-19 pandemic were evaluated by the project team according to the inclusion criteria (patients between the ages of 18 - 50, patients BMI ≥ 30, patients who have completed the 3rd module training in the obesity center, patients at least had primary care education, patients who had smartphones and have the ability to use smartphone apps, patients who agreed to participate in the project) in the study, which then identified 43 patients who were between the ages of 18 - 50 with the BMI ≥ 30, and who had already completed the 3rd module training,[13] at least had primary care education and who had smartphones besides the ability to use smartphone apps. Subsequently, the patients were invited to the Centre and were informed about the project, the phone application, and wristbands. Thirty patients who volunteered to participate in the project were included in the study upon their signed informed consent forms.

Following the completion of equipment and service procurement, the first anthropometric measurements of 30 patients, physician examinations, necessary interviews with dieticians, psychologists, and physiotherapists were conducted as of September 21, 2020. During those first meetings, a special diet-calorie program was prepared for each patient, workout plans were made, and the necessary motivation was provided for changing appropriate behavior and raising consciousness. In addition, the software developed by the technical team was downloaded to the patients' smartphones, phone-wristband synchronization was ensured, and wristbands were delivered to the patients. The patients' blood pressure measurements and laboratory tests were also performed in the same interview. Then, 30 project patients recorded their calorie intake, water consumption and mood via smartphones and their exercise status, calorie expenditure, sleep patterns, and durations via smart wristbands. All data were monitored 24/7 online. The patients were given instant feedback, warnings and suggestions. And also participated in face-to-face interviews at the center every two weeks, and anthropometric measurements were made. Of all the patients, 27 control patients who were followed up in the Obesity Centre and had clinically similar characteristics were interviewed face-to-face with a dietician, a psychologist and a physiotherapist by taking their anthropometric measurements every two weeks without using any digital applications. However, since the laboratory measurements of the control group patients were

not performed, only the anthropometric measurements of the project group and control group patients were compared at the end of the 3 -month follow-up. The algorithm of the research is presented in Figure 1.

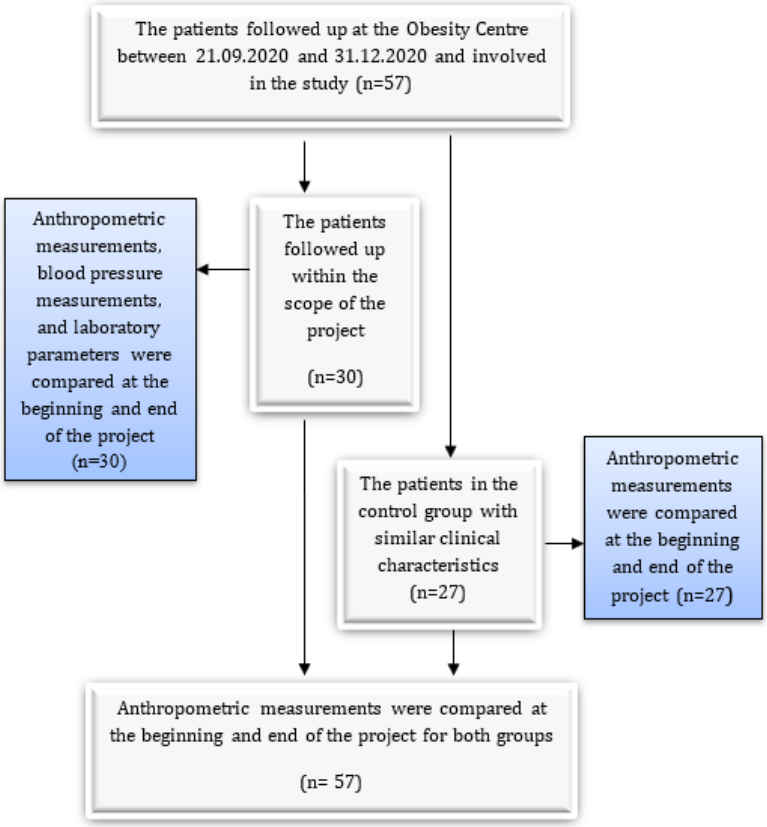


**Figure 1**. The algorithm of the research

*Data collection and procedure*

The blood pressure measurements of the patients at the beginning of the project were made in the sitting position after at least 5 minutes of rest, with the arm placed at the heart level, using a sphygmomanometer (Gez G-life Perfect Mechanic) and a stethoscope (3M Littman Classic II) from the cubital fossa and taken as the average of two measurements. The patients' heights were measured when the heels were together, the body was upright, without shoes, by taking the distance between the vertex point and the floor on the TESS brand height and weight scale. Bioelectrical impedance analysis (TANITA MC 580) was used to calculate body weights and body mass index (BMI). The measurement was made by placing the patient on the scale so that s/he could step on the appropriate parts of the analyzer with bare feet. Waist circumference measurements were made by placing the tape measure through the umbilicus level and hip circumference measurements by placing the tape

measure through the widest part of the hips by the same assistant personnel. Fasting blood glucose (FBG), glycosylated hemoglobin (HbA1c), fasting insulin, insulin resistance, total cholesterol (total-C), low-density lipoprotein cholesterol (LDL-C), high-density lipoprotein cholesterol (HDL-C) and triglyceride (TG) were analyzed in blood samples taken after 12 hours of fasting. FBG, total - C, triglyceride and HDL - C levels were evaluated using a spectrophotometric method using Beckman Coulter commercial kits in a Beckman Coulter AU5800 (Beckman Coulter Inc., CA, USA) autoanalyzer. HbA1c levels were measured by a commercially available high-performance liquid chromatography method (Tosoh HLC 723 G8; Tosoh Bioscience, Japan). The Homeostasis Model Assessment (HOMA-IR) formula [FBG (mg/dL) x fasting insulin (μU/mL) / 405][14] was used in the estimation of insulin resistance, whereas the formula developed by Friedewald et al. was used to calculate the LDL-C level.[15] Prediabetes was diagnosed in accordance with TEMD recommendations in patients with FPG = 100 - 125 mg/dL and/or HbA1c = 5.7% - 6.4% who did not receive antidiabetic therapy. Based on the hospital laboratory classification, those with HOMA-IR > 2.5 were diagnosed with insulin resistance.

*Statistical analysis*

The data analyses were conducted with IBM SPSS 23.0 package software (IBM Corp., Armonk, NY). Descriptive statistics were presented with n (%), mean±standard deviation, and median (min-max) values. Categorical data were analyzed by Pearson chi-square or Fisher's Exact test. Mann–Whitney U test and Student's t-test were used for the analyses of non-normally and normally distributed numerical data, respectively. The McNemar-Bowker test was used to evaluate the changes in the patients' emotional states before and after the project, and only the McNemar test was used to evaluate the changes in chronic diseases. The difference between the measurement values of the patients before and after the project was analyzed with the Wilcoxon Signed Rank test when the assumption of normal distribution was not provided and with the Paired Samples t-test when provided. Multiple linear regression analysis was used to identify the factors independently associated with patients' post-project weight loss. As a result of the post hoc power analysis performed to compare the BMI percentage change of the patients in the project patients and the control group, statistical power was calculated as 99.3% for 0.05 margin of error and d=1.188 effect size. And for the weight percentage change, statistical power was calculated as 99.5% for 0.05 margin of error and d=1.224 effect size. The p values less than 0.05 were considered statistically significant.

## Results

A total of 57 patients with obesity, 30 of whom were digitally monitored, and 27 of them were control patients, were included in the study. The mean age of the project patients was calculated as 42.57 ± 7.57 years, while it was 54.63 ± 6.20 years for the control group. Of all the patients, 94.74% were female, and 84.21% of them were

married. Divorced patients were included in the single group. Table 1 presents the detailed demographic data and clinical characteristics of the control group and the project patients.

**Table 1.** Comparison of the demographic and clinical characteristics of the project patients and the control group

| Variables | Project patients (n=30) | Control group (n=27) | p-value |
|---|---|---|---|
| **Age (years)** | 42.57±7.57 | 54.63±6.20 | **<0.001** |
| **Gender** | | | |
| Women | 29(96.67) | 25(92.59) | 0.599 |
| Men | 1(3.33) | 2(7.41) | |
| **Marital status** | | | |
| Single | 3(10.00) | 6(22.22) | 0.283 |
| Married | 27(90.00) | 21(77.78) | |
| **Educational background** | | | |
| Primary school | 9(30.00) | 14(51.85) | 0.119 |
| High school | 10(33.33) | 9(33.33) | |
| University | 11(36.67) | 4(14.82) | |
| **Chronic diseases** | | | |
| Diabetes mellitus | 8(26.67) | 9(33.33) | 0.583 |
| Prediabetes | 7(23.33) | 2(7.41) | 0.149 |
| Insulin resistance | 5(16.67) | 2(7.41) | 0.427 |
| Hypertension | 6(20.00) | 17(62.96) | **0.001** |
| Hyperlipidemia | 15(50.00) | 4(14.81) | **0.005** |
| Hypothyroidism | 6(20.00) | 3(11.11) | 0.476 |
| Chronic pulmonary disease | 2(6.67) | 1(3.70) | 0.999 |
| Anxiety disorder | 3(10.00) | 3(11.11) | 0.999 |

Findings are shown as mean ± SD or n (%). Column percentages are given. Student's t-test, Pearson chi-square test, Fisher's Exact test are used.

There was a statistically significant decrease in the project patients' final control weight and BMI. They were followed up for three months by instant digital means and met face-to-face every two weeks, in comparison to the baseline values. In contrast, the decline in the weight and BMI of the control group, who were followed up face-to-face only once every two weeks within the same period, was not statistically significant (Table 2).

When the weight changes of the project patients and control group patients at the beginning and end of the process were evaluated as percentage values, the declines in weight and BMI in the project patients were statistically significant compared to those of the control group (Table 3).

**Table 2.** The change in anthropometric measurements of all patients at the beginning and end of the project

| | **Project patients (n=30)** | | | **Control group (n=27)** | | |
|---|---|---|---|---|---|---|
| | **Project beginning** | **Project end** | **p** | **Project beginning** | **Project end** | **p** |
| **Weight (kg)** | 92.25 (73.50-138.20) | 89.70 (71.80-136.60) | **<0.001** | 87.80 (65.10-183.40) | 87.70 (66.30-191.60) | 0.614 |
| **BMI (kg/m²)** | 35.60 (31.50-50.20) | 34.80 (30.50-49.60) | **<0.001** | 35.20 (30.10-56.00) | 34.90 (29.70-58.50) | 0.764 |
| **Waist circ. (cm)** | 105 (87-159) | 105 (90-158) | 0.730 | 104(86-201) | 107 (81-209) | 0.457 |
| **Hip circ. (cm)** | 116.50 (104-159) | 113 (102-158) | 0.089 | 113 (104-201) | 115 (100-209) | 0.646 |

Findings are shown as median (min-max). Wilcoxon Signed Ranks test.
BMI: Body mass index.

**Table 3.** The comparison of percentage changes in anthropometric measurements of project patients and control group during the follow-up

| | **Project patients (n=30)** | **Control group (n=27)** | **p** |
|---|---|---|---|
| **Weight change (%)** | -2.06(-8.41-0.62) | -0.11(-4.12-7.39) | **<0.001** |
| **BMI change (%)** | -2.04(-8.49-0.84) | -0.28(-3.84-7.29) | **<0.001** |
| **Waist circumference change (%)** | -0.31(-7.14-5.75) | -1.79(-6.11-6.86) | 0.467 |
| **Hip circumference change (%)** | -0.88(-8.94-4.27) | -0.9(-6.11-6.96) | 0.637 |

Findings are shown as median (min-max). Mann-Whitney U test was used.
BMI: Body mass index.

At the end of the project, there was a statistically significant decrease observed in HbA1c, triglyceride, systolic blood pressure (SBP) and diastolic blood pressure (DBP) values. In contrast, the decline in fasting blood glucose (FBG) and insulin resistance was not statistically significant. On the other hand, an increase was found in the high-density lipoprotein-cholesterol (HDL-C) level, though not statistically significant (Table 4).

At the end of the project, it was also observed that there was a non-significant decline in the amount of calories consumed by the patients and a significant increase in the length of jogging and sleeping. A statistically significant change was found in the emotional states of the patients towards developing anxiety-stress and feeling empty (Table 5).

The changes in weight percentage of the patients at the end of the project was found to have a statistically significant weak negative correlation (r = -0.371; p = 0.044) with the length of jogging, a moderate positive

correlation with fasting insulin values (r = 0.408; p = 0.034), and a weak positive correlation (r = 0.374; p = 0.043) with HOMA-IR values at the end of the project. It was observed that the increase in the length of jogging at the end of the project increased the weight loss, while the increase in fasting insulin and HOMA-IR values decreased the amount of weight loss (Table 6).

The examination of the effect of the change in the amount of calories consumed by patients on blood pressure and laboratory parameters indicated a statistically significant moderate positive correlation between the changes in the amount of calories consumed and fasting insulin (r = 0.403; p = 0.041), HOMA-IR (r = 0.466; p = 0.016), and triglyceride values (r = 0.453; p = 0.020) (Table 7).

**Table 4.** The changes in laboratory data of project patients at the beginning and end of the project

| Variables | Project start (n=30) | Project end (n=30) | p-value |
|---|---|---|---|
| **FBG (mg/dL)** | 94.50(77.00-157.00) | 93(78.00-242.00) | 0.597 |
| **HbA1c (%)** | 5.50(4.40-7.70) | 5.30(4.60-8.20) | ***0.009*** |
| **Fasting insulin (mIU/mL)** | 7.55(2.12-16.64) | 5.74(1.89-16.54) | 0.055 |
| **HOMA-IR** | 1.87(0.44-3.74) | 1.32(0.41-5.16) | 0.118 |
| **Total-C (mg/dL)** | 210.50(134.00-387.00) | 216.00(149.00-325.00) | 0.614 |
| **LDL-C (mg/dL)** | 130.50(65.00-278.00) | 132.00(89.00-221.00) | 0.324 |
| **HDL-C (mg/dL)** | 53.60±15.22 | 56.48±9.08 | 0.310 |
| **Triglyceride (mg/dL)** | 125.50(38.00-365.00) | 111.00(35.00-265.00) | ***0.036*** |
| **SBP (mmHg)** | 120(110-140) | 110(90-145) | ***<0.001*** |
| **DBP (mmHg)** | 80(70-90) | 70(60-90) | ***<0.001*** |

Findings are shown as mean ± SD or median (min-max). Paired Samples t-test, Wilcoxon Signed Ranks test.
FBG: Fasting blood glucose, HbA1c: Glycosylated hemoglobin, LDL-C: Low-density lipoprotein cholesterol, HDL-C: High-density lipoprotein cholesterol, SBP: Systolic blood pressure, DBB: Diastolic blood pressure

**Table 5.** The changes in the amount of calories taken, lengths of exercises and sleep, and their emotional states at the beginning and at the end of the project in project patients

| Variables | Project start (n=30) | Project end (n=30) | P |
|---|---|---|---|
| **The amount of calories patients consumed (kcal)** | 1271(984-2596) | 1257(932-1810) | 0.222 |
| **The length of exercises performed by the patients (minutes)** | | | |
| Jogging | 45(30-105) | 47.50(23-116) | ***0.029*** |
| Home workout | 30(0-120) | 30(0-120) | 0.388 |
| Total | 70(30-180) | 82.50(28-180) | 0.087 |
| **The length of sleep (hours)** | 07h58m±01h05m | 08h34m±01h03m | ***0.004*** |
| **Emotional states** | | | |
| Feeling empty | 4(13.33) | 6(20) | ***0.020*** |
| Anxious and Stressful | 9(30) | 19(63.33) | |
| Happy | 17(56.67) | 5(16.67) | |

Findings are shown as mean ± SD, median (min-max), or n (%). Paired Samples t-test, Wilcoxon Signed Ranks test, McNemar-Bowker Test, h: hours, m: minutes.

**Table 6.** The relationship between the changes in weight percentage and demographic features, laboratory parameters in project patients

| Values | Changes in weight percentage | |
|---|---|---|
| | r* | p* |
| **Age (years)** | -0,132 | 0,486 |
| **Metabolic age (years)** | 0,062 | 0,744 |
| **The amount of calories taken (kcal)** | -0,258 | 0,177 |
| **The length of exercises (minutes)** | | |
| Jogging | -0.371 | ***0.044*** |
| Home workout | -0.170 | 0.370 |
| Total | -0.313 | 0.092 |
| **The length of sleep (hours)** | -0.080 | 0.702 |
| **Fasting insulin (uIU/mL)** | 0.408 | ***0.034*** |
| **HOMA-IR** | 0.374 | ***0.043*** |

*Spearman correlation test

**Table 7.** The relationship between the changes in the amount of calories consumed by patients and the change in blood pressure and laboratory parameters

| Variables | Change in the amount of calories consumed | |
|---|---|---|
| | r* | p* |
| **FBG (mg/dL)** | 0.235 | 0.248 |
| **HbA1c (%)** | 0.059 | 0.775 |
| **Fasting insulin (mIU/mL)** | 0.403 | ***0.041*** |
| **HOMA-IR** | 0.466 | ***0.016*** |
| **Total-C (mg/dL)** | -0.128 | 0.532 |
| **LDL-C (mg/dL)** | -0.121 | 0.557 |
| **HDL-C (mg/dL)** | -0.166 | 0.417 |
| **Triglyceride (mg/dL)** | 0.453 | ***0.020*** |
| **SBP (mmHg)** | 0.035 | 0.859 |
| **DBP (mmHg)** | 0.235 | 0.229 |

*Spearman correlation test.
FBG: Fasting blood glucose, HbA1c: Glycosylated hemoglobin, HOMA-IR: Homeostatic model assessment insulin resistance, LDL-C: Low-density lipoprotein cholesterol, HDL-C: High-density lipoprotein cholesterol,
SBP: Systolic blood pressure, DBB: Diastolic blood pressure

## Discussion

In this study, 30 patients who had been followed up at the Obesity Centre of University of Health Sciences, Antalya Training and Research Hospital, but whose therapy was disrupted due to the COVID-19 pandemic, were followed up for three months by instant digital means as well as meeting face-to-face every two weeks. As a result, a statistically significant decrease was found in weight and BMI from anthropometric measurements and in HbA1c and triglyceride levels from laboratory parameters as well as in systolic and diastolic blood pressures (during the project period, no changes were made in the antidiabetic, antihypertensive and antihyperlipidemic treatment of any patient. Therefore, the results obtained were only the changes obtained by losing weight). In the same process, a non-significant decline was detected in weight and BMI of the control group patients who were followed up face to face only once every two weeks.

Although there are various studies in the literature investigating the effectiveness of digital technologies (web-based, internet, e-mail, smartphone applications, etc.) in obesity treatment and weight control, the amount of studies examining the follow-up and treatment of patients with obesity via digital technologies and online methods during the pandemic is limited.

Numerous studies have been published showing that weight gain has increased in the general population and particularly in obese patients since the beginning of the COVID-19 pandemic. In a study investigating the effect of "stay-home" days due to the COVID-19 on weight-related behaviors, 123 obese patients who were followed up in an obesity clinic were evaluated. It was determined that 69.6% of the patients had difficulty losing weight during the period, 11.1% did not exercise at all, 47.9% reduced the length of their exercise, and 61.2% tended to eat more because of stress.[16] A study conducted by Pellegrini et al. in Italy with 150 obese patients, who were followed up in an obesity center affiliated to a Diabetes and Metabolic Diseases Clinic and went through a "mandatory quarantine" period for a month, found that males gained an average of 1.3 kg, whereas females gained 1.57 kg during the period. In the same study, eating more, doing less exercise, feeling boredom/loneliness, experiencing anxiety/depression, and increasing consumption of snacks/unhealthy foods/cereals/sweets were associated with greater weight gain.[17]

Examining the relevant data obtained from the studies (web-based, over the internet, as well as e-mails or smartphone apps, etc.) investigating whether weight control can be achieved through digital applications in the pre-pandemic period is of great value in terms of shedding light on the treatment of patients with obesity who tend to avoid going to health institutions and whose comorbidity is likely to aggravate the course of the COVID-19 disease, as is widely expressed in every circumstance. Before writing our project, we reviewed the literature regarding the issue and included a new perspective of remote follow-up treatment into our existing program in our Obesity Centre. We developed a model with smartphones, smart wristband applications, and

only 2-weekly planned visits to our Centre. Conducting a study to evaluate online weight control and weight change along with the related factors, Pappa et al. reported that female participants as well as those with higher BMI, those who were using the program more actively, and those who were taking part more in discussions that could provide online activity and social support ended up losing more weight.[18] In the light of such research, we observed that the patients who were more successful in losing weight in our program appeared to be those who went jogging more, those who entered their data more regularly via the smartphone application, those who used their smart wristbands more efficiently, and those who attended the face-to-face meetings held once every two weeks more regularly. In another study conducted before the pandemic, 91 patients with BMI = 25 - 40 kg / $m^2$ were randomly divided into two treatment groups, one of which was determined as the intervention group and the other as the late intervention group. The study in the intervention group involved using smart Bluetooth-connected scales for daily weighing, web-based graphs of weight changes, checking the frequency of self-weighing, and weekly special feedback on weight loss progress via e-mails, besides further e-mails consisting of 22 lessons on behavioral weight control. In the controls in the third month, an average weight loss of 4.41% was observed in the intervention group, while an average weight loss of 0.37% was observed in the delayed intervention control group.[19] In our study, an average of 2.76% weight loss was observed in the Project patients during the 3 -month follow-up period. However, the study by Steinberg et al. excluded those who participated in a structured weight loss program in the last six months and lost 10 lbs (1 lb = 453.5924 gram), those with HT, those with unstable thyroid disease, those with psychiatric disorders other than depression, and those who were pregnant or planning to get pregnant. In our study, all of our patients had been treated in the structured weight loss program in our Centre in the last six months (the patients included in our study had completed at least Module 3 training in our Obesity Centre, and even the one who achieved the least weight lost, successfully lost 5.21 kg during that period). Meanwhile, six patients were being followed up and treated with HT diagnosis, six patients with hypothyroidism, and three patients with anxiety disorder. On the other hand, one patient informed us that she was pregnant in the last three weeks of the project. Factors such as lifestyle changes during the pandemic and weekend lockdowns that started to be implemented in the last four weeks of the project can be considered important obstacles for our patients to lose more weight.

In the study, which can be considered the closest study to our project because it was planned with people who participated in a web-based weight loss program during the COVID-19 pandemic, Pellegrini et al. investigated the relationship between stress and weight management in 99 participants. They reported a clear association between more stress and higher BMI, higher education level, more working hours, and having a school-age child at home. In the same study, more stress was also associated with higher levels of worry and anxiety related to the COVID-19 and less time spent on weight loss efforts.[20] In our study, it was observed that at the end of the project, the emotional states of our patients changed at a statistically significant level in the direction

of being anxious and stressed. Despite this, a significant decrease in the weight and BMI of our patients were performed.

As a result, it has been determined that online or smartphone/smart wristband-based follow-up and guidance can be used as an effective method to maintain the treatment of patients with obesity who do not prefer to go to the hospital due to the pandemic. In addition, appropriately adapting and expanding the system, which we apply, is considered beneficial in public and private obesity centers, in obesity units affiliated to Endocrinology and Metabolism Clinics, and in centers where obesity surgery is performed. This system is also believed to provide convenience both for the treatment provider and the patient receiving treatment in the instant evaluation of the data in the follow-up of chronic diseases such as diabetes mellitus and hypertension, and to be effective in solving the problem of malnutrition, which is a common and considerable health concern, especially in patients receiving home health care.

**Ethical Considerations:** The Antalya TRH Clinical Research Ethics Committee approved the study before its implementation (approval no; 7/18, date; June 03, 2020), and the study was performed in compliance with the Declaration of Helsinki.

**Conflict of Interest:** The authors declare no conflict of interest.

**Funding:** Financial support was attained for this study, within the scope of TUBITAK 1001 - Scientific and Technological Research Projects Support Program (project number: 120S445).

*The summary of this research was presented as an oral presentation at the 20th International Eastern Mediterranean Family Medicine Congress, which was held in Adana-online between May 20th and 23rd, 2021.

## References


1. World Health Organization (2020). Health topics, obesity [Internet]. https://www.who.int/health -topics/obesity#tab=tab_1 (Accessed: 30.12.2020).
2. Turgut T, İn E. Obesity and respiratory system. Firat Med J. 2018;23(Supp):35-41.
3. Franssen FME, O'Donnell DE, Goossens GH, Blaak EE, Schols AMWJ. Obesity and the lung: 5. Obesity and COPD. Thorax 2008;63:1110-7.
4. Zammit C, Liddicoat H, Moonsie I, Makker H. Obesity and respiratory diseases. Int J Gen Med. 2010;3:335-43.
5. Jones RL, Nzekwu MM. The effects of body mass index on lung volumes. Chest 2006;130:827-33.
6. Peters U, Suratt BT, Bates JHT, Dixon AE. Beyond BMI: Obesity and lung disease. Chest 2018;153:702-9.
7. Watson RA, Pride NB, Thomas EL, et al. Reduction of total lung capacity in obese men: comparison of total intrathoracic and gas volumes. J Appl Physiol. 2010;108:1605-12.
8. Albashir AAD. The potential impacts of obesity on COVID-19. Clin Med. (Lond) 2020;20(4):e109-e13.
9. Chu Y, Yang J, Shi J, Zhang P, Wang X. Obesity is associated with increased severity of disease in COVID-19 pneumonia: a systematic review and meta-analysis. Eur J Med Res. 2020;25:64.
10. Kang Z, Luo S, Gui Y, et al. Obesity is a potential risk factor contributing to clinical manifestations of COVID-19. Int J Obes. (Lond) 2020;44(12):2479-85.
11. Lockhart SM, O'Rahilly S. When Two Pandemics Meet: Why is obesity associated with increased COVID-19 mortality? Med. (N Y) 2020;1(1):33-42.
12. Tartof SY, Qian L, Hong V, et al. Obesity and mortality among patients diagnosed with COVID-19: Results from an integrated health care organization. Ann Intern Med. 2020;12:M20-3742.
13. Nur Eke R. The Role of Obesity Centers in the Fight against Obesity: The Case of Antalya Province. TJFMPC. 2021;15(1):19-26.
14. Matthews DR, Hosker JP, Rudenski AS, Naylor BA, Treacher DF, Turner RC. Homeostasis model assessment: insulin resistance and b cell function from fasting plasma glucose and insulin concentration in man. Diabetologia. 1985;28:412-9.
15. Friedewald WT, Levy RI, Fredrickson DS. Estimation of the concentration of low-density lipoprotein cholesterol in plasma, without use of the preparative ultracentrifuge. Clin Chem. 1972;18:499-502.
16. Almandoz JP, Xie L, Schellinger JN, et al. Impact of COVID-19 stay-at-home orders on weight-related behaviours among patients with obesity. Clin Obes. 2020;10:e12386.
17. Pellegrini M, Ponzo V, Rosato R, et al. Changes in weight and nutritional habits in adults with obesity during the "lockdown" period caused by the COVID-19 virus emergency. Nutrients 2020;12(7):2016.

18. Pappa GL, Cunha TO, Bicalho PV, et al. Factors associated with weight change in online weight management communities: A case study in the LoseIt Reddit Community. J Med Internet Res. 2017;19(1):e17.
19. Steinberg DM, Tate DF, Bennett GG, Ennett S, Samuel-Hodge C, Ward DS. The efficacy of a daily self-weighing weight loss intervention using smart scales and e-mail. Obesity (Silver Spring) 2013;21(9):1789-97.
20. Pellegrini CA, Webster J, Hahn KR, Leblond TL, Unick JL. Relationship between stress and weight management behaviors during the COVID-19 pandemic among those enrolled in an internet program. Obes Sci Pract. 2021;7:129-34.