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Associations among Hypertension, Depression and Obesity in a Sample of the U.S. Adults

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Abstract Although there have been studies showing the determinants of obesity, there have been relatively little attention paid to other factors such as mental health disorders like depression and chronic illnesses like hypertension. In addition, there exists a controversy over the association between hypertension and depression. Thus, we have investigated the associations among hypertension, depression, and obesity by adjusting age, gender, race, and socioeconomic status. The data was from the 2011 National Health and Nutrition Examination Surveys (NHANES). This survey is conducted every year and in particular the data involves approximately 5,000 individuals of all ages in the United States, who completed the health examination component of the survey. We have utilized a logistic regression analysis to examine how hypertension, depression and obesity are associated one another. We have also used a proportional odds model to test how hypertension and depression may affect obesity. The main findings from the results of study are the following: first, being obese and feeling down, depressed or hopeless were associated with an increased likelihood of having hypertension and second, hypertension and depression may positively affect obesity. The findings suggest that as the determinants of obesity, depression and hypertension should be timely diagnosed and treated properly for considering the associations one another. By doing so, it can provide with the overall cost-savings and more importantly, people's health.

Keywords: *obesity, hypertension, depression, association, odds ratio, chronic illness, mental health illness, NHANES*

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1. Introduction

Hypertension (high blood pressure) is a major risk factor for heart disease and stroke, which are the leading causes of death for Americans (Gillespie et al. 2011). According to Centers for Disease Control and Prevention, about 30% of the U.S. adults have high blood pressure but only approximately half (52%) of them have their hypertension under control. It is also reported that about 9.5% of the U.S. adults suffer from a depressive illness and in which depression is known as the most prevalent mental health problem among the older adults in the U.S.

The prevalence of obesity in the U.S. is very high and is becoming a big concern in public health. Approximately 34.9% of U.S. adults (78.6 million) are obese, which shows that more than half of them are obese (Ogden et al. 2013).From forecasted results of obesity, the entire U.S. population obesity rates can increase by the year 2230 if the current trends of obesity persist (ME Dı´az 2002). According to CDC, obesity is reported as a health risk factor since it is related to certain conditions such as heart disease, stroke, type 2 diabetes and certain types of cancer, some of the leading causes of preventable death. In addition, if the level of obesity becomes more extreme, it can also cause the increase of medical expenditures, the loss of productivity and even premature mortality (Quesenberry 1998; Thompson et al. 2001; Finkelstein et al. 2003; Andreyeva et al. 2004).

Although there have been studies of identifying determinants of obesity, there has been relatively little attention paid to other factors such as mental health disorders and chronic illnesses such as depression and hypertension. The relationship between hypertension and obesity, the majority people who had hypertension (74.4%)also had a higher Body Mass Index greater than 25 kg/m (ME Dı´az 2002) which is identified as overweight or possibly obese. Overweight people were more likely to have hypertension compared with normal weight people as odds ratio of 1.7 (Nguyen et al. 2008).

Now looking towards the relationship between depression and obesity, depression has been found to be associated with the increased risk of being obese (de Wit et al. 2010; Pine et al. 2001). Carpenter et al. (2000) also found a strong association between them, but the change of body weight was different between women and men. That is, BMI increased for women who had major depression and suicide ideation; however, BMI was lower for men who had the same kind of major depression, suicide attempts, and suicide ideation. Meanwhile, Luppino et al. (2010) tried to provide the exact

mechanisms connecting depression and obesity with a meta-analysis approach.

In the meantime, there are disputing researches over the association between hypertension and depression. Grimsrud et al. (2009) found that hypertension was more common among people who had mental health disorders such as depression and anxiety than people who did not have. However, ScalcoI et al. (2005) found that depression could negatively affect the course of hypertensive illness. On the other hand, Wiehe et al. (2006) found that there was no association between hypertension and depression after adjusting confounding variables.

Although the previous literature discussed bidirectional associations among hypertension, depression and obesity, currently there have been no studies that find and mention the association among hypertension, depression and obesity all together; in particular, there are still disputes over the association between hypertension and depression. Thus, in this paper we have examined the associations among hypertension, depression, and obesity by adjusting age, gender, race, and socioeconomic status.

2. Methods

2.1. Data

The data is from the 2011 National Health and Nutrition Examination Surveys (NHANES). NHANES is a major program of the National Center for Health Statistics (NCHS) which is part of the Centers for Disease Control and Prevention (CDC). The survey is conducted on every year and involves approximately 5,000 individuals of all ages in the United States, who completed the health examination component of the survey. The population in the data consists of the Hispanic, the non-Hispanic black, and the non-Hispanic white. Among this population, 161 (2.8%) were excluded due to missing weight or height, which caused a final sample size of 5454.

2.2. Measures

'Weight group' was created as a categorical variable which consists of the underweight, the average weight and the obese. Body Mass Index (BMI) is a number calculated from an individual's weight and height and thus provides with the information of body fatness of the person. People with BMI of 30 or more are defined as the obese. People with BMI of 20.77 or below are categorized as the underweight and people with BMI between 20.78 and 29.99 are defined as the average weight.

'Obesity' was also created as a binary variable indicating whether an individual was obese or not. If a person was obese, obesity was equal to '1'. If an individual was not obese, then obesity was equal to '0'.

'Hypertension' was treated as a binomial variable. From the question 'Ever been told by a doctor or other health professionals that you have high blood pressure or borderline hypertension', we grouped participants into the two who answered 'Yes' and 'No', respectively.

'Feeling down, depressed or hopeless' (*'depressed'*)was treated as either a categorical variable with an ordering or a binary variable. From the question 'Are you feeling down, depressed, hopeless', we grouped participants into the four such as 'feeling down, depressed or hopeless not at all', 'feeling down, depressed or hopeless for several days', 'feeling down, depressed or hopeless more than half the days', and 'feeling down, depressed or hopeless nearly every day'. As a binary variable, we grouped participants into the two who felt down, depressed or hopeless and who did not as 'Yes' and 'No', respectively.

'Thought you would be better off dead'(*'thtdead'*)was also treated as either a categorical variable with an ordering or a binary variable. From the question 'Have you thought you would be better off dead', we grouped participants into the four such as 'thought you would be better off dead not at all', 'thought you would be better off dead for several days', 'thought you would be better off dead more than half the days', and 'thought you would be better off dead nearly every day'. As a binary variable, we grouped participants into the two who thought you would be better off dead and who did not as 'Yes' and 'No', respectively.

'Covariates' Demographic and socioeconomic variables were also included. *'Age'* was treated as a continuous variable and was included in the both of males and females aged from 16 to 80 years old. *'Sex'* meant '1' for men and '0' for women as a binomial variable. *'Race'* was treated as a multinomial variable and we grouped participants into the three such as 'the Hispanic (including the Mexican American)', the non-Hispanic black (or the black), and the non-Hispanic white (or the white).*'Education'* was treated as a multinomial variable and we grouped participants into the four such as 'less than 9th grade', 'high school graduate/GED or equivalent', 'some college or AA degree', and 'college graduate or above'. *'Family monthly poverty level index* (an index for the ratio of monthly income to poverty)' was also included and was calculated by dividing family income by the poverty guidelines specific to family size as well as the appropriate year and state (National Center for Health Statistics). It consists of the three categories such as 'monthly poverty level index <= 1.30', '1.30 < monthly poverty level index <= 1.85', 'monthly poverty level index > 1.85'.

3. Results

R version 3.1.2. was used for all statistical analyses.

As our first question, how are hypertension, depression and obesity associated one another? Consider '*Hypertension*' as an outcome and dependent variable. '*Hypertension*' is a dichotomous, binomial variable indicating whether an individual has hypertension or not, using a logistic regression, we determine the relationship. Suppose 'Logit$\{\pi(x)\}= \beta_0 + \beta_1 x$', then $\pi(x)$ is the probability of having hypertension, and thus logit$\{\pi(x)\}$ refers to the log odds of having hypertension, which is our outcome, dependent variable. Thus, my model would be the following:

$$\text{Logit}\{\pi(x)\}=\alpha_0 + \alpha_1 \textit{Weight group} + \alpha_2 X + \alpha_3 \textit{Sex*Age} + \alpha_4 Z$$

X refers to 'Feeling down, depressed, or hopeless' and 'Thought you would be better off dead', which consist of the models 1 and 2, respectively. *'Sex by Age'* is an interaction term and it estimates that as an individual's age

increases, how the log odds of having hypertension is different between men and women. *Z* refers to covariates such as age, gender, race, and socioeconomic status variables such as education and family monthly poverty level index. From the models 1 and 2,weinvestigated how hypertension was associated with obesity and depression by adjusting gender, age, race and socioeconomic status.

In Table 1, when looking at the underweight versus the obese individuals, the log odds of hypertension were increased by .69 (p<.001) and .7 (p<.001), respectively. In addition, looking at the underweight versus the average weight individuals, the log odds of hypertension were increased by .24 (p<.05).

For depression, compared with an individual who did not feel depressed at all, when a person felt depressed more often, then the log odds of having hypertension were higher by .2 (p=.07) ('several days'), .46(p=.02) ('more than half the days'), and .57 (p=.01) ('nearly every day'). In addition, compared with an individual who did not think he or she would be better off dead at all, when a person thought he or she would be better off dead for several days, then the log odds of having hypertension were higher by .64 (p=.01). In terms of 'more than half the days' and 'nearly every day', the results were not either consistent or significant.

Regarding covariates, men are more likely to have the higher log odds of having hypertension by .63 (p<.05) compared with women. One year increase in age was related to the higher log odds of having hypertension by .03 (p<.001) and .04 (p<.001). However, the interaction 'sex by age' did not show significant results. Compared with the black, the Hispanic are more likely to have the lower log odds of having hypertension by .52 (p<.001) and .6 (p<.001). Also, the white are more likely to have the lower log odds of having hypertension by .47 (p<.001) and .32 (p<.01) compared with the black. For education, when a person's education level was higher 'some college or AA degree', then the log odds of having hypertension were higher by .46 (p<.05) and .44 (p<.05). However, for other education levels, they did not show significance. Although this result might show a different intuition, there were studies showing that education level was inversely associated with blood pressure (Dyer et al. 1976 and Tedesco et al. 2001). Meanwhile, compared with a person who was less poor (family monthly poverty level index (X) <= 1.3), when an individual was poorer (X > 1.85), the log odds of having hypertension were higher by .21 (p<.05).

Figure 1 also shows correlations among obesity, depression and hypertension.

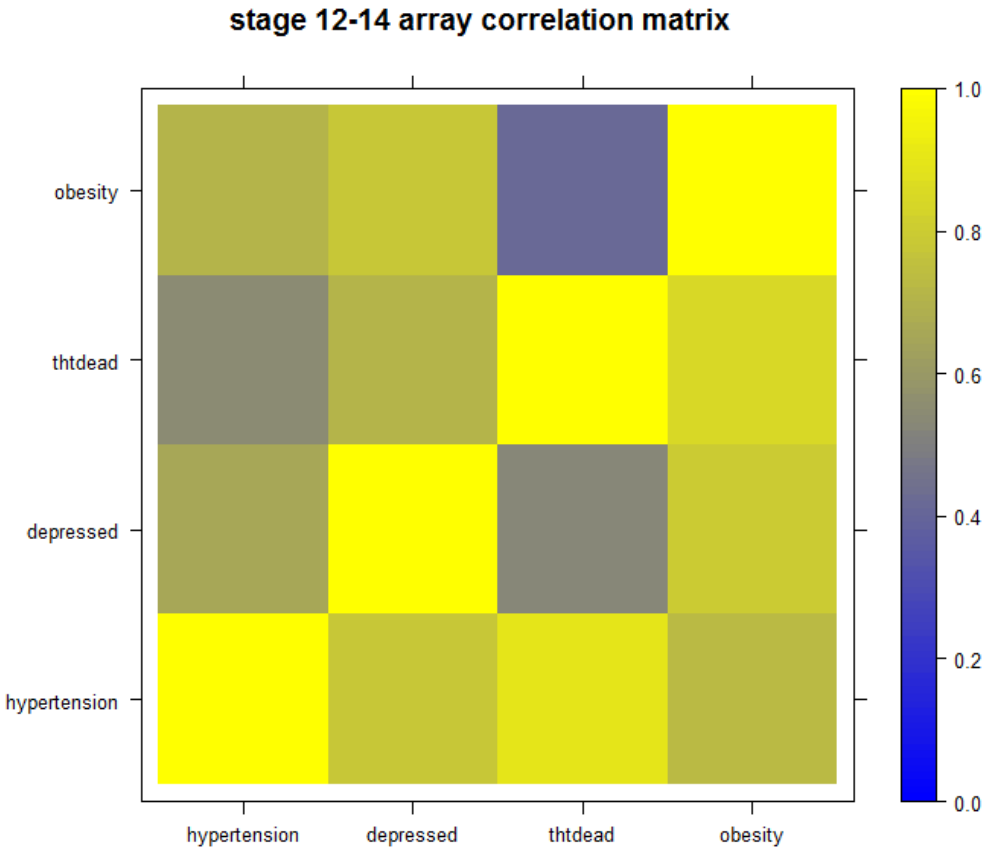

Figure 1. Correlations among obesity, depression and hypertension

To interpret the results in Table 1 more conveniently, odds ratios have been provided in Table 2. Compared with the underweight, the average weight were associated with 1.28 and 1.27 fold increased likelihoods of having hypertension and the obese were related to2and 2.01 fold increased likelihoods of having hypertension. Compared with an individual who did not feel depressed at all, a person who felt depressed for 'several days', 'more than half the days' and 'nearly everyday' were related to1.23, 1.59 and 1.77 fold increased likelihoods of having hypertension, respectively. In addition, compared with an individual who did not think he or she would be better off dead at all, a person who thought he or she would be better off dead for 'several days' and 'nearly everyday' were associated with 1.9and 1.09 fold increased likelihoods of having hypertension, respectively. However, for 'more than half the days', it showed a different result (.57).

Table 1. Explaining Hypertension from Predictors Obesity and Depression with Other Factors

Dependent Variable : Hypertension[a]	Logistic Regressions	
Independent Variables/Predictors	**Model 1**	**Model 2**
Weight group[b]	.247*	.245*
Underweight	(.11)	(.109)
Average weight		
Obese	.693***	.702***
	(.111)	(.111)
Sex	.631*	.561
Male	(.312)	(.309)
Female		
Age	.04***	.039***
	(.004)	(.004)
Sex by Age	-.007	-.006
	(.005)	(.005)
Race[c]	-.526***	-.603***
Hispanic	(.113)	(.135)
Black	-.47***	-.32**
White	(.092)	(.099)
Feeling down, depressed, or hopeless[d]	.208	
Not at all	(.118)	
Several days	.466*	
More than half the days	(.21)	
Nearly every day	.57**	
	(.212)	
Thought you would be better off dead[e]		.645*
Not at all		(.252)
Several days		-.55
More than half the days		(.624)
Nearly every day		.091
		(.515)
Education[f]	-.059	-.062
Less than 9th grade	(.206)	(.206)
9-11th grade	.261	.241
High school graduate/GED or equivalent	(.191)	(.191)
Some college or AA degree	.469*	.448*
College graduate or above	(.189)	(.189)
	.296	.263
	(.202)	(.202)
Family monthly poverty level index (X)[g]	-.101	-.115
X <= 1.30	(.146)	(.146)
1.30 <X <= 1.85	.211*	.173
X > 1.85	(.105)	(.104)

Note. a. As an outcome/dependent variable, it shows whether a person had hypertension or not.
b. As a predictor/independent variable, it consists of three categories and the reference level is 'underweight'.
c. The black is the reference level.
d. Feeling down, depressed or hopeless for Not at all is the reference level.
e. Thought you would be better off dead for Not at all is the reference level.
f. Less than 9th grade is the reference level.
g. Monthly poverty level <= 1.30 is the reference level.
***, **, * denote significance at the 0.1%, 1% , 5% level, respectively

Table 2. Odds Ratio for Hypertension with Obesity and Depression

Outcome Variable : Hypertension	Model 1	Model 2
Predictors	**OR (95% CI)[a]**	**OR (95% CI)[a]**
Weight group[b]		
Underweight	1.28 (1.03, 1.59)	1.27 (1.03, 1.58)
Average weight	2 (1.6, 2.49)	2.01 (1.62, 2.51)
Obese		
Feeling down, depressed, or hopeless[c]		
Not at all	1.23 (.97, 1.55)	
Several days	1.59 (1.04, 2.38)	
More than half the days	1.77 (1.15, 2.66)	
Nearly every day		
Thought you would be better off dead[d]		
Not at all		1.9 (1.14, 3.09)
Several days		.57 (.13, 1.69)
More than half the days		1.09 (.35, 2.79)
Nearly every day		

Note. a. OR=Odds ratio; 95% CI=95% confidence level. All ORs are adjusted for sex, age, race, education, and family monthly poverty level.
b. The reference level is 'underweight'.
c. Feeling down, depressed or hopeless for Not at all is the reference level.
d. Thought you would be better off dead for Not at all is the reference level.

Next, as our second question, how may hypertension and depression affect obesity? Then, the outcome and dependent variable would be '*Obesity*' indicating whether an individual was obese ('1') or not ('0'). Since the outcome variable is a dichotomous, binary one, a logistic regression was also used as the following:

Logit$\{\pi(x)\}=\alpha_0 + \alpha_1 Hypertension + \alpha_2 X + \alpha_3 Sex*Age + \alpha_4 Z$

X refers to 'Feeling down, depressed, or hopeless' and 'Thought you would be better off dead', which consist of the models 3 and 4, respectively. '*Sex by Age*' is an interaction term showing how the log odds of being obese is different between men and women as their age increases. *Z* refers to covariates such as age, sex, race, and socioeconomic status variables such as education and family monthly poverty level index. From the models 3 and 4, we examined how hypertension and depression may affect obesity by adjusting gender, age, race and socioeconomic status.

Table 3 shows some results. When an individual did not have hypertension, the log odds of being obese were decreased by .53 (p<.001) and .55 (p<.001), respectively. This implies that hypertension may positively affect obesity. For depression, compared with an individual who did not feel depressed at all, when a person felt depressed more often, the log odds of being obese were higher by .37 (p<.001) ('several days'), .39 (p=.05) ('more than half the days'), and .47 (p=.01) ('nearly every day'). For 'Thought you would be better off dead', however, the results did not show significance.

Table 3. Explaining Obesity fromPredictors Hypertension and Depression with Other Factors

Dependent Variable :Obesity[a]	**Logistic Regressions**	
Independent Variables/Predictors	**Model 3**	**Model 4**
Hypertension[b]		
Yes	-.536***	-.552***
No	(.094)	(.093)
Sex[c]		
Male	.275	.223
Female	(.224)	(.223)
Age	-.005	-.005
	(.003)	(.003)
Sex by Age	-.0005	-.0002
	(.004)	(.004)
Race[d]		
Black	-.462***	-.436***
Hispanic	(.108)	(.107)
White	-.502***	-.485***
	(.086)	(.086)
Feeling down, depressed, or hopeless[e]		
Not at all	.372***	
Several days	(.1)	
More than half the days	.393*	
Nearly every day	(.181)	
	.479**	
	(.185)	
Thought you would be better off dead[f]		
Not at all		.271
Several days		(.227)
More than half the days		-.587
Nearly every day		(.496)
		.0007
		(.452)
Education[g]	.021	.018
Less than 9th grade	(.172)	(.172)
9-11th grade	.133	.129
High school graduate/GED or equivalent	(.164)	(.164)
Some college or AA degree	.011	-.001
College graduate or above	(.164)	(.164)
	-.092	-.117
	(.177)	(.176)
Family monthly poverty level index (X)[h]		
X <= 1.30	-.055	-.079
1.30 <X <= 1.85	(.119)	(.119)
X > 1.85	-.092	-.14
	(.09)	(.089)

Note. a. As an outcome/dependent variable, it shows whether a person was obese('1') or not('0').
b.No hypertensionwas estimated.
c.Sex 'male' was estimated.
d.The black is the reference level.
e. Feeling down, depressed or hopeless for Not at all is the reference level.
f. Thought you would be better off dead for Not at all is the reference level.
g. Less than 9th grade is the reference level.
h. Monthly poverty level<= 1.30 is the reference level. ***, **, * denote significance at the 0.1%, 1% , 5% level, respectively

Meanwhile, if we consider another outcome, dependent variable '*Weight group*', this variable is a categorical one with an 'ordering' which consists of 'underweight (Y=1)', 'average weight (Y=2)', 'obese (Y=3)'. Then, we need to use an ordered logit model 'logit ($Pr(Y\leq j)=\beta_{j0}+\beta_{ixi}$' in a sense that the ordering forms logits using cumulative probabilities which are $Pr(Y\leq j|x)=\pi_1(x)+\pi_2(x)+\ldots+\pi_j(x)$, j=1,2,3. Thus, the model that uses all cumulative logits simultaneously would be the following:

Logit $\{Pr(Y\leq j|x)\}=\beta_{j,0}+ \beta_1 Hypertension + \beta_2 X + \beta_3 Z$, j=1,2,3

This is also called a 'proportional odds model' utilized as models 5 and 6. This model has an advantage since the effect β_i for each logit is the same regardless of which cumulative logits are used to form the log odds.

X refers to 'Feeling down, depressed, or hopeless' or 'Thought you would be better off dead', which consist of the models 5 and 6, respectively. Zrefers to covariates such as gender, age, race, socioeconomic status variables such as education and family monthly poverty level index. Unlike models 3 and 4, models 5 and 6 treated variables 'Feeling down, depressed, or hopeless' and 'Thought you would be better off dead' as binomial variables instead of categorical ones. That is, they simply indicate whether an individual either felt down, depressed, or hopeless or thought you would be better off dead. Therefore, we used models 5 and 6 to test how hypertension and depression may affect obesity indicated from '*Weight group*'. Table 4 shows some results. The coefficients of variables are given ordered log odds.

For hypertension, when there is one unit increase in hypertension (say from '0' to '1'), the odds of being 'obese' versus being 'average weight' or 'underweight' are 1.69 and 1.7 times greater, provided that other variables are considered constant. For feeling down, depressed, or hopeless, for one unit increase in feeling down, depressed, or hopeless (say from '0' to '1'), the odds of being 'obese' versus being 'average weight' or 'underweight' are 1.26 times greater, provided that other variables are considered constant. Meanwhile, for thought you would be better off dead, for one unit increase in thought you would be better off dead (say from '0' to '1'), the odds of being 'obese' versus being 'average weight' or 'underweight' are 1.19 times greater, provided that other variables are considered constant.

Table 4. Proportional Odds Ratio for Obesity with Hypertension and Depression

Outcome Variable : Weight group[b]	Model 5				Model 6			
Predictors/Intercepts	**Estimate**	**t-value**	**p value**	**OR (95% CI)[a]**	**Estimate**	**t-value**	**p value**	**OR (95% CI)**
Hypertension	.527 (.072)	7.268	<.001	1.69 (1.47,1.95)	.532 (.072)	7.34	<.001	1.7 (1.47, 1.96)
Age	.003 (.001)	2.294	<.001	1 (1,1)	.003 (.001)	2.24	<.001	1 (1, 1)
Feeling down, depressed, or hopeless	.234 (.063)	3.657	<.001	1.26 (1.11,1.43)				
Thought you would be better off dead					.18 (.14)	1.284	<.001	1.19 (.9, 1.57)
underweight|averageweight[c]	.076 (.076)	1.005	<.001		.026 (.074)	.351	<.001	
average weight|obese[c]	1.502(.079)	18.84	<.001		1.45 (.077)	18.61	<.001	

Note. a. OR=Odds ratio; 95% CI=95% confidence level. All ORs are adjusted for sex, age, race, education, and family monthly poverty level.
b. It is an ordinal response outcome ('underweight (Y=1)', 'average weight(Y=2)', and 'obese(Y=3)').
c. As intercepts, they are also called cutpoints.

4. Discussion

This study was the first one to have utilized a proportional odds model to examine how obesity predicted by weight group was associated with hypertension and depression by adjusting other covariates such as age, gender, race and socioeconomic status variables such as education and family monthly poverty level. A proportional odds model is the most commonly used when the outcome variable of interest is a categorical one with an ordering and it has an advantage of having a convenient characteristic that the effect of a predictor on the outcome variable can be measured by one regression coefficient (Bender and Grouven, 1997). Prior to utilizing a proportional odds model, first, we have used a logistic regression where the outcome variable was '*Obesity*' as a binary one and tested how hypertension and depression may affect obesity. The results from models 3 and 4 imply that when an individual had hypertension and felt depressed more often, he or she was more likely to be obese compared with a person who did not have hypertension and feel depressed at all. Next, we have applied a proportional odds model where the outcome variable '*Weight group*' was ordinal as its categories were 'underweight', 'average weight' and 'obese'. The results from models 5 and 6 have showed that the odds of being 'obese' versus being 'average weight' or 'underweight' were greater for one unit increase in hypertension (OR=1.69 and 1.7) and for one unit increase in feeling down, depressed, or hopeless (OR=1.26), which implies that depression and hypertension may positively affect obesity as well. This result was similar to the previous literature (ME Dı´az 2002; Nguyen et al. 2008; de Wit et al. 2010) in terms of bidirectional relationships among hypertension, depression and obesity; however, they have not attempted to look at the association among them simultaneously, which could be the main difference of this study from others.

For models 1 and 2, a general logistic regression was utilized since the outcome variable 'hypertension' was a binary variable. Logistic regression is very commonly used when the outcome variable is not continuous. Compared with other studies treating hypertension as a continuous variable, our outcome variable was dichotomous so that logistic regression method was suitable and useful to show the association with predictors and covariates. We can mention about some implications for the associations among variables. The results from models 1 and 2 showed that the average weight (OR=1.28 and 1.27) and the obese (OR=2 and 2.01) were more likely to have a higher likelihood of having hypertension compared with the underweight, which implies for the positive association between obesity and hypertension. In addition, feeling depressed more often ('several days', 'more than half the days', and 'nearly every day') was associated with a higher likelihood of having hypertension (OR=1.23, 1.59, and 1.77) compared with no feeling depressed at all, which might imply for the positive association between depression and hypertension. This

result is consistent with some previous literature; for instance, Grimsrud et al. (2009) also found that hypertension was more common among people who had depression and anxiety than people who did not have. Allgulander (2015) also found anxiety as the most crucial factor for cardiovascular disease, which also established other determinants such as overweight, substance use and depression, emphasizing on the importance of making the effect of anxiety in terms of hypertension. In the meantime, Wang et al. (2015) examined the risk factors for depression among arteriosclerosis obliterans (ASO) patients and found that hypertension (OR=4.63) was one of them, which implies for the positive association between depression and hypertension. Meanwhile, Talwar et al. (2015) found that patients with pulmonary arterial hypertension (PAH) had a decreased health-related quality of life (HRQOL) which had a correlation with dyspnea and depression. In terms of another measure 'thought you would be better off dead', it did not show a consistent result in the sense that when a person who thought he or she would be better off dead for 'several days', the likelihood of having hypertension was greater than that for 'nearly everyday' (OR=1.9 vs 1.09) compared with an individual who did not think at all. For 'thought you would be better off for several days', on the other hand, it did not show any significant result. This conflicting result could be explained by some existing literature. Mukamal et al. (2007) attempted to look at how BMI was associated with depression and suicide attempts and death among men from a prospective cohort study and found that a decreased mortality rate from suicide was associated with a higher BMI even after adjusting other covariates such as medical illness, physical activity and the use of antidepressant, etc. Similarly, the risk of suicide was inversely related to the increase of BMI (Magnusson et al. 2005). For young adults, however, the result was different in that the overweight were more likely to have the higher odds of having suicide ideation (Eaton et al. 2005).

The results suggest that timely diagnoses and treatments of mental disorders and chronic diseases are needed in the sense that it could be costly if we do not. Chapman et al. (2005) mentioned that 'depression has emerged as a risk factor for chronic illnesses such as hypertension and obesity and thus, timely diagnosis and treatments of mental disorders could greatly influence on the impact of chronic disease'. Finkelstein, et al. (2009) approximated the costs of obesity in the U.S. health care system and found it to be $147 billion per year; in addition, compared with the average weight, the obese are estimated to cost 42% more in the system. In the meantime, Mozzafarian et al. (2015) estimated the costs of high blood pressure and mentioned that it could cost $46 billion each year in the U.S. This includes 'the cost of health care services, medications of treatment, and missed days of work'. Meanwhile, Moran et al. (2015)examined the effect of implementing the new guidelines of hypertension and found that it could cause '56,000 fewer cardiovascular events and 13,000 fewer deaths from cardiovascular causes annually'. This implies that we might be able to save the associated costs overall by applying the new guidelines of hypertension. With regards to the costs of depression, the National Center for Health Statistics estimated the national health expenditures for mental health services which were over $100 million in 2003.Depressioncould also cause '200 million missed days of work each year with the cost of $17 to $44 billion (Leopold 2001 and Stewart et al. 2003)'.Not only timely diagnoses and treatments of chronic illnesses are important, but also management of them is. Approximately 99 million people live with a chronic illness in the U.S. and people who have major chronic illnesses do not receive suitable or effective management (Rothman and Wagner 2003). In this regard, a primary care system is crucial in terms of providing continuity, coordination and comprehensiveness, which are suitable for caring chronic illnesses, and can meet the needs of patients with them (Rothman and Wagner 2003). In the meantime, Chodosh et al. (2005) evaluated the effectiveness and crucial components of self-management program for hypertension, and found that the intervention program contributed to decreases in systolic blood pressure by 5 mm Hg and diastolic blood pressure by 4.3 mm Hg, which possibly produce clinically essential benefits.

This study is based on large national survey data and our results have shown the associations among obesity, hypertension and depression by adjusting for gender, age, race and socioeconomic status. This study is an important contribution to the literature on the chronic conditions such as hypertension and depression as the determinants of obesity, which implies for the importance of timely diagnoses and treatments of them. However, several limitations exist. First, the data was based on the self-reported response to questionnaire. Second, the measures of depression, 'feeling down, depressed, or hopeless' and 'thought you would be better off dead', were not based on a diagnosis albeit having several scales of depression. Each of these limitations provides an opportunity for me to expand my analysis of the associations among chronic conditions in the future.

5. Conclusions

The findings suggest that public health should be more interested in such factors that could be associated with obesity, it is an concern in public health. Mental health problems and chronic illnesses should be also timely be diagnosed and treated properly for considering such associations one another. By doing so, it can provide with the overall cost-savings and more importantly, people's health.

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