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# Impact of the COVID-19 Pandemic on Obesity, Metabolic Parameters and Clinical Values in the South Korean Adult Population

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**Abstract:** This study aimed to evaluate the effects of the COVID-19 pandemic on obesity, metabolic parameters, and clinical values in the South Korean population. Data from the seventh and eighth National Health and Nutrition Examination Surveys were analyzed, comprising 3560 participants in 2018 (pre-COVID-19) and 3309 participants in 2021 (post-COVID-19). The study focused on adults aged 19 years and older who were overweight (BMI $\geq$ 25 kg/m$^2$). The results showed a significant increase in waist circumference (approximately 2 cm), BMI (approximately 0.11 kg/m$^2$), systolic blood pressure, fasting blood sugar (1.76 mg/dL higher), and glycated hemoglobin (0.14% higher) in the post-COVID-19 group compared to the pre-COVID-19 group. Additionally, the prevalence of hypercholesterolemia increased by 4% after the COVID-19 pandemic. These findings suggest an increased risk of obesity, abdominal obesity, and metabolic disorders, such as blood sugar disorders, in the post-COVID-19 period. Urine analysis revealed abnormal findings, including occult blood, urobilinogen, hematuria, proteinuria, ketone urea, glycosuria, and bacteriuria. The study highlights the negative impact of lifestyle changes, such as reduced physical activity and social gatherings, on physical vital signs and clinical values during the COVID-19 pandemic.

**Keywords:** COVID-19 pandemic; obesity; metabolic parameters; clinical values; population health

## 1. Introduction

The COVID-19 pandemic, also referred to as the "COVID-19 crisis", had a sudden and massive impact on daily life, politics, economics, society, and culture [1,2]. However, three years after the global outbreak that originated in Wuhan, China, the incidence rate has decreased, but the pandemic has not yet ended [3]. The most significant changes resulting from this health crisis were not limited to the healthcare sector alone; the event led to a restructuring of the socioeconomic order and a fundamental transformation of the social system [4]. Due to the outbreak of the novel infectious disease COVID-19, human physiology has undergone many alterations [1,4]. Additionally, efforts have been made to prevent the spread of the infectious disease by imposing restrictions on global transportation [5]. Furthermore, social and personal activities have been forcibly reduced and prohibited [6,7]. Unlike previous outbreaks, such as those of SARS and MERS, COVID-19 has had a significant impact on politics, economics, society, and culture [8]. The Ministry of Culture, Sports, and Tourism in South Korea conducted a survey in 2020 on the public's perception of COVID-19 quarantine measures. The survey revealed that 84.3% of respondents took the situation seriously, while 55.8% expressed concern and worry about the possibility of infection [9].

In 2018, the Korean Diabetes Association (KDA) estimated that between 13.8% and 26.9% of adults over the age of 30 in South Korea are expected to have impaired fasting glucose, and that 35% of diabetic patients have not yet been diagnosed with diabetes [10]. South Korea is experiencing a significant prevalence of diabetes, with 53.2% of individuals with diabetes also having hypertension, and 72% having hypercholesterolemia, necessitating urgent and systematic management strategies for this patient population [10–12].

In this study, we investigated the alterations in physical vital signs, blood tests, and urine tests among overweight and obese adults aged 19 years and above in South Korea, before and after the onset of the COVID-19 pandemic. To achieve our objective, we aimed to examine the variations in physical vital signs, blood tests, and urine test values from the data collected by national institutions. Additionally, we aimed to assess how the risk of developing adverse health conditions changed. Based on these findings, we intended to provide a foundation for research aimed at identifying, managing, and preventing factors that can have adverse effects on both mental and physical health during and after the COVID-19 pandemic. Furthermore, we believe that this research will provide essential data for managing the health of individuals in the event of future infectious disease outbreaks, similar to that of COVID-19.

## 2. Materials and Methods

### 2.1. Study Designs and Sampling

This study utilized raw public data from the seventh and eighth National Health and Nutrition Examination Surveys, which are nationally approved statistical sources (No. 117002), for the second time. Out of a total of 15,082 participants, only individuals with a body mass index (BMI) classified as overweight or obese (BMI $\geq$ 25) and aged 19 years or older were included in the study. Participants under the age of 19 were excluded. The final study sample comprised 3560 participants from 2018 and 3309 participants from 2021. Data were obtained through the online distribution procedure of the relevant institution, utilizing national open data. The two groups were designated as pre-COVID-19 and post-COVID-19, respectively. The study focused on overweight and obese adults aged 19 years and older, with a BMI of 25 or higher (Figure 1).
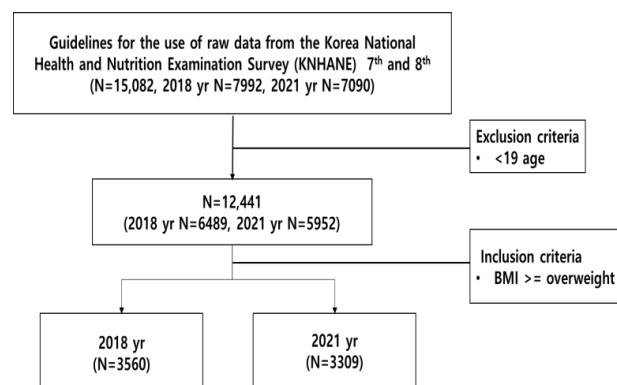


**Figure 1.** Data cleaning process flow. (The year 2018 was a year before the COVID-19 outbreak, and 2021 was the year after the COVID-19 outbreak.)

### 2.2. Data Variables

The variables examined in this study include the following: (1) physical characteristics, such as gender, age, height, weight, waist circumference, body mass index (BMI) based on Asian standards, pulse rate, and blood pressure (average of two measurements); (2) blood test parameters, including fasting blood glucose, glycated hemoglobin (HbA1c), total cholesterol, high-density lipoprotein (HDL) cholesterol, triglycerides, low-density lipoprotein (LDL) cholesterol, the prevalence of hypercholesterolemia, the prevalence of hypertriglyceridemia, aspartate aminotransferase (AST), alanine aminotransferase (ALT), hepatitis B surface antigen positivity, hepatitis C antibody positivity, hemoglobin, hematocrit, the prevalence of anemia,

blood urea nitrogen, serum creatinine, white blood cell (WBC) count, red blood cell (RBC) count, and platelet count; and (3) urine test parameters, including uric acid, urine pH, nitrite, urine protein, urine glucose, and urine ketone. Additionally, participants underwent tests for urine bilirubin, urine occult blood, urobilinogen, urine creatinine, and urine bilirubin, as well as measurements of sodium, potassium, and cotinine levels in urine.

### 2.3. Data Analysis

The study variables were categorized as being either categorical or continuous variables. Categorical variables were presented as frequencies and percentages, while continuous variables were reported as means and standard deviations after assessing the normality of their distributions. Differences between the groups were analyzed by using the Mann–Whitney U test for continuous variables and Fisher's exact test or the chi-square test for categorical variables, as appropriate. Multiple regression analysis was performed to identify variables associated with the severity of the COVID-19 outbreak, with a significance level criterion of 0.10 for input variable selection. All statistical analyses were conducted using IBM SPSS software (version 25.0, IBM Corp., Armonk, NY, USA), with a significance level of 0.05.

### 3. Results

#### 3.1. Blood Pressure Changes in Overweight/Obese Adults Pre-/Post-COVID-19

Changes in the general characteristics of the overweight group before and after the COVID-19 outbreak are presented in Table 1. A significant difference was observed in systolic blood pressure (122.12 ± 16.29 mmHg vs. 123.32 ± 15.12 mmHg) and diastolic blood pressure (77.39 ± 10.45 mmHg vs. 75.56 ± 9.60 mmHg) between the group classified as obese (BMI ≥ 30 kg/m$^2$, 13.4%) and the non-obese group (BMI 25–29.9 kg/m$^2$, 16.7%) (Table 1).

**Table 1.** General characteristics of the overweight group before and after the COVID-19 outbreak.

| Characteristic | | Before the COVID-19 Outbreak (2018) | | After the COVID-19 Outbreak (2021) | | Z [2]/[4]$X^2$ | *p*-Value [3] |
|---|---|---|---|---|---|---|---|
| | | N [5]/Mean [1] | % [5]/SD [1] | N/Mean | %/SD | | |
| Sex [4] | Male | 1817 | 51.0 | 1687 | 51.0 | 0.002 | 0.962 |
| | Female | 1743 | 49.0 | 1622 | 49.0 | | |
| Age [1] | | 53.54 | 15.97 | 54.73 | 16.39 | −3.382 | 0.001 |
| Height (cm) [1] | | 163.81 | 9.85 | 163.97 | 10.03 | −0.501 | 0.617 |
| Weight (kg) [1] | | 70.79 | 11.58 | 71.26 | 12.02 | −1.363 | 0.173 |
| Waist circumference [1] | | 88.41 | 7.95 | 90.35 | 8.20 | −9.694 | <0.001 |
| Body mass index (BMI) [1] | | 26.28 | 2.77 | 26.39 | 2.88 | −1.499 | 0.134 |
| Pulse (60 s) [1] | | 56.68 | 10.60 | 57.62 | 13.00 | −0.711 | 0.477 |
| Systole [1,6] | | 122.12 | 16.29 | 123.32 | 15.12 | −3.593 | <0.001 |
| Diastole [1,6] | | 77.39 | 10.45 | 75.56 | 9.60 | −8.255 | <0.001 |
| BMI [4] (weight control for 1 year) | BMI 23.0~24.9 (overweight) — Loss effort | 545 | 39.0 | 529 | 41.6 | 3.908 | 0.272 |
| | Maintenance effort | 313 | 22.4 | 299 | 23.5 | | |
| | Gain effort | 28 | 2.0 | 23 | 1.8 | | |
| | Never effort | 510 | 36.5 | 420 | 33.0 | | |
| | BMI 25.0~29.9 (obesity) — Loss effort | 992 | 55.3 | 931 | 55.8 | 10.432 | 0.015 |
| | Maintenance effort | 241 | 13.4 | 279 | 16.7 | | |
| | Gain effort | 6 | 0.3 | 5 | 0.3 | | |
| | Never effort | 554 | 30.9 | 453 | 27.2 | | |
| | BMI 30.0 over (high obesity) — Loss effort | 219 | 64.4 | 228 | 65.3 | 0.249 | 0.883 |
| | Maintenance effort | 32 | 9.4 | 35 | 10.0 | | |
| | Gain effort | 0 | 0.0 | 0 | 0.0 | | |
| | Never effort | 89 | 26.2 | 86 | 24.6 | | |

[1] M: average; SD: standard deviation; [2] Mann–Whitney test; [3] *p* < 0.05; [4] $X^2$: chi-square test; [5] N: frequency; %: percentage; and [6] average of two measurements.

### 3.2. Blood Test Changes in Overweight/Obese Adults Pre-/Post-COVID-19

The differences in blood test values before and after the COVID-19 outbreak are presented in Table 2. Significant differences were observed in fasting blood glucose levels (104.84 ± 24.24 mg/dL vs. 106.60 ± 25.98 mg/dL), glycated hemoglobin (HbA1c) levels (5.83 ± 0.84% vs. 5.97 ± 0.90%), total cholesterol levels (193.81 ± 39.21 mg/dL vs. 189.07 ± 40.17 mg/dL), high-density lipoprotein (HDL) cholesterol levels (48.02 ± 11.26 mg/dL vs. 49.17 ± 11.66 mg/dL), and triglyceride levels (154.60 ± 118.50 mg/dL vs. 141.33 ± 106.48 mg/dL) between the pre-COVID-19 and post-COVID-19 groups (Table 2).

**Table 2.** Blood test values before and after the COVID-19 outbreak.

| Characteristic | | Before the COVID-19 Outbreak (2018) N [5]/Mean [1] | % [5]/SD [1] | After the COVID-19 Outbreak (2021) N/Mean | %/SD | Z [2]/[4]$X^2$ | *p*-Value [3] |
|---|---|---|---|---|---|---|---|
| Fasting blood sugar (FBS) [1] | | 104.84 | 24.24 | 106.60 | 25.98 | −4.508 | <0.001 |
| HbA1c [1] | | 5.83 | 0.84 | 5.97 | 0.90 | −9.984 | <0.001 |
| Total cholesterol [1] | | 193.81 | 39.21 | 189.07 | 40.17 | −4.845 | <0.001 |
| HDL cholesterol [1] | | 48.02 | 11.26 | 49.17 | 11.66 | −4.114 | <0.001 |
| Triglycerides [1] | | 154.60 | 118.50 | 141.33 | 106.48 | −6.643 | <0.001 |
| LDL cholesterol [1] | | 115.86 | 33.96 | 116.24 | 35.98 | −0.075 | 0.940 |
| Hypercholesterolemia [4] | No | 2370 | 70.6 | 2092 | 66.6 | 12.557 | <0.001 |
| | Yes | 985 | 29.4 | 1051 | 33.4 | | |
| Hypertriglyceridemia [4] | No | 2233 | 79.8 | 2388 | 84.5 | 21.389 | <0.001 |
| | Yes | 566 | 20.2 | 438 | 15.5 | | |
| AST(SGOT) [1] | | 25.23 | 14.37 | 26.41 | 12.88 | −5.977 | <0.001 |
| ALT(SGPT) [1] | | 26.40 | 19.20 | 27.45 | 21.28 | −2.622 | 0.009 |
| Hepatitis B surface antigen [4] | Negative | 3354 | 97.1 | 3141 | 97.1 | 0.002 | 0.966 |
| | Positive | 101 | 2.9 | 94 | 2.9 | | |
| Hepatitis C antibody [4] | Negative | 3429 | 99.2 | 3203 | 99.0 | 1.089 | 0.297 |
| | Positive | 26 | 0.8 | 32 | 1.0 | | |
| Hemoglobin [1] | | 14.37 | 1.60 | 14.03 | 1.58 | −8.663 | <0.001 |
| Hematocrit [1] | | 43.00 | 4.30 | 42.56 | 4.28 | −4.074 | <0.001 |
| Anemia [4] | Negative | 3234 | 93.8 | 2906 | 89.9 | 33.283 | <0.001 |
| | Positive | 215 | 6.2 | 326 | 10.1 | | |
| Blood urea nitrogen [1] | | 15.74 | 4.89 | 15.25 | 4.73 | −4.590 | <0.001 |
| Blood creatinine [1] | | 0.83 | 0.21 | 0.82 | 0.22 | −1.650 | 0.099 |
| WBC [1] | | 6.35 | 1.74 | 6.26 | 1.66 | −2.205 | 0.027 |
| RBC [1] | | 4.66 | 0.50 | 4.63 | 0.51 | −2.563 | 0.010 |
| Platelets [1] | | 262.32 | 64.45 | 253.84 | 62.79 | −5.251 | <0.001 |

[1] M: average; SD: standard deviation; [2] Mann–Whitney test; [3] $p < 0.05$; [4] $X^2$: chi-square test; [5] N: frequency; and %: percentage.

### 3.3. Urinalysis Changes in Overweight/Obese Adults Pre/Post-COVID-19

The results of the differences in urine test values before and after the COVID-19 outbreak are presented in Table 3. Significant differences were observed in the percentage of participants with negative results for urinary protein (80.2% vs. 90.9%), negative urinary glucose (94.7% vs. 91.9%), negative urinary ketone (98.5% vs. 98.9%), negative urinary bilirubin (99.3% vs. 100.0%), negative urinary occult blood (82.8% vs. 93.5%), negative urobilinogen (99.5% vs. 99.3%), as well as in urine creatinine levels (147.08 ± 80.10 mg/dL vs. 125.89 ± 74.77 mg/dL), urine sodium levels (116.79 ± 48.09 mmol/L vs. 113.66 ± 47.75 mmol/L), urine potassium levels (52.66 ± 23.22 mmol/L vs. 41.51 ± 20.75 mmol/L), and urine coti-

nine levels (346.22 ± 718.56 ng/mL vs. 783.69 ± 826.45 ng/mL) between the pre-COVID-19 and post-COVID-19 groups (Table 3).

**Table 3.** Urine test before and after the COVID-19 outbreak.

| Characteristic | | Before the COVID-19 Outbreak (2018) N/Mean [1] | %/SD [1] | After the COVID-19 Outbreak (2021) N/Mean | %/SD | Z [2/4] X² | *p*-Value [3] |
|---|---|---|---|---|---|---|---|
| Uric acid [1] | | 5.44 | 1.41 | 5.47 | 1.43 | −0.970 | 0.332 |
| Uric acidity [1] | | 5.87 | 0.74 | 5.90 | 0.77 | −0.940 | 0.347 |
| Nitrate [4] | No | 3334 | 97.5 | 3172 | 97.7 | 0.490 | 0.484 |
| | Yes | 87 | 2.5 | 74 | 2.3 | | |
| Urine protein [4] | Negative | 2743 | 80.2 | 2950 | 90.9 | 171.090 | <0.001 |
| | Trace | 510 | 14.9 | 197 | 6.1 | | |
| | 1 [+] | 131 | 3.8 | 65 | 2.0 | | |
| | 2 [+] | 33 | 1.0 | 28 | 0.9 | | |
| | 3 [+] | 1 | 0.0 | 4 | 0.1 | | |
| | 4 [+] | 3 | 0.1 | 2 | 0.1 | | |
| Urine glucose [4] | Negative | 3241 | 94.7 | 2984 | 91.9 | 40.045 | <0.001 |
| | Trace | 44 | 1.3 | 66 | 2.0 | | |
| | 1 [+] | 23 | 0.7 | 35 | 1.1 | | |
| | 2 [+] | 33 | 1.0 | 25 | 0.8 | | |
| | 3 [+] | 38 | 1.1 | 33 | 1.0 | | |
| | 4 [+] | 42 | 1.2 | 103 | 3.2 | | |
| Urine ketone [4] | Negative | 3370 | 98.5 | 3209 | 98.9 | 20.122 | <0.001 |
| | Trace | 17 | 0.5 | 0 | 0.0 | | |
| | 1 [+] | 20 | 0.6 | 28 | 0.9 | | |
| | 2 [+] | 12 | 0.4 | 9 | 0.3 | | |
| | 3 [+] | 2 | 0.1 | - | - | | |
| | 4 [+] | - | - | - | - | | |
| Urine bilirubin [4] | Negative | 3397 | 99.3 | 3246 | 100.0 | 22.855 | <0.001 |
| | trace | - | - | - | - | | |
| | 1 [+] | 24 | 0.7 | - | - | | |
| | 2 [+] | - | - | - | - | | |
| | 3 [+] | - | - | - | - | | |
| | 4 [+] | - | - | - | - | | |
| Urine occult blood [4] | Negative | 2831 | 82.8 | 3034 | 93.5 | 191.933 | <0.001 |
| | trace | 336 | 9.8 | 122 | 3.8 | | |
| | 1 [+] | 138 | 4.0 | 32 | 1.0 | | |
| | 2 [+] | 67 | 2.0 | 30 | 0.9 | | |
| | 3 [+] | 43 | 1.3 | 28 | 0.9 | | |
| | 4 [+] | 6 | 0.2 | - | - | | |
| Urine bilinogen [4] | Negative | 3405 | 99.5 | 3222 | 99.3 | 8.533 | 0.014 |
| | trace | 4 | 0.1 | - | - | | |
| | 1 [+] | 12 | 0.4 | 23 | 0.7 | | |
| | 2 [+] | - | - | 1 | 0.0 | | |
| | 3 [+] | - | - | - | - | | |
| | 4 [+] | - | - | - | - | | |
| Urine creatinine [1] | | 147.08 | 80.10 | 125.89 | 74.77 | −11.726 | 0.000 |
| Urine sodium [1] | | 116.79 | 48.09 | 113.66 | 47.75 | −3.212 | 0.001 |
| Urine potassium [1] | | 52.66 | 23.22 | 41.51 | 20.75 | −19.034 | 0.000 |
| Urine cotinine [1] | | 346.22 | 718.56 | 783.69 | 826.45 | −23.264 | 0.000 |

[1] M: average; SD: standard deviation; [2] Mann–Whitney test; [3] *p* < 0.05; [4] X²: chi-square test; [5] N: frequency; %: percentage.

### 3.4. Multivariate Analysis of Blood Test Changes Pre-/Post-COVID-19

The results of the multivariate analysis on changes in blood test values before and after the COVID-19 outbreak are presented in Table 4. The analysis revealed that systolic blood pressure was significantly higher after the COVID-19 outbreak (β = 0.964, 95% CI: 0.956–0.972, $p < 0.001$). The results of the study showed significant associations between various health indicators and the outcome variable. Specifically, diastolic blood pressure (β = 0.964, 95% CI: 0.956–0.972, $p < 0.001$), high-density lipoprotein (HDL) cholesterol (β = 1.010, 95% CI: 1.004–1.016, $p = 0.001$), hemoglobin (β = 0.280, 95% CI: 0.240–0.326, $p < 0.001$), hematocrit (β = 1.476, 95% CI: 1.386–1.572, $p < 0.001$), blood urea nitrogen (β = 0.963, 95% CI: 0.950–0.975, $p < 0.001$), red blood cell (RBC) count (β = 1.352, 95% CI: 1.016–1.801, $p = 0.039$), and platelet count (β = 0.996, 95% CI: 0.995–0.997, $p < 0.001$) were significantly associated with the outcome variable (Table 4).

**Table 4.** Blood and urine test values before and after the COVID-19 outbreak.

| Blood Test * | | | | Urine Test * | | | |
|---|---|---|---|---|---|---|---|
| ORs | 95% CI | | *p*-Value | | ORs | 95% CI | | *p*-Value |
| Systole | 1 + 0.019 | 1.014 | 1.024 | <0.001 | Systole | 1.018 | 1.010 | 1.025 | <0.001 |
| | | | | | Diastole | 0.958 | 0.948 | 0.969 | < 0.001 |
| Diastole | 0.964 | 0.956 | 0.972 | <0.001 | Protein No | | | | <0.001 |
| | | | | | Ttrace | 0.385 | 0.276 | 0.537 | <0.001 |
| FBS | 1.000 | 0.995 | 1.004 | 0.910 | Protein [1+] | 0.597 | 0.340 | 1.049 | 0.073 |
| | | | | | Protein [2+] | 1.281 | 0.487 | 3.371 | 0.616 |
| HbA1c | 1.062 | 0.934 | 1.206 | 0.359 | Protein [3+] | $5.83 \times 10^9$ | 0.000 | | 0.999 |
| | | | | | Protein [4+] | 0.000 | 0.000 | | 0.999 |
| Total cholesterol | 0.999 | 0.997 | 1.001 | 0.201 | Glucose No | | | | 0.001 |
| HDL cholesterol | 1.010 | 1.004 | 1.016 | 0.001 | Trace | 1.832 | 0.980 | 3.425 | 0.058 |
| | | | | | Glucose [1+] | 1.949 | 0.807 | 4.710 | 0.138 |
| Triglycerides | 1.000 | 0.999 | 1.000 | 0.322 | Glucose [2+] | 0.420 | 0.171 | 1.028 | 0.057 |
| | | | | | Glucose [3+] | 0.630 | 0.280 | 1.415 | 0.263 |
| Hypercholesterolemia, yes | 1.131 | 0.993 | 1.287 | 0.063 | Glucose [4+] | 2.311 | 1.350 | 3.955 | 0.002 |
| | | | | | Ketone No | | | | 0.699 |
| Hypertriglyceridemia, yes | 0.917 | 0.741 | 1.134 | 0.422 | Trace | 0.000 | 0.000 | | 0.998 |
| | | | | | Ketone [1+] | 1.460 | 0.556 | 3.829 | 0.442 |
| AST (SGOT) | 1.004 | 0.998 | 1.011 | 0.189 | Ketone [2+] | 1.861 | 0.498 | 6.945 | 0.355 |
| | | | | | Urine bilirubin Trace | 0.000 | 0.000 | | 0.999 |
| ALT (SGPT) | 1.003 | 0.998 | 1.008 | 0.245 | Urine occult blood No | | | | <0.001 |
| | | | | | Trace | 0.374 | 0.246 | 0.568 | <0.001 |
| Hemoglobin | 0.280 | 0.240 | 0.326 | <0.001 | Occult blood [1+] | 0.203 | 0.085 | 0.481 | <0.001 |
| | | | | | Occult blood [2+] | 0.477 | 0.193 | 1.178 | 0.108 |
| Hematocrit | 1.476 | 1.386 | 1.572 | <0.001 | Occult blood [3+] | 0.963 | 0.408 | 2.274 | 0.931 |
| | | | | | Occult blood [4+] | 0.000 | 0.000 | | 0.999 |
| Blood urea nitrogen | 0.963 | 0.950 | 0.975 | <0.001 | Urobilinogen No | - | - | - | 0.660 |
| | | | | | Trace | 0.000 | 0.000 | - | 0.999 |
| WBC | 0.964 | 0.928 | 1.001 | 0.056 | Urobilinogen [1+] | 1.584 | 0.589 | 4.261 | 0.362 |
| | | | | | Urine creatinine | 1.003 | 1.001 | 1.005 | <0.001 |
| RBC | 1.352 | 1.016 | 1.801 | 0.039 | Urine sodium | 1.000 | 0.998 | 1.002 | 0.776 |
| | | | | | Urine potassium | 0.973 | 0.968 | 0.977 | <0.001 |
| Platelets | 0.996 | 0.995 | 0.997 | <0.001 | Urine cotinine | 1.001 | 1.001 | 1.001 | <0.001 |

[1] M: average; SD: standard deviation; [2] Mann–Whitney test; [3] $p < 0.05$; [4] $X^2$: chi-square test; [5] N: frequency; and %: percentage. * Multi-variable regression analysis adjusted for age, waist circumference, and BMI.

*3.5. Multivariate Analysis of Urine Test Changes Pre-/Post-COVID-19*

The results of the multivariate analysis on the changes in urine test values before and after the COVID-19 outbreak are presented in Table 4. After the COVID-19 outbreak, compared to the pre-COVID-19 period, there was a significant increase in trace urinary protein levels (β = 0.385, 95% CI: 0.208–0.486, $p < 0.001$), urinary glucose levels of +++ or higher (β = 2.311, 95% CI: 1.350–3.955, $p = 0.002$), trace urinary occult blood levels (β = 0.374, 95% CI: 0.246–0.568, $p < 0.001$), urinary occult blood levels of + or higher (β = 0.203, 95% CI: 0.085–0.481, $p < 0.001$), urine creatinine levels (β = 1.003, 95% CI: 1.001–1.005, $p < 0.001$), urine potassium levels (β = 0.973, 95% CI: 0.968–0.977, $p < 0.001$), and urine cotinine levels (β = 1.001, 95% CI: 1.001–1.001, $p < 0.001$) (Table 4).

## 4. Discussion

This study analyzed changes in blood and urine test results among adults aged 19 years and older who were overweight before and after the outbreak of COVID-19, an emerging infectious disease. The COVID-19 pandemic imposed significant lifestyle changes and various restrictions on daily activities. It was deemed necessary to monitor the impact of these changes on physical health indicators.

This study found that participants' mean waist circumference increased by approximately 2 cm, and that their mean body mass index (BMI) increased by approximately 0.11 compared to pre-pandemic measurements. Additionally, their mean systolic blood pressure was higher than pre-COVID-19 levels. An increase in blood pressure is known to correlate with a higher incidence of hypertension. Previous studies have reported an association between the prevalence of hypertension and the incidence of kidney disease. Research indicates that maintaining appropriate blood pressure levels can reduce the risk of kidney disease by an odds ratio (OR) of 0.42 [13].

The COVID-19 pandemic imposed limitations on daily activities and reduced in-person interactions, which may have negatively impacted physical well-being. Adolescence is a critical period for developing lifelong health habits, both mentally and physically [14–17]. It is noteworthy that individuals over 19 years of age made efforts to sustain their weight during the pandemic, as evidenced by this study. When assessing disease risk, there was an OR of 1.019 for increased systolic blood pressure, an OR of 0.964 for increased diastolic blood pressure, and an OR of 0.999 for increased high-density lipoprotein (HDL) cholesterol levels.

For diabetes, fasting blood glucose and glycated hemoglobin are recognized as important diagnostic factors [18,19]. In clinical practice, risk factors related to diabetes, such as genetics and lifestyle, are considered important, along with disease risk factors associated with obesity. In this study, the mean fasting blood glucose was 1.76 mg/dL higher, and mean glycated hemoglobin was 0.14% higher than pre-pandemic levels. The pandemic led to an increased risk of diabetes due to restrictions on physical activity and sudden lifestyle changes [18,20–22].

The prevalence of hypercholesterolemia has increased by 4% since the start of the COVID-19 pandemic. According to the 2010 National Health and Nutrition Examination Survey, the prevalence of hypercholesterolemia increased significantly from 8.0% in 2005 to 11.5% in 2009 among individuals aged 30 years and older [23]. In 2016, the prevalence rose to 14.4% among those over 30 years of age [24]. These findings suggest an ongoing increase in the prevalence of dyslipidemia. The present study revealed a mean increase of 0.38 mg/dL in high-density lipoprotein (HDL) cholesterol levels. Dyslipidemia is characterized by decreased HDL cholesterol concentration [25–27]. Low HDL cholesterol levels are specifically linked to cardiovascular disease risk. The Framingham Study by Gordon et al. (1977) found that, among adults aged 49–82 years, individuals with low HDL cholesterol levels had a higher incidence of cardiovascular disease, even with low low-density lipoprotein (LDL) cholesterol [28].

Additionally, low HDL cholesterol levels have been associated with abdominal adiposity [29], metabolic syndrome [30], cognitive impairment and dementia [31], impaired

fasting glucose [32], and diabetes [33]. Therefore, managing obesity and daily lifestyle habits is crucial for maintaining healthy HDL cholesterol levels, which are strongly linked to adult diseases like cardiovascular disease [34,35]. The observed changes were likely due to decreased physical activity, the adoption of a Westernized diet, and pandemic-related lifestyle restrictions. These factors can lead to increased obesity, abdominal obesity, and a risk of conditions such as dysglycemia. In modern society, various home-based training programs can increase aerobic and resistance exercise, which is particularly important during periods of restricted movement due to infectious diseases like COVID-19. Appropriate physical activity can also aid weight management and reduce the risk of dysglycemia that may be exacerbated by frequent alcohol consumption. Furthermore, if hepatocellular injury is severe, aspartate aminotransferase (AST) levels rise more than those of alanine aminotransferase (ALT). When the hepatocyte membrane is damaged, both AST and ALT enzymes are released into the bloodstream, causing an increase [36]; however, elevated AST and ALT levels do not always indicate the extent of hepatocyte necrosis or injury. Levels exceeding five times the upper limit are considered indicative of impaired liver function [36]. In this study, mean AST levels increased by 1.18 U/L and mean ALT levels increased by 1.05 U/L compared to pre-pandemic levels.

Anemia is a condition that often coexists with various diseases and is particularly prevalent in chronic conditions such as infectious diseases, autoimmune disorders, chronic kidney disease, and cancer [37]. The prevalence of anemia was 3.9% higher in this study, with a mean decrease of $0.03 \times 10^6/\mu L$ in red blood cells and a mean decrease of $0.09 \times 10^3/\mu L$ in white blood cells. Anemia is characterized by a lower-than-normal number of red blood cells, which are responsible for oxygen transport, leading to an increased risk of tissue hypoxia. During a recent study on COVID-19, mean hemoglobin levels decreased by 0.34 g/dL. This decrease has been linked to hemoglobinopathies and hypoxic damage, potentially leading to the development of hypoxemic blood disorders due to dysregulated iron metabolism [38]. The emergence of novel infectious and inflammatory viral diseases poses unknown outbreak risks [39].

Urinalysis can detect abnormalities such as occult blood, urobilinogen, hematuria, proteinuria, ketonuria, glycosuria, and bacteriuria. It is primarily performed to detect and manage diseases of the kidneys and urinary tract [40]. In this study, the prevalence of proteinuria was 10.7%, and glycosuria was 2.8%. The prevalence of ketonuria was 0.4%, and urobilinogen was 0.7%. The prevalence of hematuria was 10.7%, while mean urobilinogen levels decreased by 0.2 mg/dL. Mean urea nitrogen decreased by 21.19 mg/dL, while mean sodium increased by 3.13 mmol/L. Mean potassium decreased by 11.51 mmol/L. The presence of proteinuria was significant, with an odds ratio (OR) of 0.385. Similarly, the presence of glycosuria and hematuria was significant, with ORs of 0.374 and 0.203 for trace and gross hematuria, respectively. Urinalysis indicated that mean hemoglobin was likely to decrease by 0.280 g/dL, while mean hematocrit was likely to increase by 1.746%. Blood urea nitrogen was likely to decrease by 0.963 mg/dL and mean red blood cell as well as platelet counts were likely to decrease by factors of 1.352 and 0.966, respectively.

## 5. Conclusions

COVID-19 is a novel infectious disease unprecedented in modern times. Unlike past epidemics, it has resulted in widespread restrictions at the individual, societal, and national levels, with significant global economic impacts. The ongoing nature of the COVID-19 situation, rather than it being a short-term crisis, has underscored the importance of maintaining mental and physical health. The pandemic has necessitated a shift towards reduced in-person interaction, with restrictions on activities such as dining out and social gatherings; however, this study confirms that such lifestyle changes have had negative impacts on physical vital signs and clinical laboratory values.

This study examined the pre- and post-COVID-19 outbreak situations; however, caution is needed in interpreting the following results. A nationwide survey of living conditions was conducted at a time when social and economic facilities were completely

suspended or restricted due to the widespread occurrence of the pandemic and national-level disease control measures; however, there are limitations to extrapolating these findings to the direct impact of COVID-19. Additionally, although age, regional, and other stratified surveys were conducted by national research institutions, attention is needed due to the small sample size of this study. Finally, there is a need to directly investigate the impact of COVID-19 on individuals by examining factors such as their physical condition, blood, and urine.

Future research should continue to investigate the impact of COVID-19 on dental practices and explore innovative strategies with which to optimize patient care while ensuring the safety of both patients and dental professionals. Additionally, studies examining the psychological impact of the pandemic on dental professionals and effective interventions to promote their well-being are warranted [41,42].

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