

## Original Article



# Depression Is a Mediator for the Relationship between Physical Symptom and Psychological Well-being in Obese People

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## ABSTRACT

This present study aimed to investigate the association effect of obesity status, physical symptom, insecure attachment, and depression on psychological well-being in non-diabetic healthy Koreans. Height, weight, waist circumference, blood pressure, and socio-psychological questionnaires (insecure attachment, depression, and physical symptom psychological well-being, etc.) were examined in 123 healthy Koreans. Student t-test, correlation analysis, and mediation analysis were performed. Study subjects were divided into 2 groups based on body mass index (BMI, kg/m<sup>2</sup>): obesity (BMI ≥ 25, n = 36) and non-obesity (BMI < 25, n = 87). Obese people were older and showed higher proportion of males than non-obese ones. Regarding the values of socio-psychological test, obesity group showed lower insecure attachment, and higher physical symptom than non-obesity group. In correlation and mediation analyses, depression was positively related to insecure attachment and physical symptom in both BMI groups. Positive relationship between physical symptom and insecure attachment was observed only in non-obesity group, but not in obesity group. The effect of insecure attachment on psychological well-being was completely mediated by depression in both BMI groups. On the other hand, the effect of physical symptom on psychological well-being was completely mediated by depression in obesity group, but not in non-obesity group. In conclusion, this study presented that the effects of physical symptom and insecure attachment on psychological well-being were completely mediated by depression in obese healthy Koreans, but not in non-obese ones. It will provide useful data for extending the knowledge on the relationship between the physical health and mental health.

**Keywords:** Obesity; Depression; Insecure attachment; Physical symptom; Psychological well-being

## INTRODUCTION

Subjective well-being (SWB) homeostasis theory is considered as a leading theory to explain the association between mental health and physical health [1]. According to the theory, SWB homeopathies is to maintain a normally positive sense of wellbeing [2], and to make individuals maintain a sense of psychological well-being even if they have physical

### Conflict of Interest

The authors declare that they have no competing interests.

or psychological abnormality [3]. Among the psychological factors, depression and anxiety exerted a negative impact on well-being [4], but optimism gave a positive effect on that [5]. However, measuring well-being by the psychological factors is more different than that by the physical factors [6]. It has been reported that the degree of depression can be increased by physical diseases and symptoms [7-14]. In particular, chronic physical pain increases depressive symptoms [15,16], and perceived physical symptoms that occur in the elderly [17]. It may indicate that the occurrence of physical symptoms can affect depression-mediated psychological well-being. In addition, insecure attachment negatively affects depression [18,19] and well-being [20], but secure attachment contributes to the well-being [3]. Thus, the insecure attachment might affect depression which can also affect psychological well-being.

Previous studies reported the relationship between obesity and depression [21,22]. Obesity exerts a negative impact on self-esteem and interpersonal relationships as well as depression [22]. Blaine [21] reported that depressed female adolescents had a higher risk of being overweight by overeating to eliminate the negative emotions. Katsaiti [23] also showed the negative impact of overweight on SWB. However, according to the SWB homeostasis theory, the level of well-being can be stably maintained, unless obesity status reaches the level which worsens the well-being status [1]. Cummins et al. [1] reported that well-being status was stably maintained before body mass index (BMI) reached 35 kg/m<sup>2</sup>, that is, people in severe obesity (BMI ≥ 35 kg/m<sup>2</sup>) showed significantly lower well-being status than those in normal weight or mild obesity (BMI ≤ 35 kg/m<sup>2</sup>). In fact, the cutoff point to define obesity used in Korea followed the Asian-Pacific guideline which indicates a BMI of 25 [24,25]. This is lower than that used in the United States and Europe (BMI of 30) [26,27].

Based on the SWB homeostasis theory and previous research results, therefore, this study aimed to investigate the association effect of obesity status, physical symptom, insecure attachment, and depression on psychological well-being in non-diabetic healthy Koreans.

## MATERIALS AND METHODS

### Subject recruitment and study design

Study subjects were recruited from the public advertisement among those who are living in Busan, Korea. Data collection was carried out from July 2015 to March 2016. Exclusion criteria were diagnosis of vascular, renal, liver, or thyroid disease, acute or chronic inflammatory diseases, diabetes, cancer (diagnosed clinically or by anamnesis), orthopedic limitations, and weight loss/gain over the previous 6 months. None of the participants was taking antihypertensives, antidyslipidemics, antithrombotics, or antidiabetic medications. The 175 individuals who met the criteria agreed to participate and signed the participation consent form. The written informed consent was obtained from all the participants, and the study was approved by the Institutional Review Board of Dong-A University (2-104709-AB-N-01-201505-BR-005-03). Among the participants, the cases with missing data from questionnaires (n = 45) or those with BMI less than 18 (n = 7) were excluded. Finally, 123 subjects were enrolled in the analysis and subdivided into 2 groups according to their BMI level: non-obesity (BMI < 25 kg/m<sup>2</sup>) and obesity (BMI ≥ 25 kg/m<sup>2</sup>).

### Anthropometric parameters and blood pressure (BP)

Body weight and height were measured in the morning, with participants lightly clothed and without shoes. Body weight was measured using a TBF-105 body fat analyzer (Tanita

Corp., Tokyo, Japan), and standing height was measured with a wall stadiometer. BMI ( $\text{kg}/\text{m}^2$ ) was calculated as body weight divided by height in square meters. Waist circumference was measured at the umbilical level in standing participants after normal expiration. BP was measured at seated patients' arms after a rest for 20 minutes, using an automatic BP monitor (HEM-7220; Omron, Matsusaka, Japan).

### Surveys

#### 1) Insecure attachment

Insecure attachment was measured using a tool developed by Hazan and Shaver [28]. It consists of 3 questions to ask what extent that secure, anxious, and avoidant attachment style are in the respondents. Questions for anxious and avoidant attachments represents the insecure attachment. The 7-point Likert scale was used in this study: from a 'very severe' of 7 to a 'no' of 1. A higher score represents a severe degree of attachment insecurity. The reliability of insecure attachment in this study was relatively low, with Cronbach's  $\alpha = 0.56$ .

#### 2) Physical symptom

Physical symptoms were measured using the subjective perception of physical symptom [29] consisting of 11 questions which were divided into 4 sub-factors of headaches, digestive disorders, insomnia, and heart disease symptoms. In this study, we used a total score of physical symptom. The 5-point Likert scale was used in this study: from a 'very severe' of 5 to a 'no' of 1. A higher score represents the subjective perception of severe physical symptoms. The reliability of the tools in this study appeared to Cronbach's  $\alpha = 0.81$ .

#### 3) Depression

Depression was measured with a Korean version of Randloff's Center for Epidemiological Studies-Depression (CES-D) scale [30]. A total of 20 items were divided into 4 sub-factors, as a result of the factor analysis in the study of Chon et al. [31], but a total score of CES-D was used in this study. The 3-point scale was used in this study: from a 'rarely or none of the time (less than 1 day in a week)' of 0 to a 'most or all of the time (5–7 days in a week)' of 3. A higher score represents severe depression. The reliability of the tools in this study appeared to be Cronbach's  $\alpha = 0.88$ .

#### 4) Psychological well-being

Well-being was measured using a tool of Ji and Yoo [32] modified from the 4 sub-factors of 24 questions developed by Yang [33], the 4 sub-factors of 20 questions which were based on the Waterman's standard version of the Personally Expressive Activities Questionnaire (PEAQ-S) [34], Ryff's psychological well-being scale [35], Csikszentimihalyi's flow theory [36], and Sachs' phenomenon of Runner's high [37]. The 5-point Likert scale was used in this study, and a higher score represents a very good psychological well-being. In this study, we put a score for each of the 4 sub-factors as observed endogenous variables. The reliability of well-being score in this study appeared to Cronbach's  $\alpha = 0.91$ . Prior to the multi-group comparison, confirmatory factor analysis was conducted to test whether the well-being scale worked the same for the 2 groups. The results of confirmatory factor analysis are as follows: delta  $\chi^2$  score is 5.785 (degrees of freedom [df] = 3;  $\alpha = 0.05$ ) between unconstrained model ( $\chi^2 = 2.206$ ; df = 4) and measurement weights model ( $\chi^2 = 7.991$ ; df = 7), the score is under the critical level ( $\chi^2 = 7.815$ ; df = 3;  $\alpha = 0.05$ ). In addition, delta  $\chi^2$  score is 6.537 (df = 4;  $\alpha = 0.05$ ) between unconstrained and structural covariance model ( $\chi^2 = 8.743$ ; df = 8), and the score is under the critical level ( $\chi^2 = 9.488$ ; df = 4;  $\alpha = 0.05$ ). Thus, the well-being measure was confirmed as the same measure in the obesity group and the non-obesity group.

### Data analysis

Data was analyzed using in R 3.2.4 software (R Core Team, Vienna, Austria; <https://www.R-project.org>) and SPSS AMOS 23.0 software (IBM Corp., Armonk, NY, USA). The t-test and  $\chi^2$  test between obesity group and non-obesity group and age and sex-adjusted correlation analysis (partial correlation analysis) were conducted by R program. Descriptive results are expressed as the mean  $\pm$  standard errors or percentage. Mediation analysis was performed by AMOS program. First, we compared the statistics of model fit between models of all participants and the multiple-group (obesity and non-obesity). Next, we determined the regression coefficient, and p value for comparing the pattern structure of the research model in obese and non-obese subjects. Finally, we tested the direct and indirect effects of research model. The  $\chi^2$  score that increases from between-group constraints and squared multiple correlations (SMC) of dependent variables were also identified. Verifying significances of the effects were analyzed by Bootstrapping (B = 1,000, 95% confidence interval [CI], maximum likelihood method). A p value < 0.05 was considered statistically significant.

## RESULTS

### General characteristics

**Table 1** presents general characteristics of the participants according to obesity status. Obese people were older and heavier, and had higher proportion of men than non-obese people. These 2 groups also showed significant differences in the values of socio-psychological test: obese people showed lower insecure attachment and higher physical symptom than non-obese ones did. On the other hand, the scores of depression and psychological well-being were not significantly different between the 2 groups.

### Relationship among psychological parameters according to obesity status

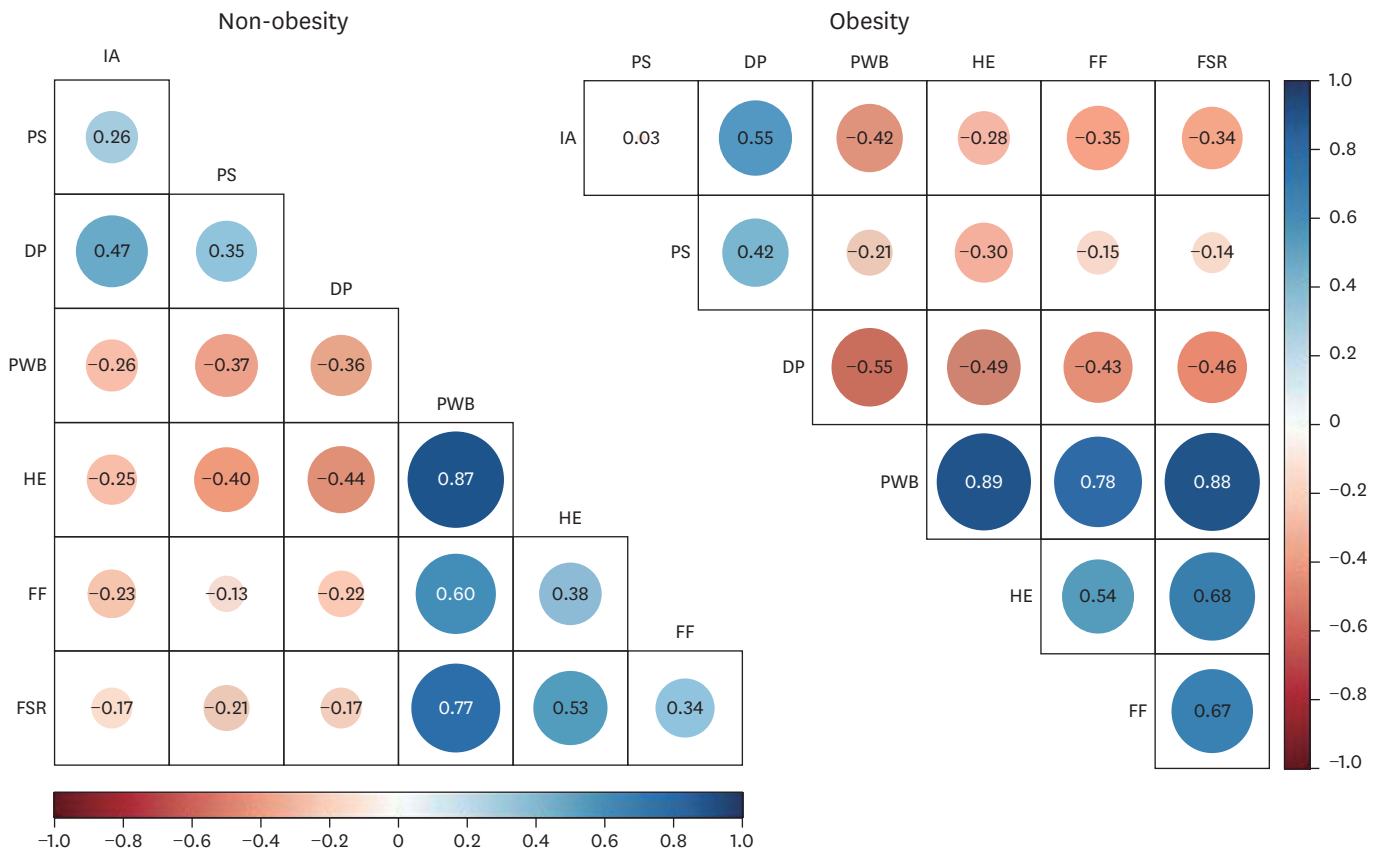
Correlation analysis shows the relationship among psychological parameters according to obesity status (**Figure 1**). Depression was positively related to insecure attachment (BMI < 25:  $r = 0.47$ ,  $p < 0.001$ ; BMI  $\geq 25$ :  $r = 0.55$ ,  $p < 0.001$ , respectively) and physical symptom (BMI < 25:  $r = 0.35$ ,  $p = 0.010$ ; BMI  $\geq 25$ :  $r = 0.42$ ,  $p = 0.010$ , respectively) in both BMI groups. In addition, both depression (BMI < 25:  $r = -0.36$ ,  $p = 0.010$ ; BMI  $\geq 25$ :  $r = -0.55$ ,  $p = 0.010$ , respectively) and insecure attachment (BMI < 25:  $r = -0.26$ ,  $p = 0.020$ ; BMI  $\geq 25$ :  $r = -0.42$ ,  $p = 0.010$ , respectively) were negatively related to psychological well-being in both obesity and non-obesity groups.

**Table 1.** General characteristics and psychological parameters according to obesity status

Characteristic	Non-obesity (BMI < 25 kg/m <sup>2</sup> ; n = 87)	Obesity (BMI $\geq 25$ kg/m <sup>2</sup> ; n = 36)	p value
Age, yr	39.50 $\pm$ 1.42	45.50 $\pm$ 2.06	0.023
Male	8 (9.0)	11 (30.6)	0.005
BMI, kg/m <sup>2</sup>	21.80 $\pm$ 0.17	27.50 $\pm$ 0.35	< 0.001
Weight, kg	57.00 $\pm$ 0.69	73.50 $\pm$ 1.87	< 0.001
Waist, cm	78.80 $\pm$ 0.63	93.30 $\pm$ 1.22	< 0.001
Systolic BP, mmHg	118.00 $\pm$ 1.50	126.30 $\pm$ 2.75	0.005
Diastolic BP, mmHg	74.70 $\pm$ 1.06	81.60 $\pm$ 1.74	0.001
Socio-psychological parameters			
Insecure attachment	4.81 $\pm$ 0.23	3.93 $\pm$ 0.35	0.041
Physical symptom	17.40 $\pm$ 0.50	20.00 $\pm$ 1.11	0.016
Depression	12.70 $\pm$ 0.76	12.70 $\pm$ 1.38	0.994
Psychological well-being	66.80 $\pm$ 0.98	68.20 $\pm$ 1.77	0.441

Data are shown as mean  $\pm$  standard error or number (%); performed by independent t-test, or  $\chi^2$  method.

BMI, body mass index; BP, blood pressure.



**Figure 1.** Relationships among psychological parameters according to obesity status. Tested by Pearson correlation analysis; circle sizes are in proportion to the correlation coefficient values; red color indicates negative correlation and blue color indicates positive relationship between the 2 values. The HE, FF, and FSR are the subs of PWB. IA, insecure attachment; PS, physical symptom; DP, depression; PWB, psychological well-being; HE, hedonic enjoyment; FF, feeling of flow; FSR, feeling of self-realization.

However, physical symptom was negatively associated with psychological well-being ( $r = -0.37$ ,  $p < 0.001$ ) and positively with insecure attachment ( $r = 0.26$ ,  $p = 0.010$ ) only in non-obesity group, but not in obesity group ( $r = -0.21$ ,  $p = 0.220$ ;  $r = 0.03$ ,  $p = 0.850$ , respectively). The significances were maintained after adjusted for age and sex.

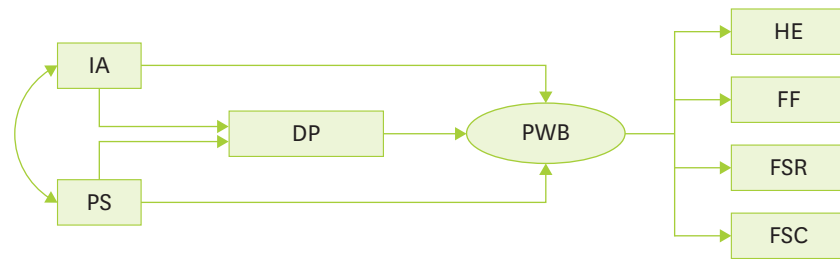
### Multi-group structural equation modeling

#### 1) Model fit

Age and sex adjusted model (**Figure 2**) for the all participations revealed a good fit to the data:  $\chi^2$  ( $df = 17$ ) = 20.48 ( $\chi^2/df = 1.21$ ); comparative fit index (CFI) = 0.99; root mean square error of approximation (RMSEA) = 0.04, suggesting that the paths were moderate for the model fit. The multiple group models according to BMI level was also a good fit to the data:  $\chi^2$  ( $df = 34$ ) = 41.77 ( $\chi^2/df = 1.23$ ); CFI = 0.98; RMSEA = 0.04, indicating that these paths were moderate model fit.

#### 2) Mediating effect of depression on the association between physical symptom, insecure attachment, and psychological well-being according to obesity status

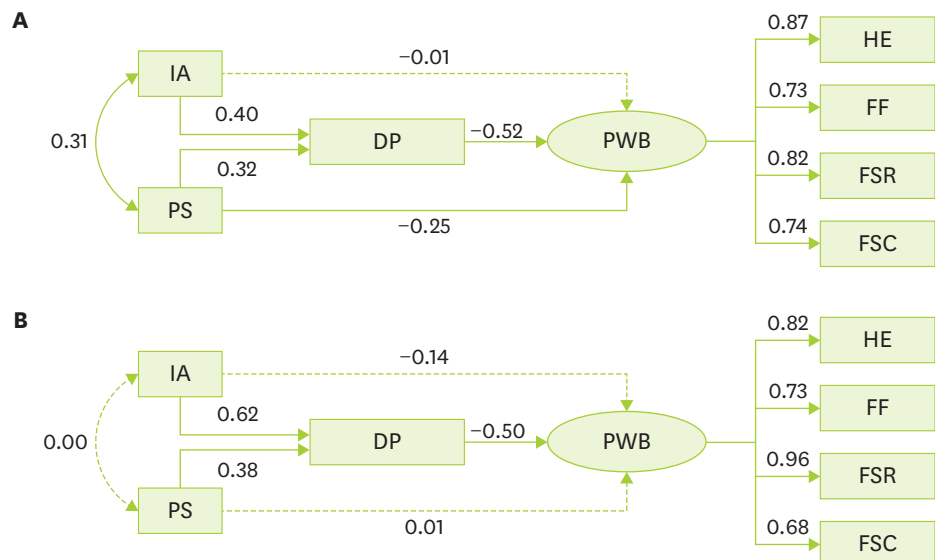
**Figure 3** present the association among physical symptom, insecure attachment, and depression on psychological well-being according to the BMI groups, and **Table 2** presents the direct, indirect and total effects on psychological well-being by bootstrapping test ( $B = 1,000$ , 95% CI, maximum likelihood method). In non-obesity group (**Figure 3A**), 4 of the



**Figure 2.** Model fit.

IA, insecure attachment; PS, physical symptom; DP, depression; PWB, psychological well-being; HE, hedonic enjoyment; FF, feeling of flow; FSR, feeling of self-realization; FSC, feeling of self-confidence.

hypothesized direct effects were significant. Depression was positively related to the insecure attachment (standardized  $\beta = 0.40$ ;  $p = 0.002$ ) and physical symptom ( $\beta = 0.32$ ;  $p = 0.004$ ). Psychological well-being was negatively associated with depression ( $\beta = -0.52$ ;  $p = 0.002$ ) and physical symptom ( $\beta = -0.25$ ;  $p = 0.034$ ), but not associated with insecure attachment ( $\beta = -0.01$ ;  $p = 0.994$ ). In obesity group (BMI  $\geq 25$ , **Figure 3B**), 3 of the hypothesized direct effects were significant. Depression was positively related to insecure attachment ( $\beta = 0.62$ ;  $p = 0.002$ ) and physical symptom ( $\beta = 0.38$ ;  $p = 0.002$ ). Psychological well-being was negatively associated with depression ( $\beta = -0.50$ ;  $p = 0.010$ ), but not associated with physical symptom ( $\beta = 0.01$ ;  $p = 0.960$ ) and insecure attachment ( $\beta = -0.14$ ;  $p = 0.410$ ). Interestingly, physical symptom was associated with psychological well-being in non-obesity group, but not in obesity group. The effect of insecure attachment on psychological well-being was completely mediated by depression in both BMI groups (**Table 2**). On the other hand, the effect of physical symptom on psychological well-being was completely mediated by depression in obesity group, but not in non-obesity group. Both non-obesity group and obesity group



**Figure 3.** Multi-path pattern of the association among physical symptom, insecure attachment and depression on psychological well-being according to the BMI groups. (A) Pattern for non-obesity group (BMI < 25 kg/m²), (B) Pattern for obesity group (BMI  $\geq 25$  kg/m²); the number indicates standardized  $\beta$  value. The model was adjusted for age and sex. Solid line indicates significant relationship between the 2 parameters. Dotted line indicates no significant relationship between the 2 parameters.

BMI, body mass index; IA, insecure attachment; PS, physical symptom; DP, depression; PWB, psychological well-being; HE, hedonic enjoyment; FF, feeling of flow; FSR, feeling of self-realization; FSC, feeling of self-confidence.



**Table 2.** Direct and indirect effects on psychological well-being according to obesity status

Path	Non-obesity (BMI < 25 kg/m <sup>2</sup> )				Obesity (BMI ≥ 25 kg/m <sup>2</sup> )				CRD	$\Delta\chi^2$ (df)
	Direct effects	Indirect effects	Total effects	SMC <sup>†</sup>	Direct effects	Indirect effects	Total effects	SMC <sup>†</sup>		
IA → DP	1.35 (0.40) <sup>†</sup>		1.35 (0.40) <sup>†</sup>	0.35	2.41 (0.62) <sup>†</sup>		2.41 (0.62) <sup>†</sup>	0.52	1.87	3.19 (1)
PS → DP	0.49 (0.32) <sup>†</sup>		0.49 (0.32) <sup>†</sup>		0.47 (0.38) <sup>†</sup>		0.47 (0.38) <sup>†</sup>		-0.11	0.05 (1)
DP → PWB	-0.28 (-0.52) <sup>†</sup>		-0.28 (-0.52) <sup>†</sup>		-0.25 (-0.50) <sup>*</sup>		-0.25 (-0.50) <sup>*</sup>		0.26	0.00 (1)
IA → PWB	-0.01 (-0.01)		-0.39 (-0.21) <sup>*</sup>	0.47	-0.28 (-0.14)		-0.88 (-0.45) <sup>†</sup>	0.57	-0.71	0.94 (1)
IA → PWB		-0.37 (-0.21) <sup>†</sup>				-0.60 (-0.31) <sup>*</sup>				3.19 (2)
PS → PWB	-0.21 (-0.25) <sup>*</sup>		-0.34 (-0.41) <sup>†</sup>		0.01 (0.01)		-0.11 (-0.17)		1.76	3.36 (1)
PS → PWB		-0.14 (-0.16) <sup>†</sup>				-0.12 (-0.19) <sup>*</sup>				0.05 (2)

 Unstandardized B (standardized  $\beta$ ), tested by bootstrapping (B = 1,000, 95% CI, maximum likelihood method).

 BMI, body mass index; CRD, critical ratios for differences between parameters; df, degrees of freedom; DP, depression; IA, insecure attachment; PS, physical symptom; PWB, psychological well-being; SMC, squared multiple correlations;  $\Delta\chi^2$ , increase from between-group constraints, critical CRD ≥ 1.97, critical  $\chi^2$  (1) ≥ 3.84,  $\chi^2$  (2) ≥ 5.99; CI, confidence interval.

<sup>\*</sup>p < 0.050; <sup>†</sup>p < 0.010.

showed similar indirect effects. Interestingly, the estimate of SMC showed the predictors of psychological well-being explain 47% of its variance in the partial mediation model for non-obesity group, but explained 57% in the full mediation model for obesity group.

## DISCUSSION

The purpose of this study was to investigate the association effect of obesity status, physical symptom, insecure attachment, and depression on psychological well-being in non-diabetic healthy Koreans through multi-path analysis. We found that the associations were significantly different according to obesity status. The effect of insecure attachment on psychological well-being was completely mediated by depression in both BMI groups. On the other hand, the effect of physical symptom on psychological well-being was completely mediated by depression only in the obese people. This result will provide useful data for extending the knowledge on the relationship between the physical health and mental health.

As mentioned above, depression is one of main psychological factors which negatively affect well-being status [4]. On the other hand, physical symptoms and insecure attachment were reported to increase depressive symptom [7-14,17-19], thereby affecting psychological well-being [20]. These are partly in accordance with our results. In our study, insecure attachment and physical symptom were positively correlated with depression which was negatively related to psychological well-being. On the other hand, we found different path pattern for the association among the parameters on psychological well-being according to obesity status. Both insecure attachment and physical symptom were not directly associated with psychological well-being, but completely mediated by depression in obesity group. The relationship between insecure attachment and psychological well-being was also similarly observed in non-obesity group. It may indicate that depression is strongly associated with psychological well-being.

However, the relationship between physical symptom and psychological well-being was not only directly observed, but also mediated by depression in non-obesity group, even though the  $\beta$  coefficient for the direct effect of physical symptom on psychological well-being ( $\beta$  = -0.25) was smaller than that for the depression mediated effect (indirect effect) ( $\beta$  = -0.16) and total effects ( $\beta$  = -0.41). It may be partly supported by the SWB homeostasis theory and several previous reports which demonstrated that well-being status can be stably maintained before the degree of obesity reaches the level which worsens the well-being status [1,21,22].

According to the report by Cummins et al. [1], well-being status was not worsen until the BMI reached the level of severe obesity (i.e., BMI  $\geq 35$  kg/m<sup>2</sup>), and stably maintained when the BMI was in normal weight or mild obesity.

Our study has a limitation that the number of study population was relatively small although the values reached statistical significances. Despite the limitation, this study demonstrated that the effects of physical symptom and insecure attachment on psychological well-being were completely mediated by depression in obese people, but not in non-obese ones. In addition, this study indicates that physical symptom may not directly affect psychological well-being if the symptom were not severe status, and shows that psychological factors such as insecure attachment and depression are much stronger factors affecting psychological well-being than physical factors such as physical symptom are.

## CONCLUSION

These results might support the SWB theory. Furthermore, this study may suggest that obese people are more susceptible to the psychological factors than non-obese people, that is, psychological intervention in obese people is needed together with physical intervention for mental health promotion. Taken together, this study will provide useful data for extending the knowledge on the relationship between the physical health and mental health.

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