



Changes in dietary habits and chronic diseases before and after COVID-19 by regions using data from the 2018-2020 Korea Community Health Survey and Consumer Behavior Survey for Foods: a cross-sectional study

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Received: November 28, 2022
Revised: April 14, 2023
Accepted: April 17, 2023

ABSTRACT

Objectives: This study examined the changes in dietary habits, the prevalence of chronic diseases, and mental health problems in the regional areas of the Republic of Korea before and after the COVID-19 pandemic to provide evidence of the status of regional health inequalities.

Methods: This study analyzed Korean adults aged 19 or older who participated in the Korea Community Health Survey (n = 686,708) and Consumer Behavior Survey for Foods (n = 19,109) from 2018 to 2020. The participants were classified according to their residence area (Seoul metropolitan area, Metropolitan cities, Provinces); 2018-2019 were defined as before COVID-19, and 2020 as after COVID-19. The dietary behaviors, chronic diseases, and mental health problems were measured using a self-report questionnaire.

Results: After COVID-19, the eating-out usage rate in the Seoul metropolitan area and Provinces decreased compared to before COVID-19 ($P < 0.001$), and when responding that they eat out, the frequency of eating out with household members in the Seoul metropolitan area increased ($P = 0.024$). The deliveries/takeout usage rate in the Provinces decreased after COVID-19 compared to before ($P < 0.001$). After COVID-19, the prevalence of obesity decreased in all regions ($P < 0.001$), and the prevalence of hypertension increased significantly in the Provinces ($P = 0.015$). The prevalence of diabetes mellitus increased continuously before and after COVID-19 in all regions ($P < 0.002$). High-risk subjective stress levels increased significantly in the Seoul metropolitan area ($P < 0.001$), and sleep duration significantly increased in all regions ($P < 0.001$). Major depressive disorder was reduced significantly in Metropolitan cities ($P = 0.042$) and Provinces ($P < 0.001$).

Conclusions: After the COVID-19 pandemic, the prevalence of chronic diseases and mental health problems showed regional differences along with changes in dietary habits. It is necessary to reflect the regional differences in dietary habits in future policies resolving regional health inequalities.

KEY WORDS COVID-19, region, dietary habits, chronic diseases, mental health

Introduction

Since its initial outbreak in Wuhan, Hubei Province, China, the Coronavirus Disease-19 (COVID-19) pandemic has progressed at an unprecedented pace, spreading to 234 countries and territories [1], with the first case of COVID-19 occurring in Daegu, South Korea, in February 2020 [2]. On March 11, 2020, the World Health Organization (WHO) declared COVID-19 a global pandemic [3]. The spread of COVID-19 is still ongoing worldwide. Liu *et al.* [4] analyzed the demographic spread pattern of COVID-19 by age and gender in Hong Kong. They reported differences in the spread pattern by the epidemic period and population characteristics. In Korea, COVID-19 infections were centered in the capital regions, and it is believed that regional characteristics, such as population structure, may have facilitated the influx of COVID-19, as the capital region is a region with high population density and high connectivity to the surrounding commercial and business areas [5]. On the other hand, as the number of COVID-19 outbreaks in the capital region has increased, it was reported that the center of COVID-19 spread diversified outside the capital region and expanded to local cities over time [6], which is expected due to the diversification of infection routes and increase in spreading among cities as the COVID-19 pandemic prolonged.

Various policies have been implemented worldwide to prevent the spread of COVID-19 [7], and the restricted daily routines significantly impact people's lives, causing radical changes in their lifestyles. Studies reporting changes in daily routines after COVID-19 reported problems, such as decreased physical activity, increased sleep time, and weight gain, due to prolonged social isolation [8, 9]. A US study reported changes in food consumption behaviors and eating habits after COVID-19, including a 34.5% increase in frozen food purchases, 31.8% increase in snack purchases, 28% increase in juice and soda purchases, and 55.2% increase in food worries [10]. In contrast, a Korean study reported a 35.0% increase in takeout orders, 34.4% increase in delivery, 26.4% increase in cooking, and 22.6% increase in HMR foods after COVID-19 [11].

On the other hand, diet is one of the basic factors related to health, and many causes of chronic diseases are related to dietary habits [12]. Hence, unfavorable changes in dietary habits after COVID-19 may lead to changes in the prevalence of chronic diseases [13]. A Korean study analyzing the data from the 2020 Korea National Health and Nutrition Examination Survey reported a significant increase in chronic diseases in 2020 compared to before COVID-19, with a 6.0% increase in the obesity prevalence, 1.8% increase in hypertension prevalence, 1.9% increase in diabetes prevalence, and 2.8% increase in hyperlipidemia prevalence [14].

The world is currently fighting COVID-19, and many detrimental health effects have been reported during the pandemic. In Korea, a large body of literature has been published comparing before and after COVID-19 dietary habits, chronic disease prevalence, and mental health prevalence. On the other hand, there is a lack of literature on before and after COVID-19 comparisons across regions. In addition, due to the difference in the scope of the COVID-19 outbreak between metropolitan and non-metropolitan areas, it is expected that the after-COVID-19 dietary habits and food consumption behaviors will differ across regions. Therefore, this study compared the before and after COVID-19 dietary factors and the prevalence of chronic diseases across regions in preparation for the post-COVID-19 era.

Methods

Ethics statement

Obtainment of informed consent was exempted by the institutional review board. The study protocol was approved by the Institutional Review Board of Sungshin Women's University (approval number: 2022-0077-001).

1. Study population

This study utilized data from the 2018-2020 Korea Community Health Survey and the Consumer Behavior Survey for Foods. The Korea Community Health Survey [15] is a national sample survey conducted by the Korea Disease Control and Prevention Agency that surveys adults aged 19 and older living in households in selected cities, counties, and districts. In this study, 686,708 adults aged 19-74 were surveyed.

The Consumer Behavior Survey for Foods [16] was conducted under the auspices of the Korea Rural Economic Institute and utilized a primary purchaser questionnaire for primary purchasers of food in households aged 19 or older and an adult questionnaire for adults in households aged 19 or older. The study included 19,109 adults aged 19-75 years old.

2. Characteristics of the study population

1) Korea Community Health Survey

The general characteristics of the study population from the 2018-2020 Korea Community Health Survey data included age, gender, education, household income, alcohol consumption, smoking, breakfast frequency, nutrition label usage, obesity prevalence, hypertension prevalence, diabetes prevalence, high stress levels, major depressive disorder, and sleep duration. The education level was categorized as middle school graduate or less, high school graduate, college graduate, and graduate school graduate. The household income level was categorized as less than 2 million won, 2-5 million won, and more than 5 million won. High-risk alcohol consumption was categorized as drinking seven or more glasses for men and five or more glasses for women at least twice a week, and smoking was categorized as never smoked, smoked in the past but not currently smoking, or currently smoked. The breakfast frequency was presented as daily/weekly, and nutrition label utilization was categorized as "yes" if the respondents reported reading nutrition labels when purchasing processed foods. The changes in the prevalence of chronic diseases were categorized using height and weight to calculate the Body Mass Index (BMI), with a BMI of 25 kg/m² or higher classified as obesity [17], and data from 2019, when weight was measured directly, contrary to 2018 and 2020 when weight was self-reported, were excluded from this study because of differences in the anthropometric survey methods. Hypertension and diabetes were analyzed using a questionnaire that asked if they had ever been diagnosed by a doctor. The changes in mental health were analyzed using the subjective stress level, major depressive disorder, and sleep duration. The subjective stress level was categorized as high if participants answered "I feel stressed a lot" and "I feel very stressed a lot". The major depressive disorder was measured using the Patient Health Questionnaire-9 (PHQ-9) questionnaire, a validated depression measurement tool [18]. It was categorized as moderate depression if the respondents reported moderate depression (10 or more points) [19]. The sleep duration was presented as the average number of hours of sleep per night.

2) Consumer Behavior Survey for Foods

The general characteristics of the respondents in the 2018-2020 Consumer Behavior Survey for Foods data were analyzed in terms of age, gender, education level, and household income level. The educational level was categorized into middle school graduate or less, high school graduate, college graduate, and graduate school graduate. The household income level was categorized into 2 million won or less, 2-5 million won, and 5 million won or more. In addition, eating out with individuals and household members, and delivery/takeout behavior were analyzed. Individual eating-out behavior was defined as eating out not with families but individually with friends, colleagues, and acquaintances (or alone), and deliveries/takeout behavior was defined as ordering food for consumption with friends, colleagues, and acquaintances (or alone) at places other than home. Eating out with household members was defined as eating out with family members, and deliveries/takeout with household members was defined as using deliveries/takeout at home. For the eating out behavior, this study analyzed whether they ate out, the frequency of eating out, and the average monthly cost. For deliveries/takeout behavior, this study analyzed whether they used deliveries/takeout, the frequency of deliveries/takeout, and the average monthly cost of deliveries/takeout. In particular, the frequency of deliveries/takeout was categorized as using deliveries/takeout if the respondent answered 'both deliveries/takeout',

‘delivery only’, or ‘takeout only’.

All data based on this study consisted of self-reported questionnaires, with participants categorized by the administrative region (Seoul metropolitan area, Metropolitan cities, Provinces), and 2018-2019 defined as before COVID-19 and 2020 as after COVID-19.

3. Statistical analysis

The data in this study are presented as the frequency and percentages for categorical variables and as means and standard errors for continuous variables. The chi-square test or one-way analysis of variance (ANOVA) was used to compare the general characteristics, dietary behaviors, and chronic disease and mental health prevalence across regions. When comparing the eating out and deliveries/takeout behaviors by year within a region, a general linear model (PROC GLM) was used with gender, age, education level, and household income as covariates for continuous variables. Bonferroni post hoc tests were performed. The continuous variables were analyzed using a generalized linear model (PROC GLM) with gender, age, education, household income, smoking, and alcohol as covariates. A Bonferroni post hoc test was performed to compare breakfast frequency, nutrition label utilization, and prevalence of chronic diseases and mental health by region. A chi-square test was used to compare the categorical variables according to the region and year. Complex sample analyses considering the weights, stratification variables, and colony variables were conducted because the Korea Community Health Survey and the Consumer Behavior Survey for Foods data used in this study are complex sample designs. All analyses were conducted using SAS 9.4 (Statistical Analysis System, SAS Institute, Cary, NC, USA), and statistical tests were set at a significance level of 0.05.

Results

1. General characteristics

Table 1 lists the results for general characteristics of the Korea Community Health Survey data. The mean age was lowest in Seoul metropolitan area at 47.2 years and highest in the Provinces at 50.5 years ($P < 0.001$). In terms of sex, women were more likely than men in Seoul metropolitan area (50.6% and 50.7%, respectively) ($P < 0.001$). In terms of education, college graduates were the most common in the metropolitan areas and Metropolitan cities (40.8% and 39.2%, respectively), while high school graduates were the most common in the Provinces (37.5%) ($P < 0.001$). The monthly household income was highest in Seoul metropolitan area, with 43.5% of households earning more than 5 million won ($P < 0.001$), and in the Metropolitan cities and Provinces, with 45.4% and 43.4% of households earning 2-5 million won ($P < 0.001$), respectively. High-risk drinking was highest in the Provinces (15.3%), and smoking was highest in all regions, with the highest proportion reporting never smoking ($P < 0.001$). The breakfast frequency was lowest in Seoul metropolitan area at 4.2 times ($P < 0.001$), and checking the nutrition labels was lowest in the Provinces at 19.0% ($P < 0.001$). The prevalence of obesity, hypertension, and diabetes was highest in the provinces at 34.5%, 23.2%, and 9.5%, respectively ($P < 0.001$). The prevalence of high stress levels and major depressive disorder was highest in the Seoul metropolitan area at 27.3% and 3.4%, respectively ($P < 0.001$), and sleep duration was highest in the Provinces at 6.8 hours ($P < 0.001$).

Table 2 lists the general findings of the Consumer Behavior Survey for Foods data. The average age was 45.4 years in the Seoul metropolitan area, 45.0 years in Metropolitan cities, and 48.2 years in the Provinces, with the highest age in the Provinces among all regions ($P < 0.001$). In terms of sex, the proportion of men was higher than women in the Seoul metropolitan area and Metropolitan cities at 50.2% and 51.8%, respectively, while the proportion of females was higher than males in the Provinces at 51.8% ($P = 0.017$). In terms of the education level, 50.6% of people in the Seoul metropolitan area had graduated from university, the highest among all regions ($P < 0.001$), while 44.9% and 39.5% of people in the Metropolitan cities and Provinces had graduated from high school, respectively ($P < 0.001$). In terms of monthly household income, 2-5 million won was the most common across all regions, with the highest percentage of respondents reporting more than 5 million won in the

Table 1. General characteristics of the participants from the Korea Community Health Survey

| Variable | Seoul metropolitan area (n = 220,497) | Metropolitan cities (n = 109,333) | Provinces (n = 356,878) | P-value |
|---------------------------------------|--|--------------------------------------|----------------------------|---------|
| Age (years) | 47.2 ± 0.1 | 48.3 ± 0.1 | 50.5 ± 0.1 | < 0.001 |
| Sex | | | | |
| Men | 99,890 (49.4) | 49,205 (49.3) | 159,612 (50.1) | < 0.001 |
| Women | 120,607 (50.6) | 60,128 (50.7) | 197,266 (49.9) | |
| Education level | | | | |
| ≤ Middle school | 49,999 (16.0) | 29,457 (21.0) | 167,280 (28.0) | < 0.001 |
| High school | 81,551 (37.5) | 38,581 (36.5) | 108,182 (37.5) | |
| College & university | 78,564 (40.8) | 37,693 (39.2) | 74,510 (31.5) | |
| Graduate school | 9,882 (5.2) | 3,528 (3.8) | 6,559 (2.7) | |
| Household income (10,000 won/month) | | | | |
| ≤ 200 | 42,039 (15.4) | 28,047 (20.6) | 145,109 (27.0) | < 0.001 |
| 200-499 | 89,040 (41.2) | 47,643 (45.4) | 135,851 (43.4) | |
| ≥ 500 | 83,977 (43.5) | 32,525 (34.1) | 70,095 (29.6) | |
| High-risk alcohol consumption | 25,066 (14.2) | 11,856 (13.7) | 36,677 (15.3) | < 0.001 |
| Smoking | | | | |
| None | 142,327 (62.6) | 70,686 (62.8) | 227,869 (60.8) | < 0.001 |
| Ex-smoker | 38,147 (17.5) | 19,241 (17.6) | 69,821 (18.8) | |
| Current smoker | 39,992 (19.9) | 19,400 (19.6) | 59,168 (20.4) | |
| Frequency of breakfast (times/week) | 4.2 ± 0.0 | 4.4 ± 0.0 | 4.5 ± 0.5 | < 0.001 |
| Use of nutrition label | 49,504 (24.2) | 23,413 (23.1) | 52,428 (19.0) | < 0.001 |
| Obesity (BMI ≥ 25 kg/m ²) | 71,208 (32.6) | 33,866 (31.4) | 118,882 (34.5) | < 0.001 |
| Hypertension | 52,993 (19.9) | 25,022 (19.2) | 116,876 (23.2) | < 0.001 |
| Diabetes mellitus | 21,722 (8.1) | 10,946 (8.3) | 46,069 (9.5) | < 0.001 |
| High-risk subjective stress level | 57,183 (27.3) | 24,687 (23.5) | 72,888 (23.6) | < 0.001 |
| Major Depressive disorder | 7,763 (3.4) | 3,316 (2.7) | 11,482 (3.2) | < 0.001 |
| Sleep duration (hours/day) | 6.7 ± 0.0 | 6.7 ± 0.0 | 6.8 ± 0.0 | < 0.001 |

Mean ± SE or n (%)

P-values by chi-square or ANOVA test

Table 2. General characteristics of the participants from the Consumer Behavior Survey for Foods

| Variables | Seoul metropolitan area (n = 5,748) | Metropolitan cities (n = 5,294) | Provinces (n = 8,067) | P-value |
|-------------------------------------|--|------------------------------------|--------------------------|---------|
| Age (years) | 45.4 ± 0.5 | 45.0 ± 0.5 | 48.2 ± 0.6 | < 0.001 |
| Sex | | | | 0.017 |
| Men | 2,637 (50.2) | 2,421 (51.8) | 3,516 (48.2) | |
| Women | 3,111 (49.8) | 2,873 (48.2) | 4,551 (51.8) | |
| Education level | | | | < 0.001 |
| ≤ Middle school | 414 (7.4) | 606 (11.9) | 1,778 (22.1) | |
| High school | 2,640 (41.4) | 2,588 (44.9) | 3,456 (39.5) | |
| College & university | 2,666 (50.6) | 2,051 (42.4) | 2,783 (37.6) | |
| Graduate school | 28 (0.6) | 49 (0.8) | 50 (0.8) | |
| Household income (10,000 won/month) | | | | < 0.001 |
| ≤ 200 | 102 (1.8) | 226 (4.5) | 606 (7.9) | |
| 200-499 | 3,134 (51.2) | 3,437 (63.6) | 5,611 (68.4) | |
| ≥ 500 | 2,512 (47.0) | 1,631 (31.9) | 1,850 (23.6) | |

Mean ± SE or n (%)

P-values by chi-square or ANOVA test

Seoul metropolitan area ($P < 0.001$).

2. Changes in eating out behavior before and after COVID-19

Table 3 lists the results of the before and after COVID-19 changes in the eating-out behavior. In the Seoul metropolitan area, the eating-out rate decreased from 92.5% in 2018 and 94.1% in 2019 to 85.3% in 2020 after COVID-19 ($P < 0.001$). In the Provinces, the individual eating-out rate decreased from 84.3% in 2018 and 87.3% in 2019 to 78.4% in 2020 after COVID-19 ($P < 0.001$). There was no significant change in Metropolitan cities. Among those who reported eating out behavior, there was no significant change in the frequency of eating out in all regions. The cost of eating out for individuals in the Seoul metropolitan area increased after COVID-19, with 110,862 won in 2018, 119,238 won in 2019, and 121,962 won in 2020 ($P < 0.001$). In addition, the cost of eating out for individuals in the Metropolitan cities increased after COVID-19, with 96,369 won in 2018, 107,740 won in 2019, and 108,115 won in 2020 ($P < 0.001$).

The rate of eating out with household members in the Seoul metropolitan area decreased from 92.3% in 2019, before COVID-19, to 83.7% in 2020, after COVID-19 ($P < 0.001$). The rate of eating out with household members in the Provinces decreased from 82.3% in 2019, before COVID-19, to 75.9% in 2020, after COVID-19 ($P = 0.004$). There was no statistically significant change in Metropolitan cities. The rate of those who answered that they eat out at least once a week out of the frequency of eating out with household members in the Seoul metropolitan area increased from 32.0% in 2018 (before COVID-19) to 41.5% in 2020 (after COVID-19) ($P = 0.024$). There was no significant change in the frequency of eating out with household members in Metropolitan cities and Provinces. The expenditure on eating out with household members in Seoul metropolitan area increased from 124,559 won before COVID-19 2018 to 130,443 won after COVID-19 2020 ($P < 0.001$), expenditure on eating out with household members in the Provinces continued to increase from 94,543 won in 2018 to 101,290 won in 2019 and 107,515 won in 2020 ($P < 0.001$). There were no significant changes in the Metropolitan cities.

Table 3. Changes in eating-out behaviors before and after COVID-19 according to the area from the Consumer Behavior Survey for Foods

| Variables | Seoul metropolitan area | | | P-value |
|---|----------------------------------|----------------------------------|----------------------------------|---------|
| | 2018 (n = 2,011) | 2019 (n = 1,801) | 2020 (n = 1,936) | |
| Eating-out ¹⁾ | n = 2,011 | n = 1,801 | n = 1,936 | < 0.001 |
| Yes | 1,851 (92.5) ^a | 1,675 (94.1) ^a | 1,635 (85.3) ^b | |
| Frequency of eating out | n = 1,851 | n = 1,675 | n = 1,635 | 0.088 |
| ≥ 1 time/week | 1,166 (66.8) | 1,130 (71.1) | 1,072 (70.4) | |
| 1 time/2 weeks | 375 (18.5) | 275 (16.4) | 297 (15.9) | |
| ≤ 1 time/month | 310 (14.6) | 270 (12.5) | 266 (13.8) | |
| Eating-out expenditure (thousand won/month) ²⁾³⁾ | 110,862.6 ± 1,853.3 ^a | 119,238.9 ± 1,779.4 ^b | 121,962.9 ± 1,874.3 ^b | < 0.001 |
| Eating-out with family ¹⁾ | n = 2,011 | n = 1,801 | n = 1,936 | < 0.001 |
| Yes | 1,729 (87.4) ^a | 1,625 (92.3) ^b | 1,628 (83.7) ^a | |
| Frequency of eating out with family ¹⁾ | n = 1,729 | n = 1,625 | n = 1,628 | 0.024 |
| ≥ 1 time/week | 483 (32.0) ^a | 558 (25.2) ^{ab} | 628 (41.5) ^b | |
| 1 time/2 weeks | 673 (36.9) | 558 (36.7) | 575 (32.2) | |
| ≤ 1 time/month | 573 (31.1) | 509 (38.1) | 425 (26.3) | |
| Eating-out expenditure with family (thousand won/month) ²⁾³⁾ | 124,559.7 ± 1,767.4 ^a | 124,599.0 ± 1,662.4 ^a | 130,443.8 ± 1,750.4 ^b | < 0.001 |

Table 3. continued

| Variables | Metropolitan cities | | | P-value |
|---|---------------------------------|----------------------------------|----------------------------------|---------|
| | 2018 (n = 1,805) | 2019 (n = 1,762) | 2020 (n = 1,727) | |
| Eating-out | n = 1,805 | n = 1,762 | n = 1,727 | 0.092 |
| Yes | 1,691 (94.1) | 1,650 (92.7) | 1,576 (90.4) | |
| Frequency of eating out | n = 1,691 | n = 1,650 | n = 1,576 | 0.080 |
| ≥ 1 time/week | 964 (56.7) | 950 (59.3) | 943 (61.6) | |
| 1 time/2 weeks | 305 (17.3) | 288 (16.8) | 298 (18.6) | |
| ≤ 1 time/month | 422 (26.1) | 412 (23.8) | 335 (19.8) | |
| Eating-out expenditure (thousand won/month) ^{2 3} | 96,369.1 ± 2,042.5 ^a | 107,740.7 ± 2,028.0 ^b | 108,115.5 ± 1,977.3 ^b | < 0.001 |
| Eating-out with family | n = 1,805 | n = 1,762 | n = 1,727 | 0.174 |
| Yes | 1,613 (89.8) | 1,594 (91.2) | 1,510 (87.2) | |
| Frequency of eating out with family | n = 1,613 | n = 1,594 | n = 1,510 | 0.069 |
| ≥ 1 time/week | 610 (41.3) | 481 (31.7) | 500 (33.5) | |
| 1 time/2 weeks | 466 (26.0) | 480 (31.2) | 405 (27.2) | |
| ≤ 1 time/month | 537 (32.6) | 633 (37.1) | 605 (39.3) | |
| Eating-out expenditure with family (thousand won/month) ^{2 3} | 108,300.4 ± 2,059.9 | 111,910.0 ± 2,016.2 ^a | 107,146.6 ± 1,983.1 ^a | 0.475 |

Table 3. continued

| Variables | Provinces | | | P-value |
|---|---------------------------------|----------------------------------|----------------------------------|---------|
| | 2018 (n = 2,762) | 2019 (n = 2,613) | 2020 (n = 2,692) | |
| Eating-out ¹ | n = 2,762 | n = 2,613 | n = 2,692 | < 0.001 |
| Yes | 2,274 (84.3) ^a | 2,212 (87.3) ^a | 2,174 (78.4) ^b | |
| Frequency of eating-out | n = 2,274 | n = 2,212 | n = 2,174 | 0.111 |
| ≥ 1 time/week | 1,024 (47.7) | 1,029 (49.0) | 972 (44.0) | |
| 1 time/2 weeks | 536 (22.0) | 458 (19.2) | 446 (21.6) | |
| ≤ 1 time/month | 714 (30.3) | 725 (31.8) | 756 (34.4) | |
| Eating-out expenditure (thousand won/month) ^{2 3} | 88,540.9 ± 1,566.9 | 89,531.5 ± 1,497.3 | 89,273.0 ± 1,540.2 | 0.514 |
| Eating-out with family ¹ | n = 2,762 | n = 2,613 | n = 2,692 | 0.004 |
| Yes | 2,065 (76.6) ^a | 2,091 (82.3) ^b | 2,081 (75.9) ^a | |
| Frequency of eating-out with family | n = 2,065 | n = 2,091 | n = 2,081 | 0.274 |
| ≥ 1 time/week | 711 (36.1) | 615 (31.4) | 601 (29.9) | |
| 1 time/2 weeks | 549 (26.3) | 597 (28.2) | 619 (31.3) | |
| ≤ 1 time/month | 805 (37.6) | 879 (40.4) | 861 (38.8) | |
| Eating-out expenditure with family (thousand won/month) ^{2 3} | 94,543.3 ± 1,722.0 ^a | 101,290.0 ± 1,613.9 ^b | 107,515.3 ± 1,636.1 ^c | < 0.001 |

Mean ± SE or n (%)

P-values by chi-square or ANOVA test

1) Chi-square tests compared categorical variables across survey years (2018-2019, 2019-2020, 2018-2020); significant differences ($P = 0.05$) are indicated by different lowercase letters in the same row.

2) Bonferroni tests compared continuous variables across 2018-2020 survey years; significant differences ($P < 0.05$) are indicated by different lowercase letters in the same row.

3) Adjusted for age, sex, education level, and household income

3. Changes in the delivery/take-out behavior before and after COVID-19

Table 4 lists the results before and after COVID-19 changes in deliveries/take-outs behavior. The individual delivery/takeout usage rate in the Province decreased from 44.1% in 2018, before COVID-19, to 35.0% after COVID-19 ($P < 0.001$). There was

Table 4. Changes in the deliveries/takeout before and after COVID-19 by area from the Consumer Behavior Survey for Foods

| Variables | Seoul metropolitan area | | | P-value |
|--|---------------------------------|---------------------------------|---------------------------------|---------|
| | 2018 (n = 2,011) | 2019 (n = 1,801) | 2020 (n = 1,936) | |
| Using deliveries/takeout | n = 2,011 | n = 1,801 | n = 1,936 | 0.051 |
| Yes | 1,297 (64.3) | 1,058 (60.3) | 1,020 (56.6) | |
| Frequency of deliveries/take-outs ¹⁾ | n = 1,297 | n = 1,058 | n = 1,020 | < 0.001 |
| ≥ 1 time/week | 372 (30.5) ^a | 382 (40.0) ^b | 436 (44.4) ^b | |
| 1 time/2 weeks | 482 (36.1) | 393 (35.1) | 342 (34.1) | |
| ≤ 1 time/month | 443 (33.4) | 283 (24.9) | 242 (21.5) | |
| Deliveries/takeout food expenditure (thousand won/month) ³⁾ | - | 55,695.6 ± 13,273.1 | 57,983.2 ± 9,475.6 | < 0.001 |
| Using deliveries or takeout with family | n = 2,011 | n = 1,801 | n = 1,936 | 0.565 |
| Yes | 1,619 (81.6) | 1,421 (82.0) | 1,543 (79.5) | |
| Frequency of deliveries/takeout with family ¹⁾ | n = 1,619 | n = 1,421 | n = 1,543 | < 0.001 |
| ≥ 1 time/week | 442 (31.4) ^a | 418 (31.6) ^a | 639 (44.1) ^b | |
| 1 time/2 weeks | 567 (33.6) | 572 (42.2) | 617 (39.4) | |
| ≤ 1 time/month | 610 (35.0) | 431 (26.3) | 287 (16.5) | |
| Deliveries/takeout food expenditure with family (thousand won/month) ²⁾³⁾ | 55,815.5 ± 1,042.6 ^a | 54,407.5 ± 1,010.7 ^a | 61,191.2 ± 1,025.7 ^b | < 0.001 |

Table 4. continued

| Variables | Metropolitan cities | | | P-value |
|--|---------------------|---------------------|---------------------|---------|
| | 2018 (n = 1,805) | 2019 (n = 1,762) | 2020 (n = 1,727) | |
| Using deliveries/takeout | n = 1,805 | n = 1,762 | n = 1,727 | 0.310 |
| Yes | 798 (45.5) | 862 (50.4) | 808 (46.2) | |
| Frequency of deliveries/take-outs | n = 798 | n = 862 | n = 808 | 0.391 |
| ≥ 1 time/week | 258 (34.5) | 248 (30.5) | 247 (32.3) | |
| 1 time/2 weeks | 251 (30.8) | 270 (32.0) | 281 (36.0) | |
| ≤ 1 time/month | 289 (34.7) | 344 (37.6) | 280 (31.7) | |
| Deliveries/takeout food expenditure (thousand won/month) ³⁾ | - | 50,805.2 ± 15,047.7 | 46,188.7 ± 11,729.8 | 0.053 |
| Using deliveries or takeout with family | n = 1,805 | n = 1,762 | n = 1,727 | 0.080 |
| Yes | 1,390 (78.9) | 1,281 (73.9) | 1,297 (74.5) | |
| Frequency of deliveries/takeout with family | n = 1,390 | n = 1,281 | n = 1,297 | 0.263 |
| ≥ 1 time/week | 425 (34.6) | 402 (33.9) | 434 (33.7) | |
| 1 time/2 weeks | 475 (35.8) | 381 (28.6) | 361 (26.3) | |
| ≤ 1 time/month | 490 (29.6) | 498 (37.5) | 502 (5.00) | |
| Deliveries/takeout food expenditure with family (thousand won/month) ³⁾ | 49,346.4 ± 1,040.5 | 53,954.2 ± 1,059.0 | 46,603.0 ± 1,017.2 | 0.232 |

Table 4. continued

| Variables | Provinces | | | P-value |
|---|---------------------------------|---------------------------------|-------------------------------|---------|
| | 2018 (n = 2,762) | 2019 (n = 2,613) | 2020 (n = 2,692) | |
| Using deliveries/takeout ¹⁾ | n = 2,762 | n = 2,613 | n = 2,692 | < 0.001 |
| Yes | 1,120 (44.1) ^c | 951 (40.1) ^{ab} | 939 (35.0) ^b | |
| Frequency of deliveries/take-outs | n = 1,120 | n = 951 | n = 939 | 0.178 |
| ≥ 1 time/week | 313 (32.6) | 266 (30.5) | 232 (25.3) | |
| 1 time/2 weeks | 318 (26.5) | 209 (21.6) | 283 (29.8) | |
| ≤ 1 time/month | 489 (40.9) | 476 (48.0) | 424 (44.8) | |
| Deliveries/takeout food expenditure (thousand won/month) ³⁾ | - | 36,884.8 ± 13,725.2 | 39,227.2 ± 10,660.1 | 0.001 |
| Using deliveries or takeout with family | n = 2,762 | n = 2,613 | n = 2,692 | 0.063 |
| Yes | 1,758 (67.9) | 1,600 (64.0) | 1,717 (62.3) | |
| Frequency of deliveries/takeout with family | n = 1,758 | n = 1,600 | n = 1,717 | 0.444 |
| ≥ 1 time/week | 452 (28.6) | 396 (28.0) | 498 (29.0) | |
| 1 time/2 weeks | 558 (33.5) | 498 (32.3) | 598 (37.5) | |
| ≤ 1 time/month | 748 (37.8) | 706 (39.5) | 621 (33.5) | |
| Deliveries/takeout food expenditure with family (thousand won/month) ^{2),3)} | 47,929.1 ± 1,008.6 ^a | 52,152.6 ± 1,007.1 ^b | 56,267.8 ± 994.7 ^c | < 0.001 |

Mean ± SE or n (%)

P-values by chi-square or ANOVA test

1) Chi-square tests compared categorical variables across survey years (2018-2019, 2019-2020, 2018-2020); significant differences ($P < 0.05$) are indicated by different lowercase letters in the same row.

2) Bonferroni tests compared continuous variables across 2018-2020 survey years; significant differences ($P < 0.05$) are indicated by different lowercase letters in the same row.

3) Adjusted for age, sex, education level, and household income

no significant change in the individual delivery/takeout utilization in Seoul metropolitan area ($P = 0.051$). The frequency of individual delivery/takeout in the Seoul metropolitan area, the proportion of respondents who answered that they use it at least once a week increased to 44.4% after COVID-19 compared to 30.5% in 2018 before COVID-19 ($P < 0.001$). Individual delivery/takeout costs in the Seoul metropolitan area increased from 55,695 won in 2019 to 57,983 won in 2020 ($P < 0.001$), and individual delivery/takeout costs in the Provinces increased from 36,884 won in 2019 to 39,227 won in 2020 ($P = 0.001$). Metropolitan cities showed no significant changes.

The deliveries/takeout usage rates with household members showed no changes in all regions. Among those who reported using deliveries/takeout in Seoul metropolitan area, the proportion who reported using deliveries/takeout with household members at least once a week increased from 31.4% in 2018 and 31.6% in 2019 before COVID-19 to 44.1% after COVID-19 ($P < 0.001$). The cost of deliveries/takeout with household members in the Seoul metropolitan area increased from 55,815 won in 2018 and 54,407 won in 2019 to 61,191 won in 2020 ($P < 0.001$). The delivery/takeout expenses with household members in Provinces increased from 47,929 won in 2018, 52,152 won in 2019, and 56,267 won in 2020 ($P < 0.001$). The Metropolitan cities showed no significant changes.

4. Changes in breakfast frequency and nutrition label utilization before and after COVID-19

Table 5 lists the changes in breakfast frequency and nutrition label utilization before and after COVID-19. The breakfast frequency in the Seoul metropolitan area decreased from 5.01 times/week in 2018 and 2019 to 3.89 times/week, respectively, before COVID-19 and continued to decrease to 3.76 times/week after COVID-19 ($P < 0.001$). In Metropolitan cities, the breakfast frequency decreased from 5.23 and 4.12 times/week in 2018 and 2019, respectively, before COVID-19, to 3.96 times/week after COVID-19 ($P < 0.001$). In the Provinces, the breakfast frequency decreased from 5.60 and 4.54 times/week in 2018

Table 5. Changes in the frequency of breakfast and use of nutrition labeling when purchasing processed foods before and after COVID-19, according to the area from the Korea Community Health Survey

| Variables | 2018 (n = 228,340) | 2019 (n = 229,099) | 2020 (n = 229,269) | P-value ^{1 2} |
|---|----------------------------|----------------------------|----------------------------|-------------------------|
| Frequency of breakfast (times/week) | | | | |
| Seoul metropolitan area (n = 220,486) | 5.01 ± 0.01 ^{Ac} | 3.89 ± 0.01 ^{Ab} | 3.76 ± 0.01 ^{Ac} | < 0.001 |
| Metropolitan cities (n = 109,331) | 5.23 ± 0.01 ^{Ba} | 4.12 ± 0.01 ^{Bb} | 3.96 ± 0.01 ^{Bc} | < 0.001 |
| Provinces (n = 356,828) | 5.60 ± 0.01 ^{Ca} | 4.54 ± 0.01 ^{Cb} | 4.44 ± 0.01 ^{Cc} | < 0.001 |
| P-value ^{2 3} | < 0.001 | < 0.001 | < 0.001 | |
| Use of nutrition labels when purchasing processed foods (yes) | | | | |
| Seoul metropolitan area (n = 220,486) | 14,655 (21.9) ^P | 17,088 (25.1) ^P | 17,761 (25.6) ^P | < 0.001 |
| Metropolitan cities (n = 109,331) | 7,076 (21.3) ^P | 8,053 (23.7) ^P | 8,284 (24.3) ^P | < 0.001 |
| Provinces (n = 356,828) | 14,716 (16.4) ^P | 18,461 (20.2) ^P | 19,251 (20.5) ^P | < 0.001 |
| P-value ⁴ | < 0.001 | < 0.001 | < 0.001 | |

Mean ± SE or n (%)

P-values by chi-square or ANOVA test

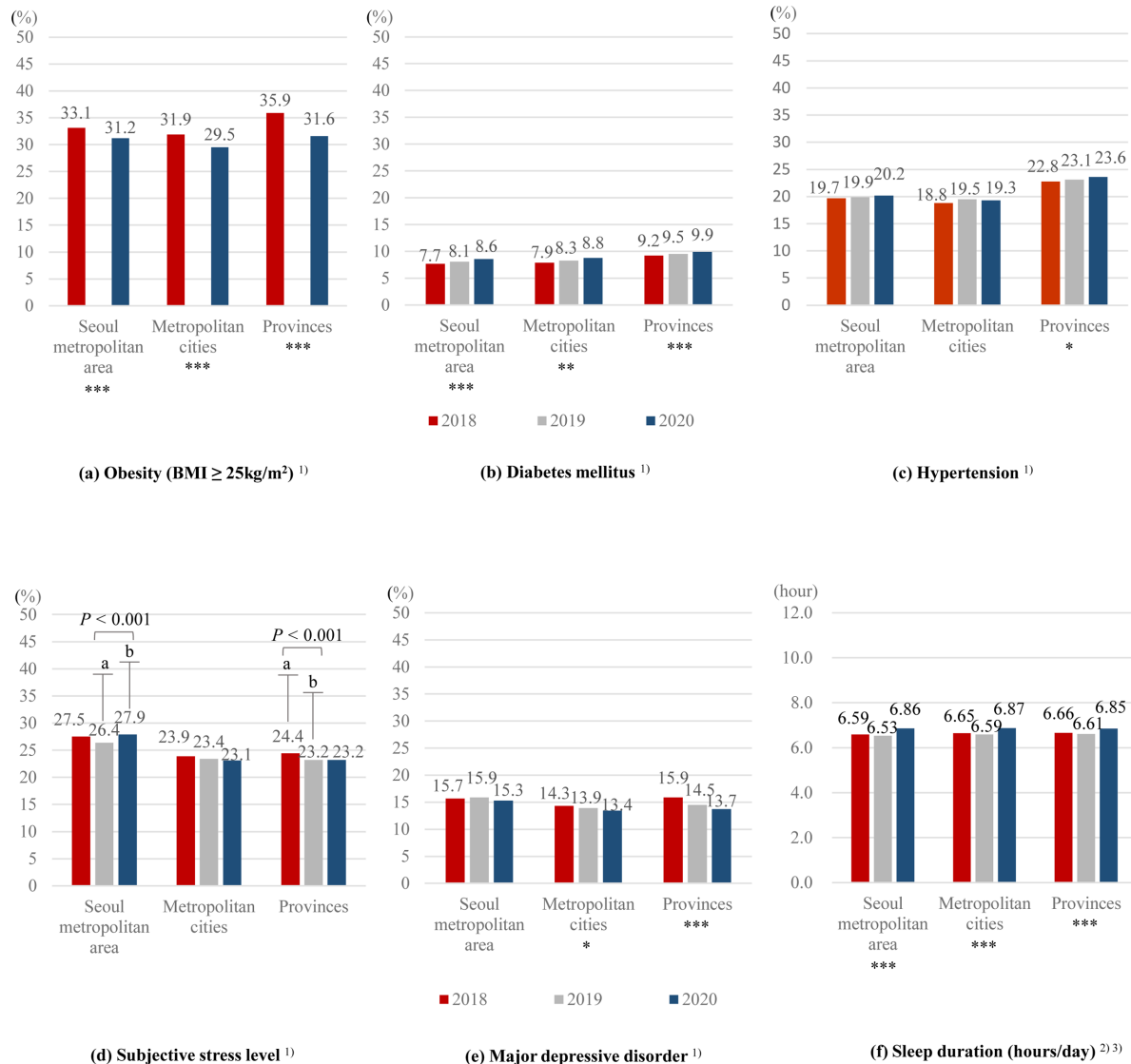
- 1) Bonferroni tests compared continuous variables across 2018-2020 survey years; significant differences ($P < 0.05$) are indicated by different lowercase letters in the same row.
- 2) Adjusted for age, sex, education level, and household income
- 3) Bonferroni tests compared continuous variables across regions (Seoul metropolitan area, Metropolitan cities, Provinces); significant differences ($P < 0.05$) are indicated by different uppercase letters in the same column.
- 4) Chi-square tests compared categorical variables across survey years (2018-2019, 2019-2020, 2018-2020); significant differences ($P < 0.05$) are indicated by different lowercase letters in the same row.

and 2019, respectively, before COVID-19, to 4.44 times/week after COVID-19 ($P < 0.001$). The utilization of nutrition labeling in the Seoul metropolitan area increased from 21.9% and 25.1% in 2018 and 2019, respectively, before COVID-19 ($P < 0.001$), but did not change significantly after COVID-19. The use of nutrition labeling in Metropolitan cities increased to 21.3% and 23.7% in 2018 and 2019, respectively, before COVID-19 ($P < 0.001$), but did not change significantly after COVID-19. The use of nutrition labeling in the Provinces increased from 16.4% and 20.2% in 2018 and 2019, respectively, before COVID-19 ($P < 0.001$), but did not change significantly after COVID-19.

5. Changes in the prevalence of chronic diseases and mental health before and after COVID-19

Figure 1 shows the chronic disease and mental health prevalence before and after COVID-19. The prevalence of obesity decreased across all regions from before COVID-19 in 2018 to after COVID-19 in 2020, from 33.1% to 31.2% in Seoul metropolitan area, 31.9% to 29.5% in the Metropolitan city, and 35.9% to 31.6% in the Provinces ($P < 0.001$). The prevalence of hypertension in the Provinces increased from 22.8% in 2018 and 23.1% in 2019 before COVID-19 to 23.6% after COVID-19 ($P = 0.015$). The prevalence of diabetes increased from 7.7% before COVID-19 in 2018 and 8.1% in 2019 to 8.6% after COVID-19 in the Seoul metropolitan area ($P < 0.001$). The Metropolitan cities increased from 7.9% before COVID-19 in 2018 to 8.8% after COVID-19 ($P < 0.001$). The Provinces increased from 9.2% before COVID-19 in 2018 and 9.5% in 2019 to 9.9% after COVID-19 ($P < 0.001$).

The high stress levels in Seoul metropolitan area continued to increase to 27.5% in 2018, 26.4% in 2019, and 27.9% in 2020 ($P < 0.001$). Major depressive disorder in Seoul metropolitan area continued to decrease: 14.3% in 2018, 13.9% in 2019, and 13.4% in 2020 ($P = 0.042$). Major depressive disorder in the Provinces decreased from 15.9% in 2018, 14.5% in 2019, and 13.7% in 2020 ($P < 0.001$). The sleep duration increased in all regions after COVID-19, with the Seoul metropolitan area increasing from 6.59 hours/day in 2018 and 6.53 hours/day in 2019 to 6.86 hours/day in 2020 after COVID-19 ($P < 0.001$). The Metropolitan cities increased from 6.65 hours/day in 2018 and 6.59 hours/day in 2019 to 6.87 hours/day in 2020 after COVID-19 ($P < 0.001$). The Provinces increased from 6.66 hours/day in 2018 and 6.61 hours/day in 2019 to 6.85 hours/day in 2020 after COVID-19 ($P < 0.001$).



y-axis means percentage (%)

*: $P < 0.05$, **: $P < 0.01$, ***: $P < 0.001$

1) Chi-square tests compared categorical variables across survey years (2018-2019, 2019-2020, 2018-2020); significant differences ($P = 0.05$) are indicated by different lowercase letters in the survey years.

2) Bonferroni tests compared continuous variables across 2018-2020 survey years; significant differences ($P < 0.05$) are indicated by different lowercase letters in the survey years.

3) Adjusted for age, sex, education level, household income, high risk alcohol consumption and smoking

Fig. 1. Changes in chronic diseases and mental health before and after COVID-19 from the Korea Community Health Survey

Discussion

This study compared dietary factors and the prevalence of chronic diseases and mental health by region before and after COVID-19. Compared to before COVID-19, the rate of eating out in the Seoul metropolitan area and Provinces after COVID-19 decreased, and the frequency of eating out with household members in the Seoul metropolitan area increased.

In Korea, social distancing policies have been implemented to prevent COVID-19 infections, including limiting private

gatherings, limiting the number of people, restricting events and gatherings, and restricting the business hours of restaurants and other public facilities [5]. Chang *et al.* [23] reported that people also voluntarily reduced their outside activities for reasons, such as fear of COVID-19 infection and social criticism, resulting in fewer private outings and more time spent at home, leading to a preference for home-cooked meals rather than eating out, and more frequent consumption of delivered food rather than cooking home-cooked meals, which may have contributed to the decrease in eating out. On the other hand, the frequency of eating out with household members in the Seoul metropolitan area increased. Emergency disaster relief funds refer to the support the state or local governments' provide to stabilize people's livelihood and promote consumption in response to COVID-19 [24]. Hong [25] reported that consumption expenditure decreased by 16.3% in 2020 due to COVID-19, but it increased by 10.4% due to the emergency disaster assistance paid by the government or local governments from mid-May. Of these payments, 27.9% were used to replace the consumption that would have occurred without the payments, and approximately 72.1% of the payments generated new consumption. According to the Ministry of the Interior and Safety, 90.1% of households in South Korea received the COVID-19 emergency disaster benefit, and the most common industries where the emergency disaster benefit was used were "supermarket/grocery" at 26.3% and "restaurant" at 24.3% [26]. Kim *et al.* [27] reported that households purchased groceries and ate at restaurants, which increased to 27.0% after receiving the disaster assistance, suggesting that the impact of the disaster assistance may have contributed to the consumption of eating out.

The comparison of before and after COVID-19 delivery/takeout behaviors conducted in this study showed a decrease in individuals delivery/takeout use in the Provinces, with Chang *et al.* [23] reporting that the increase in delivery and home delivery meant that people avoided meeting with acquaintances due to high anxiety about contracting COVID-19. On the other hand, for those who reported using deliveries/takeout, the frequency of deliveries/takeout has increased in the Seoul metropolitan area, with Kim [29] reporting that 75.1% of respondents reported an increase in the amount of time they spent at home with their families during COVID-19. In addition, there was a 43.0% increase in grocery purchases and a 78.3% increase in money spent on food deliveries, in addition to maintaining interpersonal relationships centered on family [23]. Furthermore, when meeting up with friends after COVID-19, they reported an increase in the proportion of people ordering home-delivered food rather than eating out due to the anxiety about going out. These reasons may have contributed to the increased frequency of delivery/takeout with individuals or household members.

The cost of eating out and deliveries/takeout has been increasing since before COVID-19 because the price index for food items in the Consumer Price Index has been rising steadily to 98.254 in the fourth quarter of 2018, 99.413 in the fourth quarter of 2019, and 100.2 in the fourth quarter of 2020 (base: 2020 = 100) [28]. These results suggest that macro factors, such as rising inflation, may have contributed to the increase in individual food expenses.

A comparison of breakfast frequency and nutrition label utilization in this study also showed regional differences before and after COVID-19. The breakfast skipping rate, according to the 2020 National Health and Nutrition Examination Survey, was 28.9% in 2018, 31.3% in 2019, and 34.6% in 2020 [30], which is the same as the result of a steady increase in the breakfast skipping rate in this study. Yun and Oh [31] reported an increase in the breakfast skipping rate after the COVID-19 pandemic, which may be attributed to irregular eating due to restrictions on school attendance and work caused by COVID-19. On the other hand, it is unlikely that non-COVID-19 influences can be excluded entirely because the breakfast skipping rates have been increasing consistently since before COVID-19. As breakfast skipping can increase the risk of overweight and obesity, as well as the risk of type 2 diabetes [32, 33], it is necessary to monitor the breakfast skipping rates and develop measures, such as non-face-to-face nutrition education programs that can be conducted during the pandemic. In addition, this study showed a significant increase in the use of nutrition labels between 2018-2019 in all regions but no significant change in 2020 after COVID-19. Moreover, the use of nutrition labels, according to the 2020 National Health and Nutrition Examination Survey, was reported to be slightly lower than before: 32.8% in 2020 after COVID-19, compared to 30.3% in 2018 and 33.5% in 2019 before COVID-19 [30]. The increase in online purchases of processed foods during COVID-19 [34] and the tendency for shoppers to place more emphasis on taste and less on nutrition when purchasing processed foods online [35] may have

contributed to the after-COVID-19 decline in nutrition label use. On the other hand, nutrition labeling is effective in promoting healthier food choices, and nutrition labeling has been reported to reduce the body mass index and prevent chronic diseases, such as diabetes, cancer, and cardiovascular disease [36], so specific measures should be taken to promote online nutrition labeling.

A comparison of chronic disease prevalence showed differences before and after COVID-19 by region, but slightly different results were obtained. Hence, caution is needed when interpreting the results. The prevalence of obesity increased from 34.6% in 2018 and 33.8% in 2019 before COVID-19 to 38.3% in 2020 after COVID-19, according to the 2020 National Health and Nutrition Examination Survey [30]. By contrast, the prevalence of obesity decreased in this study. Lee *et al.* [14] used data from the National Health and Nutrition Examination Survey to compare the prevalence changes before and after the COVID-19 outbreak, comparing 2017-2019 and 2020, and reported that the prevalence of obesity, particularly among men, increased in 2020 compared to before COVID-19. The data from Korea Community Health Survey used in this study were analyzed by excluding the data from 2019, where the weight was measured directly, as opposed to 2018 and 2020, where weight was self-reported, because of differences in the methodology of the anthropometric survey. Therefore, the prevalence rates in 2018 and 2020 were compared, and the possibility of error in interpreting the results cannot be excluded.

This study showed that the prevalence of hypertension in the Provinces continued to increase. According to the 2020 National Health and Nutrition Examination Survey, however, the prevalence of hypertension decreased from 23.1% in 2018 before COVID-19 to 22.2% in 2019. After COVID-19, it increased slightly to 22.9% in 2020 [32]. Lee *et al.* [14] reported a slight decrease in the prevalence of hypertension in 2019 compared to before COVID-19 (2017-2018) and an increase in the prevalence of hypertension in men in 2020 compared to before COVID-19 (2017-2019). This differed from the present results, which showed that the prevalence of hypertension in the province continued to increase. The Korea Community Health Survey data used in this study is a self-reported survey, which may have limitations in interpreting the results caused by possible errors in the response accuracy and measurement methods.

Similar to the present results in all regions, the prevalence of diabetes according to the 2020 Korea Health and Nutrition Examination Survey was 9.2% in 2018, 9.5% in 2019, and 10.7% in 2020 [30]. Prior studies reported an increased time spent at home during COVID-19, decreased physical activity, and increased sleep duration [8, 9]. In addition, the use of major meal delivery apps in Korea has increased since COVID-19 [37]. Most delivered food consisted of fast food such as pizza, hamburgers, chicken, and sweetened beverages [38]. Increased fast food consumption is associated with obesity and type 2 diabetes [39, 40]. Hence, nutrition education programs are needed to foster healthy eating habits during the pandemic. On the other hand, the prevalence of diabetes has continued to increase even before COVID-19. Therefore, it is difficult to attribute the increase entirely to COVID-19.

This study compared the mental health prevalence. High subjective stress levels increased in metropolitan areas. Major depressive disorder decreased in Metropolitan cities and Provinces, and sleep duration increased in all regions. Jeong *et al.* [41] compared the prevalence of mental health before and after the COVID-19 outbreak using data from the National Health and Nutrition Examination Survey, 2016-2019 and 2020. They reported a 40% increase in the prevalence of depression and a 30% increase in high stress among men. This was similar to the present results, in which the high stress level in the Seoul metropolitan area increased in 2020 compared to 2018-2019, before COVID-19. On the other hand, there was a difference from the results of this study, which showed a decrease in major depressive disorder in Metropolitan cities and Provinces before COVID-19. In August 2020, to prevent the COVID-19 pandemic in Seoul metropolitan area, Korea raised social distancing to level 2 only in the Metropolitan area. In September 2020, the social distancing measure limited to the Seoul metropolitan area was further strengthened to level 2.5 [42]. The survey period of the 2020 Korea Community Health Survey was from August 16, 2020, to October 31, 2020 [15]. The coincidence of the survey period with the pandemic may have led to higher stress levels due to COVID-19 among people living in Seoul metropolitan area. On the other hand, various stresses, such as specific life events and cognitive expectations, can affect depression [43]. As COVID-19 progresses for a long time, the 'corona blue'

phenomenon of feeling depressed due to COVID-19 is spreading [44]. Nevertheless, this study showed a decrease in major depressive disorder in Metropolitan cities and Provinces. In this regard, Van *et al.* [45] reported that people might consider themselves to be less depressed compared to those who are more distressed. Hence, depression may be buffered by the energy and sense of togetherness that people feel when connected to a common event. Moreover, COVID-19 may have reduced the time pressure obligations, which may have benefitted mental health. On the other hand, the prevalence of major depressive disorder has been decreasing continuously since COVID-19. Therefore, it cannot be attributed conclusively to COVID-19, and caution should be taken when interpreting the results. In addition, the survey period of the 2020 National Health and Nutrition Examination Survey was conducted for about a year, from January to December 2020 [30]. Accordingly, the effects of COVID-19 may have been more pronounced than the 2020 Korea Community Health Survey, which was conducted for approximately two months, which may have contributed to the difference in results. The sleep duration increased after COVID-19 in all regions, and previous research by Yuan *et al.* [46] suggested that work-from-home and lockdown policies caused by COVID-19 increased the sleep duration. Another potential cause is that sleep may be affected by business hours restrictions, non-essential venue closures, and lockdowns.

The limitation of this study was that the Korea Community Health Survey and Consumer Behavior Survey for Foods data are independent data and must be interpreted independently of the research results. The data collection method may affect the measurement value, so the possibility of error cannot be excluded when interpreting the results. In addition, this study was analyzed by administrative division into Seoul metropolitan area, Metropolitan cities, and Provinces, which is not a detailed analysis by city, county, and district according to the concentration of COVID-19 cases. On the other hand, there were differences between regions, with 0.73% in the Metropolitan areas, 0.56% in Metropolitan cities, and 0.47% in Provinces responding “yes” to “experience of COVID-19 isolation or hospitalization” in Korea Community Health Survey data. A follow-up study should undergo a detailed analysis of the differences between regions before and after COVID-19 by selecting regions by city, county, or district according to the density of confirmed COVID-19 cases. Since the outbreak of COVID-19 in Korea in February 2020, it has been difficult to compare some dietary factors before and after COVID-19 and to observe the changes in chronic diseases based on the 2020 data. Furthermore, continuous observation and investigation through future follow-up studies will be needed.

Despite these limitations, this study is meaningful because it analyzed and considered the changes in dietary habits before and after COVID-19, chronic diseases, and mental health prevalence by region using the data from the Korea Community Health Survey and Consumer Behavior Survey for Foods. In the future, it will be necessary to reflect on the differences in dietary habits and changes in the prevalence of chronic diseases and mental health by region in policies aimed at narrowing the health gap between regions.

Conclusion

This paper provided evidence of regional health inequalities by analyzing the changes in diet, chronic disease, and mental health prevalence between regions before and after COVID-19. This study used the data from the Korea Community Health Survey ($n = 686,708$) and the Consumer Behavior Survey for Foods ($n = 19,109$) conducted in 2018-2020 among adults aged 19 and older. The participants were categorized by the administrative region into the Seoul metropolitan area, Metropolitan cities, and Provinces, with 2018-2019 defined as before COVID-19 and 2020 as after COVID-19. The diet, chronic diseases, and mental health problems were measured through self-reported questionnaires. Compared to before COVID-19, the rate of eating out for participants residing in the Seoul metropolitan area and Provinces after COVID-19 decreased. Moreover, the frequency of eating out with household members in the Seoul metropolitan area increased. On the other hand, delivery and takeout use rates decreased in the Provinces, and the frequency of delivery/takeout with individuals and household members increased significantly in the Seoul metropolitan area. After COVID-19, the prevalence of obesity decreased in all regions, and

the prevalence of diabetes continuously increased in all regions. Hypertension prevalence increased significantly only in the Provinces. High subjective stress levels increased significantly in the Seoul metropolitan area, and the sleep duration significantly increased in all areas. Major depressive disorder was significantly reduced in the Metropolitan cities and Provinces. The regional differences in the prevalence of chronic diseases and mental disorders before and after the onset of COVID-19 were confirmed, along with changes in eating habits. The differences in dietary habits by region after COVID-19 were reflected in future policies to address the regional health inequality. In addition, a large-scale observational survey is needed to identify dietary factors before and after COVID-19 and the changes in the prevalence of chronic diseases and mental health.

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Conflicts of interest

There are no financial or other issues that might lead to a conflict of interest.

Funding

This study was supported by the Korean Society of Community Nutrition funded by the Korea Disease Control and Prevention Agency (No. ISSN 2733-5488).

Acknowledgments

The author wishes to thank the Korean Society of Community Nutrition for providing the opportunity to participate in the 2022 Excellent Researcher Research Support Project.

Data Availability

The data that support the findings of this study are openly available in the Consumer Behavior Survey for Foods at <https://www.krei.re.kr/foodSurvey/index.do>, and are available at request in the Korea Community Health Survey at <https://chs.kdca.go.kr/>

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