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Correlation Among Waist to Hip Ratio, Body Fat, BMI, Weight and Serum Lipids in Obese College Women

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Abstract

The purpose of this study was to investigate the waist to hip ratio, body fat, BMI(Body Mass Index), weight, serum lipids and to examine the correlation between waist to hip ratio, body fat, BMI(Body Mass Index), weight and serum lipids in obese college women. The subject were 52 college women with a score above 25 on the BMI, between March and May of 2000 at G Women's University.

Data has been analyzed by SPSS/PC using frequency, percentage, mean, standard deviation, and Pearson Correlation Coefficient.

The result of this study are as follows :

1. The mean of body weight and height of the subjects were 72.38kg, 160.23cm.
2. The mean of waist to hip ratio was 0.88, body fat was 38.88%, BMI(Body Mass Index) was 28.15, the level of total cholesterol was 174.88mg/dl, triglyceride was 104.29mg/dl, HDL-cholesterol was 50.83mg/dl, LDL-cholesterol was 104.23mg/dl.
3. Waist to hip ratio was more significantly correlated to triglyceride($r=.34$, $P<.05$) and BMI(Body Mass Index) was more significantly correlated to triglyceride($r=.30$, $P<.05$).

Key words : Waist to Hip ratio, Body fat, BMI(Body Mass Index), Weight, Serum lipids

Introduction

1. Currently the obesity is increasing trend due to eating habits and lifestyle change which have been influenced by westernized lifestyles. The obesity has been defined as a symptom not as a disease. However, WHO defined obesity as a disease which need to be treated in 1996.

In 21st century, women's health and empowerment of women is emphasized due to the fact that they are directly connected with people's health. The obesity of women will give a worsening effects to risk for childbirth, infertility and abnormal effects on menstration of women (Choi & Lee, 1997; Hong, 1995; Shin, 1977).

When people become obese, they will have difficulty in breathing, and furthermore, will cause discomfort when they moves, cardiovascular disease, hypertension, gallstone, hyperlipidemia,

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diabetes mellitus, fatty liver, and arthritis. For women, obesity can cause breast cancer, cervical cancer, ovarian cancer, so that will bring health problem in society (Choi, 1995; Segal & Pi-Sunyer, 1989)

In order to prevent obesity and control the obesity along with its management, accurate evaluation is critical to provide much health care. But there are many ways to evaluate the obesity problems, and which have caused contrary among the researchers in this field (David, 1989; Min, 1990; Seo and Seo, 1992).

The methods of determination of obesity are Body Mass Index(BMI) derived from weight and height, body fat ratio, waist to hip ratio and body measurements (Korean Academic Society of obesity, 1995). The current criterion of obesity is determined by weight and height of a person and one can be considered as obese if his weight is 20% over the standard value. The fat content and fat distribution in a body are more important factors to determine the obesity (Himes, Roche & Siervogel, 1979; Norgan & Ferro-Luzzi, 1987).

The current findings reported in Korea suggest that the body mass index is more strongly correlated to total cholesterol than waist to hip ratio (Yae, Lee, Cheon, No, & Nam, 1994).

Four consecutive year's study also reported the same trend (Ha, 1995). Thus we can say positively that body mass index is more strongly correlated to blood fat concentration.

The correlation between obesity and diseases related to adults can be explained in terms of excess of insulin in the blood stream caused by obesity. This excess of insulin causes diabetes which are not insulin dependent.

The high concentration of triglyceride in the blood stream causes hardening of arteries, hypertension, cardiovascular disease, and formation of gallstone (Lee, 1992). The hardening of arteries of adults are originated from childhood. If the hardening of arteries is found before at the age of 20, this can be cured. If hardening of arteries occurred between 30 to 40 years of age, it is rather difficult to cure completely (Cresanta et al., 1986).

Thus we are aiming at to find the fundamental data concerning obesity using body fat ratio, waist to hip ratio, body weight, body mass index, serum lipid concentration and the correlation among these indices which will give us the clue for the controlling the obesity in female college students.

The diseases occurring among the adults are caused by obesity. The insulin concentration in the blood stream is enhanced due to obesity and this causes diabetes among adults. Also fat concentration in the blood stream due to obesity will cause hardening of arteries and diseases related to arteries along with gallstone formation.

2. Purpose of study

The purpose of this study is to investigate the waist to hip ratio, body fat, BMI(Body Mass Index), weight, serum lipids, and to examine the correlation between waist to hip ratio, body fat, BMI(Body Mass Index), weight and serum lipids in obese college women.

3. Definition of terms:

1) Waist to hip ratio(WHR)

The WHR is defined as the waist circumference to hip circumference (1995)

The WHR is obtained through measuring waist measure, hip measure and ratio of waist measure to hip measure three times and averaging each measurements using a parallel ruler. Especially in waist measure, the ruler has to go around the belly button and in hip measurement the ruler has to pass around the most protruding part of the hip.

2) Body fat ratio

The fat content was measured in sitting position. The initial data, i.e., sex, age, height and weight are coded before measuring the fat content.

The fat content was measured using a fat measuring device (Futrex Co., U.S.A).

The measurement was done using Infrared source which can pass the upper part of the arm and through this measurement body fat % can be obtained.

The weight was measured using a weighing scale (Takai Physical Test, Japan) and the BMI

is measured simultaneously. The lower BMI means that one does a good job on controlling one's weight.

BMI= (Quetlet Index) = Wt(kg)/[Ht(m)]^2

3) Body mass index

This value is obtained through height and body weight.

The body mass index is an indicator for the obesity.

BMI(Quetlet Index) = Wt(kg)/{Ht(m)}^{2}

The weight was measured using a weighing scale (Takai Physical Test, Japan) and the BMI is measured simultaneously. The lower BMI means that one does a good job on controlling one's weight.

BMI= (Quetlet Index) = Wt(kg)/[Ht(m)]^2

4) Serum Lipid

The serum lipid is the main ingredient for steroid hormone.

In this study we measure total cholesterol(TC), Triglyceride(TG), High density lipoprotein(HDLC) and Low density lipoprotein(LDLC).

The blood fat content is obtained from the subjects who did not take any food from 10 p.m. of the previous day. A 6cc of the blood of the subjects is taken and the blood fat content is analyzed in the lab. The TC and TG are obtained using automatic analyzer (Hitachi 7150, Japan).

The HDLC is obtained using the sedimentation technique and the LDLC is obtained using the existing formula which is reported in the literature (Friedwald, 1972).

Literature Review

Obesity means an accumulation of body fat and is generally determined by using a Kaup index for infants under 2 years old, a Rohler index for children before adolescence and a BMI for adults, which measure weight in relation to height. Also thickness of subcutaneous fat, body circumference, fat measurement by body fat measurer and abdominal fat accumulation by ultrasonic and CT can be evaluation measurers of obesity assessment (Ahn, 1993).

The simplest way to define obesity, in the case the point that risk of disease increases is standard, is when Broca index—[height(cm) -100]x0.9 is ideal body weight— exceeds by 20%. A BMI of 25 and above, increasing the risk of death, is medical standard that requires treatment (Hong, 1995).

Causes of obesity are various and complex. Common causes are consuming more calories than the body can use and inadequate exercise. However, obesity can be affected for the reasons of genetic factors, central nervous diseases, thyroid hormonal disorders, endocrine metabolic diseases, stress, schizophrenia, manic-depressive sickness and others. Also social and family factors, length of TV watching hours, seasonal and regional factors can increase the risk of obesity (Dietz, 1986).

Obesity can be either classified primary obesity and secondary obesity according to the existence of disease or central(abdominal) obesity, and peripheral(limb) obesity according to the type of fat distribution. Central obesity is defined as having a WHR of 0.9 and above in female adults and 1.0 and above in male adults, which can increase the risk of hypertension, hyperglycemia and hyperlipidemia.

Obesity, as is widely known, causes a resistance to insulin in blood resulting in hyperinsulinemia, which causes insulin-independent diabetes, hypertriglycemia, arteriosclerosis and coronary artery diseases, and the risk of gallstone is frequent due to hypertension and high cholesterol (Lee, 1992). Arteriosclerosis of an adult usually starts from childhood, however, if it is found and treated before 20 years old the early symptoms of it completely disappear. On the other hand, arteries of the thirties and forties once fiberized can not be recovered with all that treatments (Cresanta et al., 1986). Current statistics showed that the death rate over 40 years of age of Koreans are more than two times over the foreigners of the same age. The cause of death is mainly cardiovascular disease related and this is originated from the abdominal obesity (Lee, 2000).

Serum lipids value studies of 418 obese people showed that serum cholesterol of 200mg/dl and over was 11%, LDL-Cholesterol(LDLC) of

130mg/dl and over was 5.7%, HDL-Cholesterol (HDLC) of 40mg/dl and under was 13.4%, and triglyceride(TG) of 160mg/dl and over was 39% (Choi, Kim, Park, Cheong, Chang & Dokgo, 1993). Hyperlipidemia is a major cause of arterio-sclerosis, which of an adult usually starts from childhood. However, when it is found and treated before 20 years old, the early symptoms of it completely disappear, whereas arteries of the thirties and forties once fiberized can not be recovered with all that treatments (Burke, Downey, Freedman & Berenson, 1986).

Waist and Hip circumferences can be assessment tools for body fat distribution patterns, however, according to the recent research of our country, it is reported that BMI has closer correlation with serum total cholesterol than with waist to hip ratio(WHR) (Kim, 1999; Yai, Lee, Chun, Ro, & Nam, 1994; Kang, et al, 1995). And in the repetitious research for every four year, serum lipid level change and WHR change were not much concerned, and preferably BMI change was more closely related with serum lipid level change (Ha, 1995). It thus appears that BMI has closer correlation with serum lipid level than with WHR in Korean people, however, subjects of most researches were male workers. Therefore, it may not be generalizable to female population.

However, Wing, et al (1991) reported WHR change and HDL change have significantly negative correlation in women, and Bonithon et al. (1992) reported BMI change has significantly positive correlation with serum lipid level change as a result of follow-up investigation of French women for three years. A yearly physical checkup between 40 to 59 years of age of Koreans showed that men are more concentrated in serum lipid than that of the women. Also men showed strong correlation between body ratio and serum lipid, whereas women showed strong correlation between body fat ratio and serum lipid ratio (Kim, 1999).

Generally, it is considered to be desirable to exercise 30-60 minutes per day, 3-5 days per week with intensity within the range of 50-80% of an individual maximum capacity. However, in order to reduce body-fat more than 60 minutes and 6-7days a week is most reasonable. This is because exercise with high intensity usually uses glycogen and little fat, while exercise with low intensity usually uses fat as energy resource. Long term exercise was effective in lowering cholesterol level (Brownell & Kaye, 1982) and increased HDLC (Shin, 1992).

Obese women are reported to have damage to health and appearance, frequent absence due to various complications, decreased personal relations, difficulty in getting a job, restriction to marriage and sexual life and in consequence they are led to anxiety and depression (Heo, 1996). Also in the aspects of obesity-related psychological, and mental problems, obese girls have expressed deep anxiety and concerns about their appearances and weights. A obese college students are reported to have partially lowered self-esteem due to the shame and guilty feeling that they failed to watch their weights (Korean Academic Society of Primary Medicine, 1996). Besides, if the weight bounces back after successful weight loss, people criticize themselves for lack of self control, and accordingly this brings a lower self-esteem (Ruth and Jane, 1995).

Female college students, corresponding to the initial stage of an adulthood, whose developmental task is forming intimate personal relations, are affected with their developmental task by the obesity and this leads to lowered self-esteem and to have negative body image and thus avoid personal relations and become passive or have inferiority complex, and sometimes develop hypochondria in serious cases (Lee, 2000; Stunkard & Penick, 1979).

It is one of the ways to prevent the adult obesity and geriatric diseases that obese female college students are treated in early stage. Also this can save both time and cost effectively (Dietz, 1986).

Methods

1. Subject of study

The subjects of our study are university female students who attended G university located at G city. The period of sampling was from March 27 to May 19, 2000.The students

were selected in the following criteria; The BMI index=Wt/Ht is over 25 and students who understand the purpose of our study and willingly participated in this study.

2. Tools of study

1) Waist to hip ratio(WHR)

The WHR is obtained through measuring waist measure, hip measure and ratio of waist measure to hip measure three times and averaging each measurements using a parallel ruler. Especially in waist measure , the ruler has to go around the belly button and in hip measurement the ruler has to pass around the most protruding part of the hip.

2) Fat content

The fat content was measured in sitting position. The initial data, i.e., sex, age, height and weight are coded before measuring the fat content.

The fat content was measured using a fat measuring device (Futrex Co., U.S.A).

The measurement was done using Infrared source which can pass the upper part of the arm and through this measurement body fat % can be obtained.

3) Body Mass index

The weight was measured using a weighing scale (Takai Physical Test, Japan) and the BMI is measured simultaneously. The lower BMI means that one does a good job on controlling one's weight.

$$\text{BMI= (Quetlet Index) = Wt(kg)/[Ht(m)]}^2$$

4) Serum Lipid content

The serum lipid content is obtained from the subjects who did not take any food from 10 p.m. of the previous day that one takes this test. A 6cc of the blood of the subjects is taken and the blood fat content is analyzed in the lab. The TC and TG are obtained using automatic analyzer (Hitachi 7150, Japan).

The HDLC is obtained using the sedimentation technique and the LDLC is obtained using the existing formula which is reported in the literature (Friedwald, 1972).

3. Data analysis and methodology

The obtained data were analyzed through SPSS/Pc and the details are given as following: The general characteristics are presented with real number and percentile. The WHR, % body fat, weight, blood fat content and BMI are depicted with average and standard deviation. The WHR, % body fat, blood fat content, BMI and the correlation between BMI, weight and blood fat content are analyzed through Pearson's Correlation Coefficient.

Results

1. General characteristics

The average weight of the subjects is 72.38 Kg(SD=7.45). The average height

is 160.23 cm (SD=4.73). The 46.1 % of the subjects' age is between 18 to 19.

The severe obesity group(25-29.9) in terms of BMI is 80.8 % and the 19.2 % of the subjects is medium obesity(30-39.9). The 61.5% of the subjects' family income is under two million won per month. Family income between two million to two and a half million is 61.5 % and above two and a half million is 26.9 %.

The correlation between obese mother and obese daughter is 40.4 %, whereas the obese father and obese daughter is 21.2 %.

The 57.7 % of the subjects had an experience on diet and 30.6 % of the subjects are going on diet in the future. Also currently the 11.5 % of the subjects are on diet. The degree of satisfaction of the subjects on their figure is as following: barely satisfied 38.5 % and unsatisfied 59.6 %.

Thus most of the subjects are not satisfied on their figure (see Table 1).

2. Waist to Hip Ratio, Body Fat Ratio, Body Mass Index, Body Weight, Serum Lipid of Subjects

The WHR of the subjects is 0.88. The body

Table 1. General Characteristics (n=52)

Variables	Class	N	Percent (%)
Age(Yr)	18-19	24	46.1
	20-21	18	34.6
	22-25	10	19.2
BMI	<25-30	42	80.8
	30-39.9	10	19.2
Economic Status(Man Won)	<200	32	61.5
	200-250	6	11.5
	>250	14	26.9
Obesity of mother	yes	21	40.4
	no	31	59.6
Obesity of Father	yes	11	21.2
	no	41	78.8
Experience of body weight control	Was done	30	57.7
	Doing present	6	11.5
	Will do	16	30.8
Satisfaction of self-appearance	Satisfied	1	1.9
	Somewhat unsatisfied	20	38.5
	Very unsatisfied	31	59.6

fat ratio is 38.88 %. The body mass index is 28.15. The weight is 72.38 kg. The total cholesterol is 174.88 mg/dl. The medium fat is 104.29 mg/dl. The HDL-cholesterol is 50.83 mg/dl.

The LDL-cholesterol is 104.23 mg/dl (see Table 2).

Table 2. WHR, Body Fat Ratio, BMI, Body Weight and Serum Lipid of Subjects

	Mean	S.D.
WHR	.88	.05
Body Fat Ratio(%)	38.88	3.50
Body Mass Index	28.15	2.08
Body Weight(kg)	72.38	7.45
Total cholesterol(mg/dl)	174.88	29.80
Triglyceride(mg/dl)	104.29	39.57
HDL cholesterol(mg/dl)	50.83	9.79
LDL cholesterol(mg/dl)	104.23	24.39

3. correlation among WHR,BMI and Body fat content along with the correlation between Weight and Serum Lipid.

The statistically positive correlation has been observed between subjects' WHR and Trigly ceride(r=.34, p<.05). The same trend has been observed between BMI and Triglyceride(r=.30, p>.05). The negative correlation has been observed between WHR and HDL-cholesterol liver(r=-.16, p>.05). The same trend is observed between BMI and HDL-cholesterol(r=-.24, p>.05). Also body weight and HDL-cholesterol (r=-.21, p>.05) showed negative correlation but, was not significant (see Table 3).

Table 3. Correlation among WHR, Body Fat Ratio, BMI and Body Weight, Serum Lipid

	Total cholesterol	Triglyceride	HDL cholesterol	LDL cholesterol
Waist to Hip Ratio	.18(.20)	.34(.01*)	-.16(.25)	.16(.25)
Body Fat Ratio(%)	.16(.27)	.05(.75)	.01(.95)	.15(.30)
Body Mass Index	.16(.27)	.30(.03*)	-.24(.09)	.15(.28)
Body Weight(kg)	.06(.67)	.15(.28)	-.21(.14)	.14(.33)

* P<.05

Discussion

Waist to hip ratio(WHR) is used in ways to predict risk for obesity-associated diseases. When the waist circumference is greater than the hip circumference, it is called abdominal obesity(male type, central obesity). Abdominal obesity is an independent risk factor for developing myocardial infarction, angina pectoris, stroke and type-II diabetes, and increases the risk of death in both men and women, and malignant genital cancer in women (Bjrntorp, 1988). A WHR of over 0.9 in men and over 0.8 in women are defined as abdominal obesity and studies of these figures are being published in our country(Kuk, et al., 1997). An average WHR of this research is 0.88, which is abdominal obesity. Body fat content, after adolescence, is greater in women than in men, and increases as age grows (David, 1989). Generally body fat is represented by percentage and men of 15% or above and women of 25% or above are considered overweight, and men of

20% or above and women of 30% or above are considered obese (Hwang, Kim & Choi, 1997). An average body fat percentage of this research is 38.88%.

Keys, et al. (1972) and Roche, et al (1981) set a high clinical value on body mass index that it is closely correlated with body fat content and almost has nothing to do with height. However, Garrow and Webster (1985) indicated that body mass index is more useful to assess obesity than body fat content, for it reflects body fat content in accordance with height. Another view is body mass index is not clinically meaningful in women not like in man. Considering these facts, though body volume index is nothing but an index presuming body fat content, body mass index is clinically meaningful because it has high correlation coefficient with body fat percentage (Pollock, Wilmore & Fox, 1984). Screening individuals for their degree of obesity by body mass index is controversial. Garrow and Webster (1985) classified a body mass index of 20 to 24.9 light obesity, whereas there is numerical difference defining it to some extent according to researchers and countries (James, 1988). An average body mass index of this research is 28.15.

Triglyceride and Cholesterol in blood are typical lipids that increase the risk of cardiovascular disease. Normal range of triglyceride is 35-130mg/dl. Cohen and Goldberg (1960) showed that high level of triglyceride increases the risk of coronary artery disease. Excess intake of generalized favorite food is likely one of the main contributors for recent increase of triglyceride in blood (Lee & Kim, 1988; Lim & Kim, 1982). An average level of triglyceride of this research is 104.29mg/dl.

The normal range of total cholesterol is 110-270mg/dl for men, 120-288mg/dl for women and cholesterol is classified in HDL-cholesterol and LDL-cholesterol. HDL-cholesterol picks up cholesterol deposited in artery walls, transports it to liver and makes bile for disposal, so it is essential to the production of certain hormones. Accordingly, HDL-cholesterol is known as prevention factor for cardiovascular disease. On the contrary, LDL-cholesterol carries cholesterol to the artery walls and remains deposited. The higher HDL-cholesterol level, the less risk of coronary artery disease, whereas the higher LDL-cholesterol level, the greater risk of coronary artery disease. Bush, Fried and Barret-Connor (1988) reported that women are much less affected than men in cardiovascular disease with same amounts of cholesterol and usually develop it at 260mg/dl, a relatively high figure. Female college student in this research showed 174.88mg/dl of total cholesterol, 50.83mg/dl of HDL-cholesterol and 104.23mg/dl of LDL-cholesterol, which are within normal range. Wing et al (1991) reported that WHR change and HDL change in women were in the negative correlation and also there was a negative correlation between WHR and HDL change in this research but statistically not significant.

Mull et al. (1991) found that when compared the risk factors of coronary artery disease and body fat distribution, the measurements of each body parts had closer relationship with these risk factors than the measurement of subcutaneous fat with caliper. Besides, WHR had significant correlation with myocardial infarction, angina pectoris and death rate. Triglyceride and Cholesterol in blood are typical lipids that increase the risk of cardiovascular disease and in this research, there were direct correlation between WHR and triglyceride, and BMI and triglyceride, which corresponds to the research of Larsson et al (1984) that WHR was closely related to the risk of cardiovascular disease.

Conclusion & Recommendation

This research was carried out with 52 women attending G Women's University in G City who understood the participation from March 27, 2000 to May, 19, 2000. Their BMI were 25 and above. Their WHR, body fat content, BMI, weight and serum lipid were measured to understand the correlation of WHR, body fat content, BMI, weight and serum lipid.

General characteristics of subjects were analyzed with the actual number and percentage, WHR, body fat percentage, BMI, body weight and serum lipid with the average and standard deviation, correlation of WHR, body fat

percentage, BMI, body weight and serum lipid with Pearson Correlation Coefficient.

The summary of the research is as follows.

1) An average body weight of participants was 72.38Kg(SD=7.45), an average height 160.23cm(SD=4.73), 46.1% of majority were from 18 to 19 years old. Heavyweight group by BMI of 25~29.9 was 80.8%, and middleweight group by BMI of 30~39.9 was 19.2%. In their monthly family income, 'under 2million won' occupied 61,5%, '2million~ 2.5million won' 11.5%, 'over 2.5million won' 26.9%. About their mother's obesity, 59.6% answered 'not obese', 40.4% 'obese' and about their fathers obesity, 78.8% answered 'not obese', 21.2% 'obese'. About their weight watching experience, 57.7% answered 'did in the past', 30.8% 'will do in the future', 11.5% 'currently doing' and about their appearances 59.6% answered 'very unsatisfactory', 38.5% 'a little unsatisfactory', which means most participants are not satisfied with their appearances.
2) WHR of participants was 0.88, body fat percentage was 38.88%, BMI 28.15, body weight 72.38kg, total cholesterol 174.88mg/dl, triglyceride 104.29mg/dl, HDL-cholesterol 50.83 mg/dl and LDL-cholesterol 104.23mg/dl.
3) There was statistically significant positive correlation between WHR and triglyceride($r=34$, $P<.05$), and BMI and triglyceride($r=30$, $P<.05$). Negative correlations were shown between WHR and HDL-cholesterol($r=-16$, $P>.05$), BMI and HDL-cholesterol($r=-24$, $P>.05$), weight and HDL-cholesterol($r=-21$, $P>.05$), but these are not statistically significant.

Nursing Implication

Our results show us that all participants participating in our study

were in the normal ranges with respect to total cholesterol, neutral fat,

HDL-cholesterol and LDL-cholesterol. But the cardiovascular related diseases, which are strongly correlated to neutral fat, are showing strong correlation to body waist ratio(BWR) and body fat ratio.

Thus we suggest that more intensive and broad ranges of study are needed to reveal the correlation between obesity index and blood fat in between ages and sex groups. Also the obesity prevention program utilizing sport program is urgently needed in nursing care.

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