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**Original Article**

# Diabetes Mellitus Inequality in South Korean Adults by Region: The Influence of Obesity and Depression

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**Abstract**

**Background:** Diabetes mellitus (DM) has different prevalence by region. This study aimed to identify the differences in the effects of obesity and depression on DM in South Korean adults by region.

**Methods:** The participants were 14,343 adults (≥30 yr) from Ulsan (regions with the lowest prevalence of DM) and Jeonbuk (regions with the highest prevalence of DM), and data were extracted from the Community Health Survey 2019. We applied a complex sampling design analysis to reflect the stratified, clustering and weights. The data were analyzed using the unweighted frequencies, weighted percentage, mean, standard error, Chi-Square test and multiple logistic regression analysis (SPSS 25.0).

**Results:** Regarding the main result for Ulsan, the odds ratio of DM increased by 1.94, 2.52,1.57, and 4.87 times for obesity(25-29.9kg/m²), high obesity(≥30kg/m²), depression, and receipt of psychological counseling for depression, respectively. In Jeonbuk, the odds ratio of DM increased by 1.79, 2.84, and 3.59 times for obesity, high obesity, and unmet medical experience, respectively. On the other hand, depression-related variables were found to not influence DM

**Conclusion:** We provided the rationale for conducting a health project that interventions for obesity and depression should be included in DM management programs differently in Ulsan and Jeonbuk regions.

**Keywords:** Adult; Depression; Diabetes mellitus; Obesity

## Introduction

Diabetes Mellitus (DM) is one of the biggest global health problems, as per the International Diabetes Federation (IDF) report 537 million adults were likely to have DM in 2021, 643 million in 2030, and 783 million in 2045 (1). According to the 2019 Korean Community Health Survey, the prevalence of DM among Korean adults was 11.6% (2). DM should hence be treated as a major health management problem in South Korea.

Obesity is related to chronic diseases such as DM (3). There is a higher incidence of impaired fasting glucose and DM in the individuals with obesity (4). Obesity is a major risk factor for exacerbating DM, which leads to premature death (5). Despite this, the obesity rate among adult males in Korea is 42.3% and among adult females is 26.4% (6). Obesity increases the prevalence of DM because fat tissue in induce resistance to insulin action and decreases

the function of pancreatic β-Langerhans cell that secrete insulin in people with obesity (7), therefore, weight loss improves glycemic control in patients with diabetes and prevents progression from pre-diabetes to diabetes (8). WHO defined obesity as BMI>30kg/m² and overweight as BMI>25kg/m² for Western populations (5). According to the Korea Centers for Disease Control and Prevention, a BMI≥25kg/m² was defined as obesity (6).

The most common psychiatric disorder in patients with DM is depression, which increases the risk of DM by 60% (9). Antidepressant use significantly increased hemoglobin A1c (HbA1c) levels and may be a risk factor for glycemic control (10). In addition, depression occurs more frequently in patients with DM than in general patients (11), with prevalence rates 2-3 times higher in patients with DM (12). Depression worsens the prognosis of DM and increases treatment non-compliance (13). DM is caused by depression (9-10), and depression is caused by DM (11); the causal relationship may be different, but DM and depression are co-related.

Previous studies related to DM include diabetes prevalence (1-2), obesity and diabetes (3-5,7), depression and diabetes (9-10), and the effect of diabetes on depression (11-13). Studies on the prevalence of obesity (6), and depression (9-11) did not confirm regional differences. Therefore, health-management programs based on regional characteristics have limited application. The present study used the Korea Community Health Survey to examine the difference in the effects of obesity and depression on DM in regions with the highest and lowest prevalence of DM in South Korea that is Jeonbuk and Ulsan respectively.

We investigated regional disparities to provide a basis for identifying and resolving the causes of health problems, towards evidence-based health projects and interventions for obesity and depression in DM management programs.

## Methods

### *Study population*

This descriptive research study analyzes the 2019 community health survey data that used a two-stage cluster sampling method to select representative survey participants in South Korea.

The survey was conducted as a personal interview survey by trained staff with 229,099 adult participants (≥19 yr); however, our study excluded participants under the age of 30 yr. Finally, the responses of 14,343 participants from Ulsan and Jeonbuk (≥30 yr) were analyzed.

In Ulsan, DM group (n=360, weighted 8.9%) and non-DM group (n=3,272, weighted 91.1%), and in Jeonbuk, DM group (n=1,520, weighted 11.5%) and non-DM group (n=9,191, weighted 88.5%).

### *Measuring Methods*

The general characteristics included age, sex, education level, economic level and unmet medical care experience.

The DM related characteristics comprised DM diagnosis ("Have you ever been diagnosed with DM by a doctor?"), age of onset, DM management education, DM complications test, blood sugar awareness, and number of HbA1c tests.

The BMI is a general indicator of obesity, measured by dividing the weight (kgs) by the square of the height (m²) (5-6). Based on the Korea Centers for Disease Control and Prevention criteria for the classification of obesity (6), in this study, normal weight (BMI<23kg/m²), overweight (BMI=23~24.9 kg/m²), obesity (BMI=25~29.9 kg/m²), and high obesity (BM=30~34.9kg/m²) were classified.

Depression as a mood disorder that presents a serious medical condition (14). As a screening test for depression in DM patients, the Patient Health Questionnaire (PHQ-9) was found to have high sensitivity and specificity (15). The PHQ-9 measures how often the symptoms described in "Patient Health Questionnaire" have been experienced in the last 2 weeks. "Not at all" was rated at 0, "for a few days" at 1, "more than a week" at 2, and "almost every day" at 3 points. The scale comprises nine items and its score ranges from 0 to 27 points, with the cut-off for major depression of 10 points or more (16).

### *Ethical approval*

This study was conducted with the approval of the H University Institutional Review Committee (IRB No. 2021-E-02-02) for the secondary analysis of the 2019 Community Health Survey data. Data was coded with serial numbers to ensure anonymity and confidentiality of personal information.

### *Data analysis*

Since the 2019 community health survey data were obtained using a complex sample design, an analysis plan file with stratification, clustering, and weights was created and analyzed. The participants' characteristics were analyzed for unweighted frequencies, weighted percentages, means, and standard errors

In Ulsan and Jeonbuk, regional differences in general characteristics, DM related characteristics, BMI and depression were analyzed using the chi square test. The factors affecting of the DM in Ulsan and Jeonbuk were analyzed using multiple logistic regression model (SPSS 25.0, IBM Corp., Armonk, NY, USA).

## Results

### *General Characteristics of Ulsan and Jeonbuk*

Maximum number of participants in both Ulsan and Jeonbuk were in the age group of 50-59 yr while the least number of participants were in ≥70 yr and 30-39 yr respectively ($\chi2$=327.45, *P*<.001). There were more female participants in Jeonbuk than Ulsan ($\chi2$=7.73, *P*=.003). Regarding the educational level, in both Ulsan and Jeonbuk, most participants were "university graduates and above;" however, the least participants in Ulsan were elementary school graduates or less, and in Jeonbuk, were middle school graduates ($\chi2$=329.52, *P*<.001). Considering the economic level, in both Ulsan and Jeonbuk, ≥4 million won/month was the most common, and < 1 million won/month, was least common ($\chi2$=644.39, *P*<.001). Unmet medical care experience was 5.3% in Ulsan and 6.6% in Jeonbuk ($\chi2$=142.95, *P*<.001) (Table 1).

**Table 1:** General characteristics of Ulsan and Jeonbuk (n†=14,343)

| *Variables* | | *Ulsan n† (W%) ‡* | *Jeonbuk n† (W%) ‡* | *χ2 (p)* |
|---|---|---|---|---|
| Age(yr) | | | | |
| | 30~39 | 612 (20.8) | 820 (15.8) | 327.45 |
| | 40~49 | 848 (25.5) | 1453 (21.8) | (<.001) |
| | 50~59 | 1001 (27.9) | 2011 (24.3) | |
| | 60~69 | 733 (16.1) | 2547 (17.5) | |
| | ≥70 | 438 (9.7) | 3880 (20.6) | |
| Sex | Male | 1710(50.8) | 4649 (48.4) | 7.73 |
| | Female | 1922(49.2) | 6062 (51.6) | (.003) |
| Education level | Below elementary school | 449 (9.5) | 4414 (21.1) | 329.52 |
| | Middle school graduate | 458 (10.5) | 1391 (10.0) | (<.001) |
| | High school graduate | 1439 (39.3) | 2750 (32.1) | |
| | Over university graduate | 1284 (40.7) | 2148 (36.8) | |
| Economic level (million won /month) | <1 | 213 (5.4) | 2373 (15.6) | 644.39 |
| | 1~1.99 | 385 (10.9) | 1943 (18.3) | (<.001) |
| | 2~2.99 | 389 (12.5) | 1377 (17.4) | |
| | 3~3.99 | 614 (22.0) | 1113 (18.9) | |
| | ≥4 | 1319 (49.2) | 1582 (29.8) | |
| Unmet medical care experience | Yes | 203 (5.3) | 626 (6.6) | 142.95 |
| | No | 3529 (94.7) | 10085 (93.4) | (<.001) |

†n=Unweighted frequencies; ‡W%=Weighted percent

### *DM related Characteristics of Ulsan and Jeonbuk*

DM diagnosis in Ulsan and Jeonbuk was 8.9% and 11.5% respectively ($\chi2$=23.10, *P*<.001). In the DM diagnosis group, the age of onset in both Ulsan and Jeonbuk was highest in the age group 50-59 yr (Ulsan 2.9%, Jeonbuk 3.9%) followed by 40-49 yr (2.3%) in Ulsan and 60-69 yr (2.8%) in Jeonbuk ($\chi2$=49.32, *P*<.001). Participants who did not receive DM management education were 6.7% in Ulsan and 9.0% in Jeonbuk ($\chi2$=25.46, *P*<.001). Among the DM complications, participants in Ulsan who did not receive fundus test ($\chi2$=33.43, *P*<.001), and micro-proteinuria test ($\chi2$=43.82, *P*<.001) were 4.5% and 3.7% respectively, and 7.0% and 6.3% respectively in Jeonbuk. Further, 6.1% participants in Ulsan and 7.6% in Jeonbuk were not aware of their blood glucose levels ($\chi2$=28.99, *P*<.001). In the DM group, the number of HbA1c test was 4 or more 3.2% in Ulsan, and 1 or less 3.9% in Jeonbuk ($\chi2$=63.32, *P*<.001) (Table 2).

**Table 2:** DM related characteristics of Ulsan and Jeonbuk (n†=14,343)

| ***Variables*** | | | ***Ulsan n† (W%) ‡*** | ***Jeonbuk n† (W%) ‡*** | ***χ2 (p)*** |
|---|---|---|---|---|---|
| DM diagnosis | Yes | | 360 (8.9) | 1520 (11.5) | 23.10 (<.001) |
| | No | | 3272 (91.1) | 9191 (88.5) | |
| DM onset age (yr) | < 30 | | 6 (0.2) | 13 (0.1) | 49.32 (<.001) |
| | 30~39 | | 32 (0.9) | 87 (0.9) | |
| | 40~49 | | 86 (2.3) | 230 (2.1) | |
| | 50~59 | | 115 (2.9) | 470 (3.9) | |
| | 60~69 | | 87 (1.9) | 438 (2.8) | |
| | ≥70 | | 34 (0.7) | 282 (1.7) | |
| DM management education | Yes | | 83 (2.2) | 293 (2.5) | 25.46 (<.001) |
| | No | | 277 (6.7) | 1227 (9.0) | |
| DM complications test | Fundus test | Yes | 178 (4.4) | 546 (4.5) | 33.43 (<.001) |
| | | No | 182 (4.5) | 974 (7.0) | |
| | Micro-proteinuria test | Yes | 209 (5.2) | 640 (5.2) | 43.82 (<.001) |
| | | No | 151 (3.7) | 880 (6.3) | |
| Blood sugar level awareness | Yes | | 113 (2.8) | 522 (3.9) | 28.99 (<.001) |
| | No | | 247 (6.1) | 998 (7.6) | |
| | Unknown | | 86 (1.9) | 418 (2.5) | |
| Number of HbA1c test | ≤1 | | 80 (2.0) | 522 (3.9) | 63.32 (<.001) |
| | 2 | | 40 (1.1) | 197 (1.7) | |
| | 3 | | 26 (0.7) | 113 (1.0) | |
| | ≥ 4 | | 128 (3.2) | 270 (2.4) | |

†n=Unweighted frequencies; ‡W%=Weighted percent; DM=Diabetes mellitus; HbA1c= hemoglobin A1c

### *BMI and Depression Related Characteristics of Ulsan and Jeonbuk*

BMI classification in Ulsan showed that 24.9% participants were overweight, 30.9% were obese, and 4.6% were highly obese, and in Jeonbuk, 25.2% were overweight, 30.7% were obese, and 5.3% were highly obese; however, there were no significant differences by region ($\chi2$=4.69, *P*=.467).

In Ulsan and Jeonbuk, 5.09 % and 7.0% of the participants were found to be in depression re-

spectively (χ2=22.59, *P*=.001), with 1.0% who received psychological counselling in Ulsan and 1.2% in Jeonbuk (χ2=23.76, *P*=.002) (Table 3).

**Table 3:** BMI and depression related characteristics of Ulsan and Jeonbuk (n†=14,343)

| *Variables* | *Ulsan n† (W %) ‡* | *Jeonbuk n† (W %) ‡* | *χ2 (p)* |
|---|---|---|---|
| BMI (kg/m²) | | | |
| Normal weight (<23) | 1439 (39.6) | 4239 (38.8) | 4.69 |
| Overweight (23~24.9) | 911 (24.9) | 2607 (25.2) | (.467) |
| Obesity (25~29.9) | 1123 (30.9) | 3317 (30.7) | |
| High obesity (≥30) | 159 (4.6) | 548 (5.3) | |
| Depression (PHQ-9) | | | |
| Yes | 195 (5.0) | 715 (7.0) | 22.59 |
| No | 3437 (95.0) | 9996 (93.0) | (.001) |
| Psychological counseling for depressive symptoms | | | |
| Yes | 39 (1.0) | 124 (1.2) | 23.76 |
| No | 3593 (99.0) | 10587 (98.8) | (.002) |

†n=Unweighted frequencies; ‡W%=Weighted percent; BMI=body mass index; PHQ-9=patient health questionnaire

### *Multiple Logistic Regression Analysis of Factors Affecting DM of Ulsan and Jeonbuk*

The factors influencing DM in Ulsan were BMI, depression, psychological counseling for depression, and age. The odds ratio of DM were increased by 1.94 times (95% CI 1.47 to 2.57; *P*=.043) for obesity and 2.52 times (95% CI 1.42 to 4.44; *P*<.001) for high obesity compared to normal weight; 1.57 times (95% CI 1.36 to 3.15; *P*=.006) in those with depression, and 4.87 times (95% CI 2.05 to 11.80; *P*<.001) in those who had psychological counseling for depression. Regarding the age groups, the odds ratio of DM were increased by 2.64 times (95% CI 1.08 to 6.47; *P*<. 001) in 40-49 yr, 5.30 times (95% CI 2.18 to 12.91; *P*<.001) in the 50-59 yr, 7.59 times (95% CI 3.14 to 18.38; *P*=.002) in the 60-69 yr and 12.05 times (95% CI 4.51 to 32.19; *P*=.036) in the ≥70 yr compared to the 30-39 yr.

The factors influencing DM in Jeonbuk were BMI, age, sex, and unmet medical care. The odds ratio of DM were increased by 1.79 times (95% CI 1.42 to 2.25; *P*<.001), 2.84 times (95% CI 1.95 to 4.15; *P*<.001), and 3.59 times (95% CI 2.07 to 6.22; *P*<.001) for obesity, high obesity, and unmet medical experience, respectively. Regarding the age groups, the odds ratio of DM were increased by 4.96 times (95% CI 1.76 to 13.99; *P*<. 001), 11.95 times (95% CI 4.36 to 32.78; *P*< .001), 20.31 times (95% CI 7.48 to 55.12; *P*< .001), and 33.04 times (95% CI 12.21 to 89.43; *P*< .001) for 40-49 yr, 50-59 yr, 60-69 yr, and ≥70 yr, respectively. The odds ratio of DM were decreased by 0.61 times in females than in males (95% CI 0.51 to 0.74; *P*=.004) (Table 4).

**Table 4:** Multiple logistic regression analysis of factors affecting DM of Ulsan and Jeonbuk (n†=14,343)

| *Variable* | *Category* | *Ulsan* | | | *Jeonbuk* | | |
|---|---|---|---|---|---|---|---|
| | | AOR | 95% CI | (*p*) | AOR | 95% CI | (*p*) |
| BMI (kg/m²) | | | | | | | |
| | Normal weight (<23) | 1 | | | 1 | | |
| | Overweight (23~24.9) | 1.38 | 0.97~1.97 | .353 | 1.23 | 0.96~1.56 | .270 |
| | Obesity (25~29.9) | 1.94 | 1.47~2.57 | .043 | 1.79 | 1.42~2.25 | <.001 |
| | High obesity (≥30) | 2.52 | 1.42~4.44 | <.001 | 2.84 | 1.95~4.15 | <.001 |
| Depression (PHQ-9) | | | | | | | |
| | Yes | 1.57 | 1.36~3.15 | .006 | 1.32 | 0.95~1.82 | 0.65 |
| | No | 1 | | | 1 | | |
| Psychological counseling for depression | | | | | | | |
| | Yes | 4.87 | 2.05~11.80 | <.001 | 1.55 | 0.83~2.89 | .169 |
| | No | 1 | | | 1 | | |
| Age(yr) | | | | | | | |
| | 30~39 | 1 | | | 1 | | |
| | 40~49 | 2.64 | 1.08~6.47 | <.001 | 4.96 | 1.76~13.99 | <.001 |
| | 50~59 | 5.30 | 2.18~12.91 | <.001 | 11.95 | 4.36~32.78 | <.001 |
| | 60~69 | 7.59 | 3.14~18.38 | .002 | 20.31 | 7.48~55.12 | <.001 |
| | ≥70 | 12.05 | 4.51~32.19 | .036 | 33.04 | 12.21~89.43 | <.001 |
| Sex | | | | | | | |
| | Male | 1 | | | 1 | | |
| | Female | 0.82 | 0.63~1.06 | .090 | 0.61 | 0.51~0.74 | .004 |
| Education level | | | | | | | |
| | Below elementary school | 1 | | | 1 | | |
| | Middle school graduate | 1.30 | 0.84~1.99 | .071 | 0.70 | 0.53~1.02 | .114 |
| | High school graduate | 0.91 | 0.57~1.46 | .065 | 0.89 | 0.67~1.18 | .807 |
| | Over university graduate | 0.53 | 0.31~1.25 | .059 | 0.72 | 0.50~1.04 | .081 |
| Economic level (million won/month) | | | | | | | |
| | <1 | 1 | | . | 1 | | |
| | 1~1.99 | 0.70 | 0.43~1.15 | .953 | 1.15 | 0.90~1.49 | .933 |
| | 2~2.99 | 0.66 | 0.40~1.08 | .837 | 1.30 | 0.94~1.79 | .113 |
| | 3~3.99 | 0.76 | 0.46~1.24 | .653 | 0.97 | 0.68~1.37 | .357 |
| | ≥4 | 0.69 | 0.42~1.13 | .810 | 0.98 | 0.68~1.42 | .410 |
| Unmet medical care experience | | | | | | | |
| | Yes | 1.08 | 0.39~1.65 | 0.56 | 3.59 | 2.07~6.22 | <.001 |
| | No | 1 | | | 1 | | |

AOR=adjusted odds ratio; CI=confidence intervals; BMI=body mass index; PHQ-9= patient health questionnaire

## Discussion

This study identified the differences in the effects of obesity and depression on DM in regions with the highest and lowest prevalence of DM, and attempted to provide evidence for regional health projects implementation. BMI was found to be an influencing factor in both regions, and the prevalence of DM increased with increase in BMI. BMI is related to DM and insulin resistance, and weight gain is a risk factor in the increased incidence of DM (17). The IDF suggests fasting blood glucose (FBS) and HbA1c criteria for the diagnosis of DM [1] as BMI is positively correlated with fasting FBS

(7) and HbA1c (3).

In obesity, there is an increase in substances such as hormones, cytokines, and inflammatory markers involved in insulin resistance (17). Excess fat due to obesity induces DM by increasing peripheral resistance to glucose uptake and decreasing β-cell sensitivity to glucose (7).

In patients with obesity and DM, HbA1c is not well controlled (3), DM is 2.79 times higher in those who are obese (18) and decreases with lower BMI (7). An increase in FBS and HbA1c, which are diagnostic indicators of DM, is related to weight gain (19).

In this study, depression and psychological counseling for depression were influencing factors in the prevalence of DM in Ulsan, but not in Jeonbuk. Depression was significantly associated with DM prevalence and glycemic control, and the prevalence of depression and comorbidities increased with DM (9). The prevalence of depression in DM patients was about 30% (20) and it increased the risk of vascular complications in patients with DM (12). Patients with DM and depression had a low adherence to treatment, which had a direct effect on blood sugar control (14). Long-term administration of antidepressants to patients with depression may decrease insulin sensitivity (21). Hence, it is necessary to minimize the negative effects of antidepressants on glycemic control (22,23).

DM and related complications cause physical, psychological, and economic burden, which leads to depression (12). Hypoglycemia in DM patients was positively correlated with the severity of depressive symptoms and depression could increase by anti-diabetic treatment (24).

In the present study, participants in Jeonbuk had a lower economic status, lower levels of education, and higher number of cases of depression and psychological counselling for depression as compared to those in Ulsan. This is similar to a study in which depression occurs more frequently as economic and educational level decline (14).

In this study, age was an influencing factor on the prevalence of DM in both regions. Specifically, prevalence of DM increased more with age in Jeonbuk than in Ulsan. Age is a risk factor for DM (18-19), more than half of DM patients are middle aged, and the prevalence of DM in both men and women increases with age (25). Further, FBS and HbA1c, indicators of DM diagnosis, increase with age (18) and insulin resistance appears with aging (25). Therefore, these findings support the results of our study. The age distribution in this study indicates that the prevalence of DM in Jeonbuk, where there were more elderly, increased significantly more than that in Ulsan.

Sex was an influencing factor in the prevalence of DM in Jeonbuk, but not in Ulsan. That is, the prevalence of DM decreased in females more than in males, in Jeonbuk. This might be due to the sex distribution of the study sample which had more females in Jeonbuk. However, men have a higher prevalence of DM than women (1), were diagnosed with DM 3-4 yr earlier and had a lower BMI of 1-3kg/m$^2$ (25). The prevalence of DM was 29.7% for women and 32.4% for men (18), indicating that women tend to have better control of blood sugar and HbA1c than men, HbA1c levels are lower in women than men, and menstruation is associated with a faster red blood cell turnover by decreasing hemoglobin levels in women (19).

Since unmet medical care experience for DM prevalence were influencing factors in Jeonbuk, but not in Ulsan, the prevalence of DM increased with unmet medical care experience in Jeonbuk. Among the unmet medical care experience reasons, a low economic level is the representative reason, and the results of previous study confirms that the lower the socio-economic status (SES) evaluated by education level, position, and income, the higher the prevalence of DM (26), supports the high prevalence of DM in Jeonbuk, which has a relatively low SES compared to Ulsan. Patients with DM were recognized as important because of their long-term medical expenses such as insulin and drug treatment along with regular hospital treatment (27). The DM treatment rate rises as access to medical institutions improves, but as access deteriorates, the cost of medical services increases (28). Our results also indicated that Jeonbuk had less DM management education, fewer fundus and micro-proteinuria tests as well as HbA1c tests than Ulsan.

The increase in management of diabetes will affect not only the individual's economic burden, but also that of the family and society, eventually increasing the socio-economic burden at the national level. However, Korea's health care system prioritizes acute treatment as chronic diseases such as DM have a long revisit period, and treatment is sometimes stopped due to medical costs and economic poverty for patients with low-income levels or elderly patients from the vulnerable class (29). Therefore, in regions with high DM prevalence, such as in Jeonbuk, it is necessary to establish a medical system and seek socio-economic support programs from the government and local communities. Contrarily, in regions with low DM prevalence, such as Ulsan, it is necessary to seek psychological support. The development of DM programs based on community characteristics will provide practical help in early detection and prevention of DM in the community.

The study has limitations in not being able to distinguish type1 diabetes (T1DM) from type2 diabetes (T2DM) by secondary analysis of community health survey data. The mechanism of interaction between T1DM and T2DM is different between obesity and depression. Therefore, in future research, we suggest a regional difference study by classifying the effects of obesity and depression into T1DM and T2DM.

## Conclusion

Obesity increased the prevalence of DM in both Jeonbuk and Ulsan. In Jeonbuk, unmet medical experience was a factor influencing the prevalence of DM. However, in Ulsan, depression was an influencing factor in the prevalence of DM.

Obesity interventions should be included in DM management programs in both Ulsan and Jeonbuk regions. In Jeonbuk, with a high DM prevalence, access to medical and socio-economic support programs in the community and nationally should be improved, and in Ulsan, emotional support programs for depression should be included. This study provides the rationale for conducting a health project that interventions for obesity and depression should be included in DM management programs differently in Ulsan and Jeonbuk regions.

## Journalism Ethics considerations

Ethical issues (Including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc.) have been completely observed by the authors.

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## Conflict of interest

The authors declare that there is no conflict of interests.

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