Comparison of Adolescents' Subjective Health Status, Physical Activity Index, and Perceived Stress Rate: Propensity Matching Analysis of Obese and Non-obese Groups

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Objective: This study aimed to compare the subjective health status, physical activity index, and perceived stress rate of obese children with those of healthy children through propensity matching analysis and to use the results to help manage obese children.

Design: Descriptive correlation study.

Methods: This study conducted a secondary analysis using raw data from the National Health and Nutrition Examination Survey. Propensity matching (1:2) was conducted between obese and healthy adolescents.

Results: The number of days of physical activity was 1.22 days for the obese adolescent group and 1.01 days for the non-obese adolescent group, which was higher in the obese group ($p = 0.003$). The subjective health status was 3.43 and 3.81 in the obese and non-obese adolescent groups, respectively, showing a higher difference in the normal group ($p < 0.001$). No statistical difference was observed in the perceived stress rate ($p = 0.871$) or strength exercises ($p = 0.190$) between the two groups.

Conclusion: This study suggests the need for development measures to effectively improve youth physical activity, muscle-strengthening programs, stress management, and subjective health status in obese and normal groups.

Key Words: Subjective health status, Physical activity index, Perceived stress rate, Obese, Propensity matching analysis

Introduction

According to the Youth Health Behavior Survey announced by the Korea Disease Control and Prevention Agency in 2021, the prevalence of obesity among middle and high school students as of 2021 has increased 2.4 times to 13.5% compared to that of 10 years ago (5.6%) and is steadily increasing [1]. Obesity in adolescents is caused by incorrect eating habits, reduced physical activity, stress, and depression, and this has been confirmed to negatively impact the subjective health status of adolescents [2].

Unlike adult obesity, where the size of fat cells increases, adolescent obesity increases the size of the cells along with the number of fat cells; therefore, there is a high possibility that adolescent obesity will develop into adult obesity [3]. Obesity increases the risk of cardiovascular diseases such as high blood pressure, diabetes, and hyperlipidemia, which cause chronic diseases [4]. Adolescence is a period of cognitive, emotional, and physical development. Negative body image due to obesity increases feelings of withdrawal, depression, and stress due to teasing or bullying by peers at school, leading to maladjustment in school life and suicidal thoughts. Obesity has a significant effect on adolescents [5,6].

The World Health Organization (WHO) considers subjective health status (self-rated health) to be an

important factor in determining health behavior from physical, mental, and social aspects and is highly reliable for adolescent obesity. Therefore, it is necessary to check and manage the subjective health status of adolescents [7,8]. Adolescence is a time when interest in appearance increases and a thin body becomes the standard of beauty; therefore, overweight or obese children are often classified by their friends as individuals they do not want to play with [9]. Additionally, obese adolescents experience higher levels of stress and depression than non-obese adolescents, which is a negative factor that increases mental health anxiety [10]. Negative experiences during growth and development can lead to various physical and mental diseases and quality of life [11], and can have negative effects such as depression and stress on cognitive development as well as psychological and emotional development; therefore, management measures are needed [12].

The World Health Organization recommends that adolescents engage in moderate- intensity exercise and vigorous-intensity physical activity for at least 60 minutes every day and vigorous-intensity physical activity that strengthens muscles and bones at least three times a week [13]. Most previous studies have reported that regular physical activity during adolescence is not only helpful for normal physical growth and development but also reduces the risk of developing diseases such as obesity through appropriate changes in body composition and strengthening healthy physical strength [14]. To manage obesity in adolescence, increasing physical activity and muscle strength not only reduces body fat and risk factors such as high blood pressure and obesity but also plays a positive role in mental health by reducing anxiety, depression, stress, and suicidal impulses [15].

Previous studies have shown that physical activity in adolescents lowers the risk of developing metabolic syndrome and insulin resistance [16] and helps improve mental health levels such as depression, anxiety, psychological damage, and emotional disorders [17]. In a study on the relationship between obesity and suicidal thoughts in adolescents, satisfaction with body image and body mass index were found to be highly related to depression and stress [18].

Therefore, the genetic risk of obesity must be reduced by increasing physical activity and improving the eating habits of obese adolescents, who are physically and mentally vulnerable [19].

As a limitation of previous research on adolescent obesity, the problem of not being able to control the selection bias of the subjects has been raised. This can lead to incorrect inferences about the causal relationship of the results or errors of under- or over-interpretation of the results, leading to heterogeneity of the results. It was stated that there was a need to remove it and explain the systematic changes[20]. Therefore, in this study, we used the Korea National Health and Nutrition Examination Survey (KNHANES) data to reduce selection bias and control for confounding variables. We employed propensity score matching (PSM) to determine the two groups. It is necessary to check for differences in related variables between the two. Therefore, we compared the subjective health status, physical activity index, and perceived stress rate of the obese and normal groups to confirm the differences and use these as basic data for health management and prognosis improvement in obese adolescents.

Research Methods Research Design

This study conducted a secondary analysis using raw data from the National Health and Nutrition Examination Survey (NHANES). This descriptive correlational study compared and analyzed the subjective health status, physical activity index, and perceived stress rate between obese and normal adolescent groups through propensity matching.

Participants Using the sampling frame of the National Health and Nutrition Examination Survey, 2,336 people were sampled from a representative obese group of adolescents aged 12～18 years living in Korea. Among them, 443 people in the obese group responded correctly to the survey, while 1,634 people in the normal group were selected, totaling 2,077. To control for the selection bias of these two groups, subjects with the same or similar propensity scores were matched 1:2, and the final number of subjects was 1,221, of whom 415 were obese and 706 were normal. Figure 1 presents the flowchart of the study process based on the 2010 CONSORT flow diagram template.
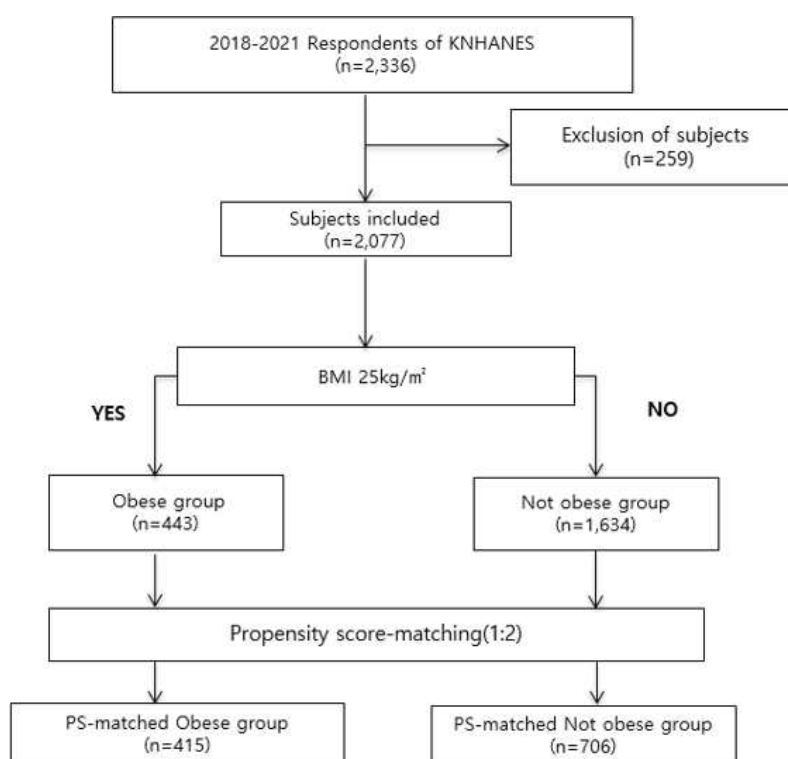
Figure 1. Flow chart of the study sample. KNHANES: Korea national health and nutrition Examination survey, Obese: BMI 25kg NHANES $=$ Korea/m^2 $>$ group, Not obese: BMI 25kg/m^2 $<$ group

Data Collection

This study utilized secondary data collected over four years from the 7th (2018) and 8th (2019~2021) periods of the KNHANES [21,22]. Health and examination survey data were collected through household member confirmation, health, examination, and nutritional surveys.

The 8th 2nd year (2020) survey included only data from 180 survey districts (completion rate: 93.8%) among the 192 survey districts nationwide because of the suspension of the survey due to the COVID-19 pandemic. The National Health and Nutrition Survey only disclosed data that complied with the Personal Information Protection Act and the Statistics Act and removed information that could estimate the households and individuals subject to the survey. This study was conducted using data that did not identify individuals from the National Health and Nutrition Survey website.

Ethical Considerations

The raw data of the KNHANES, which are the data for this study, are from the 3rd year of the 7th period (2018-01-03-P-A), the 1st year of the 8th period (2018-01-03-C-A), and the 2nd year. This is the approval number of the research ethics review committee (2018-01-03-2C-A). The National Health and Nutrition Examination Survey is conducted directly by the government in accordance with Article 2, Paragraph 1 of the Bioethics Act and Article 2, Paragraph 2, and Paragraph 1 of the Enforcement Rules of the same Act. Considering that this study was conducted on public welfare, it could be conducted without being reviewed by the Research Ethics Review Committee. Accordingly, the researcher downloaded and analyzed officially released data from the National Health and Nutrition Examination Survey website after familiarizing themselves with raw data usage and usage regulations.

Measurement Instruments

1. Sociodemographic characteristics and PSM variables

In this study, sociodemographic characteristics were used as control variables for PSM based on data from

the National Health and Nutrition Examination Survey and previous research on the general characteristics of the obese group. Sociodemographic characteristics included household income (low, low, middle, high, and high), educational level (less than elementary school, middle school, and high school), smoking status (teenagers: never or ever smoked one or two cigarettes), and drinking status (only), Weight control status (weight loss efforts, Efforts to maintain weight, weight gain effort, have never tried to control). Five sociodemographic control variables were used

2. Obese adolescents

In this study, obese adolescents were referred to as elementary, middle, and high school students, and those with a body mass index of 25 kg/m² or more were analyzed as the ratio of weight to height (weight (kg)/height^2(m²)).

3. Subjective health status, perceived stress rate

In this study, the subjective health status was reclassified (very poor, 1 point; poor, 2 points; average, 3 points; good, 4 points; and very good, 5 points), with higher scores indicating higher subjective health status.

The perceived stress rate is a variable created by dividing the number of people who responded that they feel 'very much' or 'a lot' of stress in their daily lives. The closer it is to 1, the higher the stress.

4. Physical activity index (strength exercise, physical activity days)

Strength training refers to the number of days of strength training per week (in the past week, how many days did you perform strength training, such as push-ups, sit-ups, dumbbells, and barbells). A higher score indicated greater strength training. The number of days of physical activity for more than 60 min per day, which is a representative indicator of physical activity (over the past 7 days, on how many days did you engage in physical activity that made your heart rate higher than usual or made you feel out of breath for 60 min or more per day?) The higher the score, the more days a person engaged in physical activity.

Data Analysis

PSM analysis was performed to minimize unobserved confounding variables and compensate for the limitations of unobserved heterogeneity between variables [23]. To estimate the propensity score model, the propensity score was calculated as the probability of being included in the obese youth by using the general variables of each subject, such as household income, education level, smoking status, drinking status, and weight control status, as covariates. Based on the calculated propensity score, caliper matching was performed using R's non-random package (http://www. rdocumentation. org/packages/non-random), and the number of test participants was matched 1:2 for the obese and normal groups. did. The model test of the propensity score was analyzed using C-statistics and the Hosmer–Lemeshow test. Statistical analyses were performed using R (version 3.6.2; R Foundation for Statistical Computing, Austria), and differences in the characteristics of the two matched groups were analyzed using a t-test.

Results

1. Characteristics of the subject before matching

The subjects of this study were 2,077, with 555 (34.0%) responding that their household income was 'medium-high', and their level of education was as follows: 940 (57.5%) elementary school students, 587 (35.9%) middle school students, and high school students, followed by 107 (6.6%) people. Regarding smoking status, 1,514 (92.7%) responded that 'I have never smoked one or two puffs of a cigarette' and 120 (7.3%) responded that 'I have ever smoked one or two puffs of a cigarette.' Regarding drinking status, 1,257 (76.9%) people responded that they had 'never drank alcohol' and 377 (23.1%) people responded that they had 'experienced drinking alcohol.' Regarding weight control, 651 (39.8%) responded, I have never tried to control weight, 'and 435 (26.6%) responded, Efforts to lose weight' (Table 1).

2. Before and after 1:2 PSM in obese and normal groups

Matching balance means that the closer the
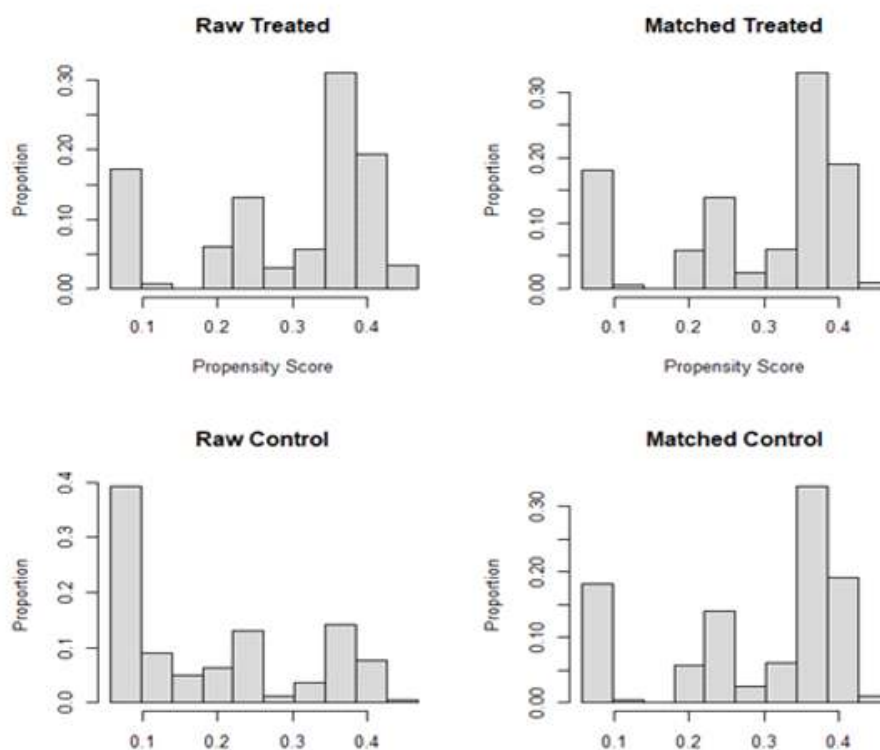
Figure 2. Before after: PSM matching

multivariate imbalance is to 0, the better the balance, and the closer it is to 1, the stronger the imbalance. This means that the variables cannot be compared in pairs. Owing to propensity score matching in this study, a similar distribution pattern appeared after matching the obese and normal groups, confirming that matching was successful (Figure 2). Before matching, the general characteristics of the study participants were education level ($p < 0.040$) and weight control ($p < 0.001$), and each variable was found to be unrelated to the obese and normal weight groups ($p > 0.05$). Thus, good matching was achieved between the two groups (Table 1).

3. Comparison of subjective health status, physical activity index, perceived stress rate, and strength training between the obese and normal groups after matching.

In this study, the number of days of physical activity was statistically different from 1.22 days in the obese group to 1.01 days in the normal weight group ($p = 0.003$). A significant difference was observed in the subjective health status: 3.43 for the obese group and 3.81 for the normal group ($p < 0.001$). However, no statistically significant differences were observed in perceived stress ($p = 0.871$) or strength training ($p = 0.190$) between the two groups (Table 2).

Discussion

In this study, a significant difference was observed between the stress perception rates of the obese and normal weight groups before matching; however, no significant difference was observed after matching, supporting the finding that the differences in depression and stress indices between the normal weight and obese groups were not significant. However, previous studies have shown that severe obesity with a high degree of obesity is associated with high levels of depression and stress [6, 10], and the results after propensity matching are believed to reflect adolescents' self-image. This indicates that obese adolescents have a more positive self-image than severely obese adolescents; therefore, they are likely to have higher

Table 1. General characteristics before and after matching

Variables	Categories	Before propensity score matching				After propensity score matching(1:2)			
		Not Obese (N=1,634) n(%)	Obese (N=443) n(%)	x^2	p	Not Obese (N=706) n(%)	Obese (N=415) n(%)	x^2	p
household income	under	144(8.8)	41(9.3)	0.19	0.979	61(8.6)	35(8.4)	1.34	0.719
	lower middle	436(26.7)	121(27.3)			217(30.7)	116(28.0)		
	medium to high	555(34.0)	148(33.4)			220(31.2)	141(34.0)		
	superiority	499(30.5)	133(30.0)			208(29.5)	123(29.6)		
Education level	elementary	940(57.5)	225(50.8)	6.43	0.040	369(52.3)	214(51.6)	0.11	0.948
	middle school	587(35.79)	185(41.8)			299(42.4)	177(42.7)		
	high school	107(6.6)	33(7.5)			38(5.4)	24(5.8)		
Smoking status	doesn't exist	1514(92.7)	402(90.7)	1.78	0.182	676(95.8)	393(94.7)	0.65	0.419
	has exist	120(7.3)	41(9.3)			30(4.3)	22(5.3)		
Drinking status	doesn't exist	1257(76.9)	333(75.2)	0.60	0.438	548(77.6)	317(76.4)	0.23	0.634
	has exist	377(23.1)	110(24.8)			158(22.4)	98(23.6)		
Weight control status	weight loss efforts	435(26.6)	277(62.5)	235.95	<.001	408(57.8)	255(61.5)	1.80	0.614
	Efforts to maintain weight weight gain	318(19.5)	85(19.2)			145(20.5)	82(19.8)		
	effort have never	230(14.1)	3(0.7)			3(0.4)	2(0.5)		
	tried to control weight	651(39.8)	78(17.6)			150(21.3)	(18.3)76		

Standardized difference of Mean; Obese : BMI 25kg/㎡＞group; Not Obese: BMI 25kg/㎡＜group

Table 2. Comparison of subjective health status, physical activity index, and perceived stress rate, strength training between obese and Not obese after matching

Variables		Not obese	Obese	t	p
		Mean±SD	Mean±SD		
Perceived stress	Unadjust	0.23±0.42	0.28±0.45	−2.04	0.042
	PS matching	0.26±0.44	0.27±0.44	−0.16	0.871
strength training	Unadjust	1.05±1.64	1.20±1.64	−1.67	0.096
	PS matching	1.01±1.59	1.14±1.59	−1.31	0.190
Physical activity days	Unadjust	1.01±1.77	1.22±1.84	−2.12	0.034
	PS matching	0.86±1.64	1.18±1.79	−2.97	0.003
Perceived Health status	Unadjust	3.82±0.81	3.42±0.83	9.16	0.000
	PS matching	3.81±0.82	3.43±0.83	7.47	0.000

Obese : BMI 25kg/㎡＞group; Not obese : BMI 25kg/㎡＜group

overall self-esteem, including physical and social acceptance, and lower levels of daily stress. Therefore, further research is required to classify the degree of obesity and analyze the differences in stress.

No significant difference was observed in muscle strength before and after matching. In a study on the factors that influence adolescent health behavior and mental health factors in obesity, a statistically significant difference was observed as the rate of practicing muscle-strengthening exercises increased; nonetheless, this study showed different results. This has been previously demonstrated [6,13-15]. This is believed to be different from the results of previous studies because it compared two groups—obese and normal groups—with similar tendencies, blocking out all exogenous variables, compared with studies on all adolescents.

The results of this study showed a significant difference before and after physical activity matching, and the obese group engaged in more physical activity than the normal group, similar to the results of previous studies [13-15]. Owing to the difficulty of accurately determining the timing design of the results of the National Health and Nutrition Survey — whether the obese group is diagnosed with obesity and engages in more physical activity than the normal group to lose weight, or whether the obese group engages in physical activity because they have a more positive self-image than the normal group — limitations exist that make it difficult to accurately determine whether more is being performed. Regular exercise in obese and non-obese groups is effective in weight management and physical strength improvement, and even in obese adolescents, if their physical strength level is high, they feel psychologically stable, healthy, and have high life satisfaction [23]. In the case of obese adolescents, since regular participation in physical activity is essential for maintaining physical and mental health, to prevent and improve obesity in adolescents, we developed a program to strengthen physical activity 2 to 3 times a week and provided it to public health centers or schools. Maintaining a continuous physical activity practice rate is also important.

The results of this study before and after matching the subjective health status indicated that the normal group had a better subjective health status than the obese group, which supports the results of previous studies [6-9].

Adolescence is an important period for acquiring and forming the personal values, attitudes, health behaviors, and life skills necessary to maintain a healthy life while experiencing many physical, mental, and social changes [25].

Since the level of perception of subjective health status has been shown to affect mental health conditions such as stress, depression, and suicidal thoughts, we developed a program that combines exercise therapy and nutritional therapy according to the degree of obesity to improve obesity and developed intervention therapy related to improving self-confidence. Therefore, such applications are necessary.

Conclusion

This study used data from the KNHANES to determine adolescents' subjective health status, physical activity indices, and perceived stress rates. After PSM of the obese and normal groups, the related variables were compared between the obese and normal groups. By analyzing the differences, the following conclusions can be drawn:

The main result of this study was that the number of days of physical activity in the obese group was higher than that in the normal group, and subjective health status was higher in the normal group than in the obese group. This was cross-sectional data from the KNHANES, and because the time-point design was unclear, there were limitations in revealing causal relationships.

In the future, we propose a study to compare the health status of the obese group before and after intervention by randomly selecting participants in the obese and normal groups and developing effective youth physical activity, muscle strengthening programs, and youth stress management programs to improve subjective. health status in daily life. Therefore, it is necessary to develop effective treatment plans.

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