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Measurement of Subcutaneous Fat Thickness of the Korean by A-Mode Type Ultrasonic Instrument

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ABSTRACT

This study attempted to measure subcutaneous fat thickness by the use of ultrasonic wave in age and sex matched Korean subjects, and to observe correlation between fat thickness and physical indices.

In male, fat thickness of suprailiac area showed the highest value of 9.40~9.51㎜ and then subscapular was 6.60~6.84㎜, femoral was 6.48~7.04㎜ and triceps regions was 3.48~3.69㎜. In female, femoral subcutaneous fat thickness was the higher, 11.85~12.15㎜ and then suprailiac was 8.79~9.87㎜ subscapular was 6.20~6.91㎜ and triceps fat thickness was 4.80~4.93㎜.

In male, fat thickness of triceps and relative body weight(RBW), body mass index(BMI), triceps or Röhrer index were positively correlated. Correlations between suprailiac and weight, relative body weight(RBW), body mass index(BMT), Röhrer index or subscapular were positively significant.

In female, there were positive correlations between fat thickness of femoral and RBW, BMI, or Röhrer index. And there were no positive correlations in other parts of the body.

KEY WORDS : fat thickness · A-mode type ultrasonic instrument.

Introduction

Obesity as the common problem on nutrition is that the fat tissue is over accumulated in the body, and the results of many studies show that the various diseases occur in obese persons and the death rate is high.

There are many methods[1] in order to measure the degree of obesity ; standard table for weight or the physical indices comparing height with weight, the skinfold thickness by caliper, the measurement of body density[2], computed tomography(CT)[3][4], near infra red (NIR), and the regression equation[2], that we can presume the quantity of body fat from anthropometry measurement.

Both the standard weight and the physical indices are convenient methods that only height and weight needed. But, it is not a consistent table because it is different according to ages or muscular people.

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In case of the measurement of skinfold thickness by caliper, there may be some error according to the picking area, the degree of muscle tension, pressure of caliper, and slippery degree by sweat.

The measurement of body density measures lean body mass and total body fat by residual lung volume and the weight in the water[3]. This utilizes the difference of energy absorption rate between fat tissue and other tissues using X-ray. The measurement of body density has been used in the clinical cases and will be increasingly used, because it is measured easily, convenient, and accurate.

Computed tomography(CT) can distinguish intraperitoneal fat from subcutaneous fat in the side of the abdomen[3][4]. Moreover it is believed to be useful because of the finding that distribution of the abdominal cavity of the body fat is main cause of disease appearance[5][6]. However, there are some problem such as the exposure of X-ray, limited places and the use of expensive facilities.

This study attempted to measure subcutaneous fat thickness by the use of ultrasonic wave. This method was chosen by many advantage compa ring with other methods mentioned above ; the reduction of measurement time, the increase of subject, high safety and accuracy, the release from the risk of X-ray exposure, and portability instrument.

The purpose of this study was to measure subcutaneous fat thickness of Korean people and investigated the correlationship of subcutaneous fat thickness with physical indices. The tested variables were triceps, subscapular, suprailiac and femoral related to subcutaneous fat thickness and weight, height, relative body weight(RBW), body mass index(BMI), and Rohrer index related to physical indiced.

Materials and Method

A number of subjects for examination were 250 of male and 299 of female aged from 20 to 39, in Chunla buk-do without any special disease. The examination was proceeded from Mar. 20 to Apr. 30, 1991, and subcutaneous fat thickness of four parts of the body, triceps, subscapular, suprailiac and femoral were measured by A-mode type TATT[7].

In this study, $2\times10^3\sim10^6$[Hz] ultrasonic wave was used. It was known that such ultrasonic wave reflected in case of different media. Ultrasonic wave radiated from skin surface gets through subcutaneous fat and then reflect from muscle surface and come back to skin surface. By characteristics of ultrasonic wave, the image of reflected ultrasonic wave and the distance between skin surface and muscle was figured out(Fig. 1).

For physical indices, weight and height were measured, Broca index[8] [weight(kg)={height (cm)-100}×0.9] was used to get a standard weight, and relative boby weight{RBW=(real weight/

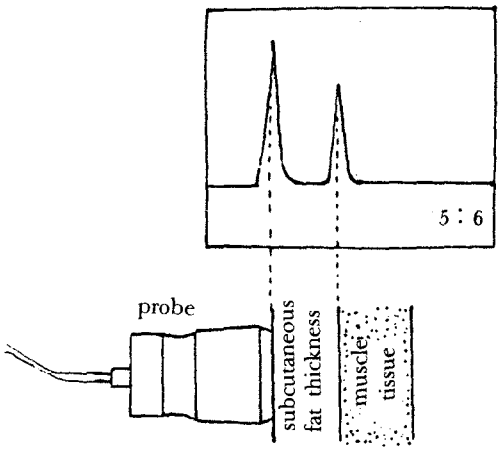

Fig. 1. Wave model of subcutaneous fat thickness on A-mode type ultrasonic instrument.

standard weight)×100}, body mass index {BMI=weigh(kg)/height(cm)^2} and Röhrer index{weight(kg)/height(cm)^3} were calculated. Frequency, the mean, standard deviation, and Pearson's correlation coefficients were calculated for this study, all the statistical analysis were performed by using the SPSS(statistical package for social science) computer package.

Results and Discussion

1. Anthropometric and physical indices for subject by ultrasonic instrument

Weight, height, subcutaneous fat thickness (such as triceps, subscapular, suprailiac and femoral), RBW, BMI and Röhrer index according to the age groups are shown in Table 1.

In male, according to the age, subjects were divided by three group. subgroups : 150 subjects aged from 20 to 24, 43 subjects aged from 25 to 29, and 57 subjects aged from 30 to 39.

Average weight and height of these three subgroups were ranged from 62.0kg to 64.8kg and 167.8 cm to 172.9cm, respectively. Anthropometric data such as weight and height of these three subgroups in this study showed that 62.0~64.8kg and 167.8~172.9cm respectively. The Korea National Nutrition Survey Report on 1988[9] showed similar trends in weight and hight classified by age.

In male, subcutaneous fat thickness of suprailiac was showed the highest value of 9.40~9.51mm, and then subscapular was 6.60~6.84mm, femoral was 6.48~7.04mm, and triceps was 3.48~3.69mm. Compairing subcutaneous fat thickness in this study with value of Japanese[11], the numerical value was generally low as 0.5~2.0mm. The lower subcutaneous fat thickness of the male subjects in this study may be a reflection of greater measurement errors compared with Japanese data.

When RBW was 110-120, BMI was over 24, and

Table 1. Measurement of antropometry and physical indices for male and female subjects by ultrasonic instrument

Age	Subject	Weight	Height	Skinfold thickness				Relative Body Weight (RBW)	Body Mass Index (BMI)	Röhrer index
				Triceps	Subscapular	Suprailiac	Femoral			
Year	Number	kg	cm	mm						
Male										
20−24	150	62.0 ±5.4[1)]	172.9±2.8	3.69±1.4	6.67±2.3	9.51±3.0	6.48±2.0	103.8±6.2	22.8±1.3	131.7 ± 8.3
25−29	43	63.1 ±8.2	171.3±1.5	3.53±1.9	6.60±2.4	9.40±2.7	6.80±4.2	103.8±8.4	22.7±1.8	132.6 ±10.3
30−39	57	64.8 ±5.2	167.8±4.5	3.48±0.7	6.84±0.8	10.44±2.1	7.04±1.2	112.3±8.6	24.2±1.7	145.0 ±12.0
Female										
20−24	186	51.25±5.0	160.5±4.8	4.88±1.8	6.91±2.6	8.79±3.4	12.11±2.5	94.32±9.0	19.89±1.8	124.04±12.4
25−29	45	49.50±0.6	163.3±4.6	4.80±1.3	6.2 ±0.9	9.25±3.9	12.15±1.1	87.31±6.6	18.61±1.1	114.19± 9.9
30−39	86	50.5 ±3.8	158.7±2.3	4.93±1.3	6.2 ±2.6	9.87±2.1	11.85±2.1	94.75±7.4	19.86±1.5	125.21± 9.9

1) Mean± S.D.

Röhrer index 145-165 were classified as over weight, in male, the group aged from 30 to 39(112.3 of RBW, 24.2 of BMI, and 145.0 of Röhrer index) was the only over weight compared to the rest of groups.

In female, average weight and height of three age subgroups ranged from 49.50kg to 51.25kg and 158.7cm to 163.3cm, respectively.

Weight and height of these three subgroups in this study showed that 49.6~51.8kg, and 158.3~161.6cm, respectively. This results showed smiliar tendency in weight and height classified by age by the Korea National Nutrition Survey Report on 1988. In female, subcutaneous fat thickness of femoral was the highest 11.85~12.15mm, and then suprailiac was 8.79~9.87mm, subscapular was 6.20~6.91mm, and triceps was 4.80~4.93mm, Comparing this value with Japanese women[11], numerical value in this study was low. It was also believed that the women subject in this study may be a refrection of greater measurement errors compared with Japanese data. RBW, BMI, and Röhrer index were within the normal range in three groups.

2. **Correlations between anthropometry measurement and physical indices for male and female subjects.**

The correlation among weight, height, subcutaneous fat thickness of the four parts of the body, RBW, BMI, and Röhrer index were as follows (Table 2).

In male, there were positive correlations between fat thickness of triceps and RBW(r=0.621), BMI(r=0.618), or Röhrer index(r=0.622), in fat thickness of suprailiac and weight(r=0.551), RBW(r=0.457), BMI(r=0.478), Röhrer index(r=0.418), or fat thikness of subscapular.

In previous research[10], fat thickness of suprailiac was the best index to show the degree of obesity in male. This results were the same in this study. Therefore, the part of suprailiac was obviously the most useful in the measurement of subcutaneous fat thickness by the use of ultrasonic wave.

In female, fat thickness of femoral had positive correlation with RBW(r=0.339), BMI(r=0.347), and Röhrer index(r=0.330). And there were no positive or negative correlations in other parts of the body.

Examiner error resulting from inadequate training, instrument error, measurement difficulties, and random error resulting from limited number of observations are thought as the limlts of this study.

Some of these measurement errors can be minimized by training personnel to use standardized, validated techniques, and instruments that are precise and correctly calibrated. And random errers can be reduced by increasing the number of observations. So, subcutaneous fat measurement by A-mode instrument should be attempted to many subjects, other measurements that are skinfold thickness by caliper, body density, CT, and constitution of plasma lipid should be run parallel.

Summary

This study obtained the average value of subcutaneous fat thickness in Koreans.

Subcutaneous fat thickness of four parts of the body, triceps, subscapular, suprailic and femoral was measured by A-mode type TATT, and got correlation between subcutaneous fat thickness and physical indices. In male, fat thickness of suprailiac was the higher, 9.04~9.51mm and then subscapular 6.60~6.84mm, femoral 6.48~7.04mm and triceps 3.48~3.69mm. In female, femoral was the higher, 11.85~12.15mm, and then suprailiac 8.79~9.87mm, subscapular 6.20~6.91mm and triceps

Table 2. Pearson's Correlation Coefficients among various factors for male and female subjects

		Weight	Height	Skinfold thickness				Relative Body Weight (RBW)	Body Mass Index (BMI)
				Triceps	Subscapular	Suprailiac	Femoral		
Height	m	0.0858***							
	f	0.4088							
Triceps	m[1)]	0.4960	−0.3618						
	f[2)]	0.1016	0.0651						
Subscapular	m	0.2773	−0.1635	0.0742					
	f	−0.0170	0.2230	0.2350					
Suprailiac	m	0.5508***	0.0816	0.0364	0.4331**				
	f	−0.0319	0.2230	−0.0343	0.2039				
Femoral	m	0.3378	0.0871	0.2283	0.2338	0.3388			
	f	−0.2878**	−0.0495	0.1997	0.1242	0.1043			
Relative Body Weight (RBW)	m	0.8268***	−0.4847	0.6209**	0.3423	0.4571**	0.2545		
	f	−0.6699***	−0.4003***	0.0279	−0.2067	−0.2217	0.3388**		
Body Mass Index (BMI)	m	0.8743***	−0.4059	0.6176***	0.3361	0.4775**	0.2706	0.9957***	
	f	−0.8010***	−0.2173	0.0540	−0.1761	−0.1872	0.3468***	0.9806***	
Röhrer index	m	0.7617***	0.5757**	0.6219***	0.3391	0.4179**	0.2266	0.9942***	0.9804***
	f	0.6028***	−0.4791***	0.0221	−0.2240	−0.2344	0.3295**	0.9960***	0.9604***

1) m : male 2) f : female **$p<0.01$, ***$p<0.001$

4.80~4.93㎜.

In male, correlation between subcutaneous fat thickness of triceps and RBW, BMI, or Röhrer index, suprailiac and weight, RBW, BMI, Röhrer index or subscapular was positive significant. So, fat thickness of suprailiac by the use of ultrasonic wave is useful.

In female, subcutaneous fat thickness of femoral had positive correalation with RBW, BMI, and Röhrer index. And there were no positive correlation in other parts of the body.

From advantage of ultrasonic instrument and useful results of this study, ultrasonic wave was suggested to be used increasingly for future studies.

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A-mode 식 초음파기를 이용한 한국인의 피하지방 측정

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= 국문초록 =

초음파기(A-mode type, TATT, TH-500, Datoherutsu Co, Japan)를 이용하여 20-39세의 한국 사람들의 삼두박근, 견갑골하부, 장골위, 대퇴부의 피하지방을 측정하고, 이 피하지방 두께와 표준체중, 상대체중(relative body weight, RBW), body mass index(BMI), Röhrer지수와의 상관관계를 알아 보았다.

남성에서는 장골위의 피하지방 두께가 9.04~9.51㎜로 가장 크고, 견갑골 아래가 6.60~6.84㎜, 대퇴부가 6.48~7.04㎜, 삼두박근이 3.48~3.69㎜이었다. 피하지방 두께와 여러 신체지수와의 상관관계를 보면 삼두박근의 피하지방 두께와 BMI(r=0.618), Röhrer 지수(r=0.622)가, 장골위의 피하지방 두께와 체중(r=0.551), RBW(r=0.457), BMI(r=0.478), Röhrer 지수(r=0.418), 견갑골 하부의 피하지방 두께(r=0.433)가 양의 상관관계가 있었다.

여성에서는 대퇴부의 피하지방 두께가 11.85~12.15㎜로 가장 크고 장골위가 8.79~9.87㎜, 견갑골하부 6.21~6.91㎜, 삼두박근이 4.80~4.93㎜이며, 대퇴부의 피하지방 두께가 RBW(r=0.339), BMI(r=0.347), Röhrer 지수(r=0.330)와 양의 상관관계를 나타냈다.

남성의 경우 삼두박근의 피하지방 두께가 RBW, BMI, Röhrer 지수와 상관관계가 있었고, 장골위의 피하지방 두께는 RBW, BMI, Röhrer 지수외에 체중과도 상관관계가 있었으므로 초음파를 이용한 피하지방측정은, 남성은 장골위가 가장 유용함을 알 수 있었고, 여성의 경우는 대퇴부의 피하지방 두께가 RBW, BMI, Röhrer 지수와 상관관계가 있었으므로 대퇴부의 피하지방 측정이 가장 유용함을 알 수 있었다. 비만 측정에서 초음파 장치는 여러가지 장점이 있으므로 앞으로 이에 대한 연구가 있어야겠다.