보건학박사 학위논문

Discrepancy of Obesity Prevalence and the Effect Sizes on Chronic Diseases depending on assessing tool: Self-reported vs. Measured Weight and Height

측정도구에 따른 비만율의 차이와 만성질환에 대한 영향력의 차이: 체중, 신장의 자가보고와 신체계측 결과의 비교

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Abstract

Discrepancy of Obesity Prevalence and the Effect Sizes on Chronic Diseases depending on assessing tool: Self-reported vs. Measured Weight and Height

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While there are strong correlations between self-reported and directly measured anthropometric data, the discrepancy and systematic errors associated with these, particularly among middle-aged and older persons residing in South Korea, remain a contentious issue.

All participants were selected from the Korean Longitudinal Study of Ageing (KLoSA), a panel study conducted by the Korea Labor Institute; data from 510 participants (290 females; 56.9%) were analyzed. We considered general characteristics, including sex, age, education, marital status, employment, income, and residential region, and used self-rated health as a generic indicator of health status.

On the first subject, accuracy of obesity classification from self-reported data, one-way ANOVA, t-test, and Scheffé's test ($\alpha = 0.1$) were employed to explore the difference between directly measured and self-reported values. Sensitivity and

specificity values were used to assess the validity of obesity diagnoses based on self-reported BMI.

The means of BMI differences were 1.3 (±1.2) kg/m^2 among men and 1.8 (±1.5) kg/m^2 among women. In men, the difference could be attributed to measured BMI and residential region; among women, age and education level influenced the discrepancy in BMI. Scheffé's test ($\alpha = 0.1$) for multiple comparisons of group means revealed that women over the age of 65 years, with relatively low middle-school education, who lived in rural areas, and had a measured BMI of 25 kg/m^2 or more, were significantly more likely to have BMI discrepancies. In contrast, for men, significant predictors were living in rural areas and being obese. Although adequate correlations were seen in self-reported BMI, they indicated low sensitivity, with 46.5% and 60.1% among males and females, respectively. However, specificities were very high, at 97.8% and 98.0% for males and females, respectively.

On the second subject, different measure of obesity leading to relevance change, χ^2 was used for differences in obesity prevalence diagnosed by BMI calculated from self-reported height and weight by categories in each variable. Multiple logistic regression for obesity in the case of using reported BMI and measured BMI was conducted to define what variables have correlation with obesity prevalence by sex.

Categories that showed higher prevalence of obesity in employment, income, and region groups were men who are employed (23.7%), receive top-quarter income (30.9%), and live in smaller cities (18.6%), respectively in men. The overall prevalence of obesity had risen in each variables, indicating the incidence of the under-reporting. The measured obesity showed no difference in highest prevalent category, however, overall prevalence of obesity was significantly higher than reported obesity in women. In men, age was a significant factor identifying the discrepancies between reported and measured obesity. Reported obesity of men aged 45-54 was 29.8% whereas measured obesity of those was 57.5%. In contrast, age of the women showed no significant trend or differences in reported and measured obesity. In men, level of education reported no differences on report and measured obesity, however, women showed significant difference between level of education and obesity prevalence. Regarding relevancy, after adjusting age, sex, and other socioeconomic status, self-rated health group presented statistically significance in moderate health status group than bad health status group in all. Analyzing after age and socioeconomic status were adjusted with sexes, in men, each variable was difficult to identify the statistical trend. However, in women, obesity prevalence was reported higher as the age decreased, reported obesity was not significant but measured obesity was.

For the study of the change in association from using different measurements, we made model with obesity and chronic conditions; diabetes, hypercholesterolemia and hypertension. The prevalence of diabetes was 15.9% in both genders. There were significant trend between diabetes prevalence in self-rated health, working status, residence area, and measured obesity in all population. The prevalence of hypercholesterolemia was just 12.6%, 64 cases. There were no significant variables for chai square test. The prevalence of hypertension were 51.8% in men and 51.0%

in women. The level of obesity from both method and residence region were significant in chai square test. As results of multiple logistic regression to assess the association between obesity and hypertension, compared obesity from reported with measured BMI, odds ratios were considerably changed by BMI measuring method and sex. For all, both men and women, odds ratio of measured obesity was higher than reported. Considered separately by sex, odds ratio of reported obesity was relatively high in both sexes.

Finally, the evaluation of effect of obesity from self-reported BMI on chronic conditions, is relevant for estimation of health risk itself and its trend depending upon obese level, compared with effect of obesity from measured BMI. But, for estimation to the magnitude of the risks, we have to be concerned about not only under-estimation but also over-estimation.

This study population was just 510 persons. Even though self-reporting error comes from multi-directional and diverse elements, all possible covariates could not be included in the analyzing model because of sample size. Therefore, the results of this study has potential instability. A larger study based in community is needed to explain a more precise estimate of effect of reporting error in obesity classification.

Keywords: BMI, obesity, validity, reporting error

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Chapter 1. Introduction

1.1 Global pandemic of obesity and Ageing society

We are now hemmed in by the serious warning against obesity. The first WHO Consultation on Obesity held in Geneva in 1997. The participating experts strongly had admonished of an intensified epidemic of obesity that would put the populations of most countries at the peril of rising non-communicable diseases (NCDs).[1] In 2008, 35% of adults of the world's population were overweight, and 11% were obese. More than 40 million children aged under 5 years were overweight or obese in 2012.[2] And now, obesity is widely recognized as the massive menace leading health problems in most countries including low-income nations around the world and as a dominant risk factor for type 2 diabetes, hypertension, cardiovascular disease, and some cancers.[3,4]

Despite diverse intervention for obesity, the prevalence has grown up without any reverse against the earlier in any population. Intransigent proliferation of obesity to any efforts for preventing and controlling it, provokes public health professional's awareness about the fundamental principles. In the epidemiologic study, the basic subject is the distribution and determinants of health problem in population.[5] Explicit delineation of obesity distribution and its relative factors is the beginning of accurate intervention through evidence-based decision making. That is the appointed task before epidemiologists. If we don't have any key to the settlement of global obesity pandemic until now, we should inspect the alpha and omega of howgozit dissidence not only in the context of the global scene but also in each regional, national population, and of various strata.

In addition to the spread of obesity, the ageing world has been main pillar of burden in public health worldwide rather than advanced countries. In older population, obesity can aggravate the age-related decline of physical and mental function lead to frailty. However, health risk for obesity in older people is controversial because of the health risk reduction associated with increasing body mass index (BMI). On the other side the concern that weight loss or lower BMI could have potential more adverse effects in the older population.[6-8]

BMI gradually increase during most of adult life and attain its peak values at 50–59 or 60-69 y of age in both men and women.[9,10] Aging is associated with considerable changes in body composition. Since the twenties, fat-free mass (FFM) gradually decreases, whereas fat mass increases. FFM (primarily skeletal muscle) shrinks by up to 40 percent from twenties to seventies. Aging also leads a redistribution of both body fat and FFM.[11] Consequently, through aging process an intra-abdominal fat increases more relatively than subcutaneous or total body fat, and a greater relative decrease in peripheral is leaded than in central FFM because of sarcopenia, that is the loss of skeletal muscle.[12]

Moderate weight loss in association with physical activity improves physical function and health status for quality of life in obese elderly people. Results from studies conducted in overweight and obese older people with either osteoarthritis or without joint disease have indicated that the combination of moderate diet for weight loss and exercise intervention improved physical function and health-related quality of life. The combination of diet and exercise showed a better beneficial effect than either diet or exercise alone.[13,14] Therefore obesity is an administrable and manageable factor of frailty and impaired quality of life for older people.

1.2 Obesity prevalence in Korea

On an international scale, obesity prevalence in Korea is the second lowest following Japan in the OECD, but is increasing steadily. About 4% of adults is obese (30.0 kg/m^2≤BMI), and about 30% are overweight (25.0 kg/m^2≤BMI, including obese). OECD prospects that overweight prevalence will increase by another 5% less than ten years in Korea.[15]

In Korea, the national health and nutrition survey (KNHANES) has been conducted regularly from 1995. In the results of 1995, the obesity (25.0 kg/m^2≤BMI) prevalence in adults, aged 19 and more, was 13.9% (11.7% in men and 18.0% in women), although this result was from data composed of self-reported information and thus can be assumed to be underestimated. After many twists and turns in the process of survey and creating and applying standard criteria for analysis and evaluation for more than a decade, now the system has been stabilized. Through the results of KNHANES, obesity (25.0 kg/m^2 ≤ BMI) prevalence has moved up in men by almost ten percent just for the last decade[16]. At the same time, prevalence of hypercholesterolemia and dyslipidemia is rising by about 5% without gender difference[17].

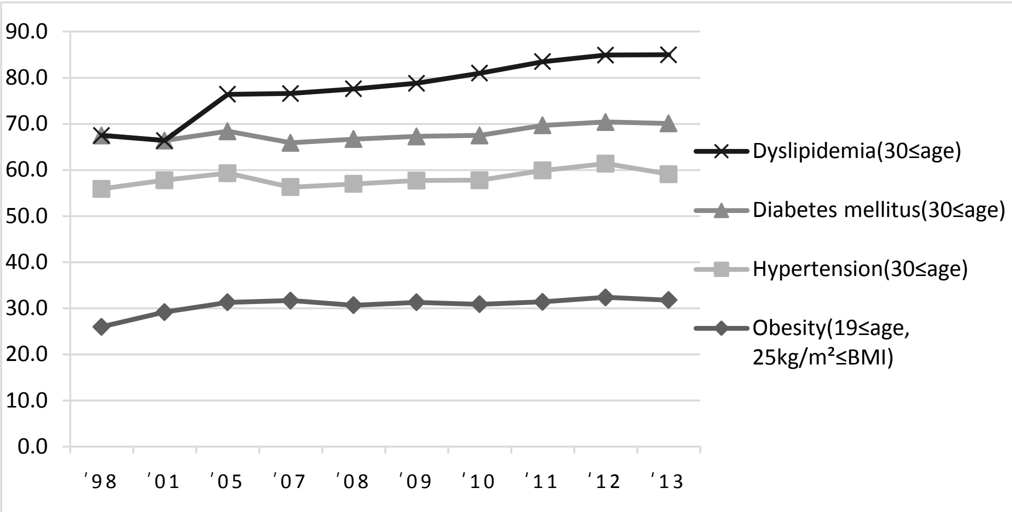

Figure 1. Trends of chronic status prevalence in Korea (from KHANES)

1.3 International obesity prevalence monitoring in OECD using self-reported and measured data

In Organization for Economic Cooperation and Development (OECD) Health Statistics 2014, among 34 member countries, five countries; Japan, Luxembourg, Mexico, New Zealand, and United Kingdom present only obesity prevalence from measured anthropometric information. Amongst else 29 countries, twelve countries present both self-reported and measured obesity prevalence.

Based on data of these 12 countries, differences between self-reported prevalence and measured of overweight or obese population are multifarious values. The mean of difference was 4.7% in men, whereas 8.8% in women (Table 1.1). If we take a close look at the table 1.1, we can find diverse pattern of difference. Chile was unique country that men reported by more difference than women. On the contrary, the Czech and Slovak Republics showed over-reporting tendency in men, and the lowest discrepancy in women among analyzed countries. Australia, Canada, and Finland were not so much different in men and women. Turkey and United States presented a huge difference in women, but almost no difference in men.

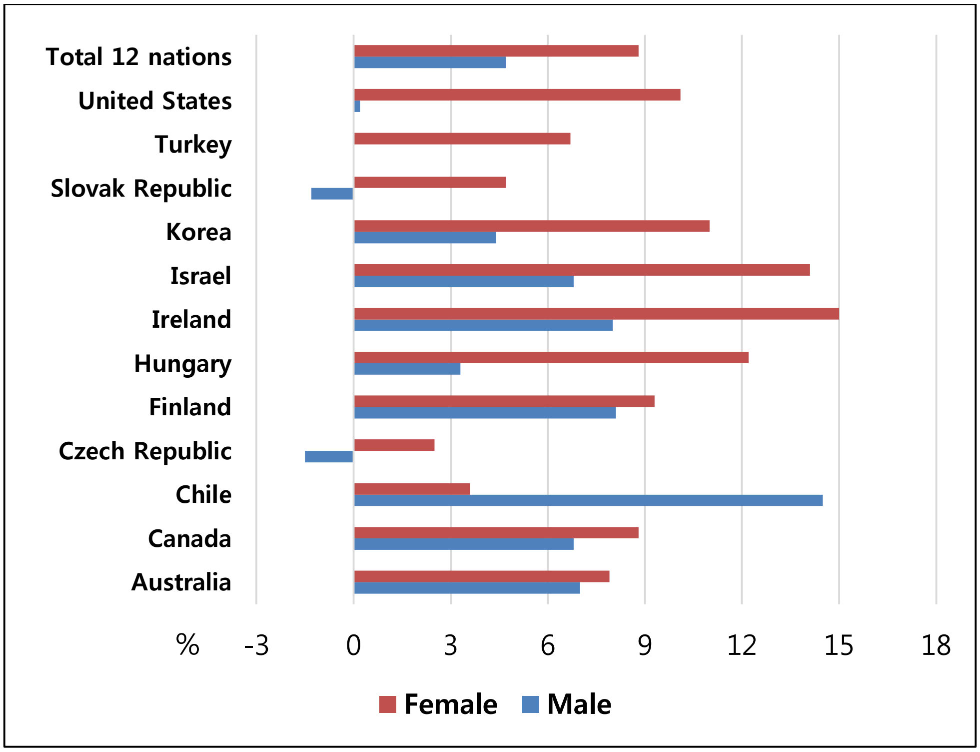

Figure 1.2, Differences in prevalence of overweight and over between from reported and measured BMI in 12 OECD countries *Source: OECD (2014), OECD Health Statistics 2014, Data*

extracted on 20 Oct 2014 05:11 UTC (GMT) from OECD.Stat

Overall women are more likely than men to under-report their corpulence worldwide. The under-reporting aspect features personal demographics, region and nationality involved sociocultural contexture.

Since most countries including low-income countries, still overweight and obesity rates are self-reported through estimates of height and weight from population-based health interview surveys, we cannot cavil at self-reported information. Rather, we need to find how to use it appropriately and what to do for understanding and improving it.

1.4 Diagnosing obesity

At their most basic, ‘overweight’ and ‘obesity’ are ways of describing morphology having too much body fat. To be more precise, obesity is a status of containing excess adipose tissue. How can we measure the amount of body fat properly from live body? And how should we define the fair amount? They are the central themes in diagnosing corpulence.

After the 1980s, the obesity diagnosis has come to rely on the value of the body mass index (BMI), defined as the weight in kilograms divided by the square of the height in meters. Today BMI becomes the most common measurement from anthropometric information to diagnose obesity all the more for its convenience.

Table 1.1 Differences† in prevalence of overweight and over between form reported and measured BMI in 12 OECD countries *Source: OECD (2014), OECD Health Statistics 2014, Data extracted on 20 Oct 2014 05:11 UTC (GMT) from OECD.Stat*

Nations	Male					Female				
	Self-reported	Year*	Measured	Year*	Difference	Self-reported	Year*	Measured	Year*	Difference
Australia	63.3	2007	70.3	2011	7.0	48.3	2007	56.2	2011	7.9
Canada	58.0	2012	64.8	2010	6.8	43.7	2012	52.5	2010	8.8
Chile	50.1	2009	64.6	2009	14.5	60.7	2009	64.3	2009	3.6
Czech Republic	62.5	2008	61.0	2010	-1.5	46.5	2008	49.0	2010	2.5
Finland	57.8	2012	65.9	2007	8.1	43.1	2012	52.4	2007	9.3
Hungary	59.4	2009	62.7	2009	3.3	48.5	2009	60.7	2009	12.2
Ireland	59.0	2007	67.0	2007	8.0	41.0	2007	56.0	2007	15.0
Israel	58.9	2013	65.7	1999	6.8	44.7	2013	58.8	1999	14.1
Korea	30.4	2012	34.8	2012	4.4	17.7	2012	28.7	2012	11.0
Slovak Republic	59.1	2009	57.8	2008	-1.3	43.0	2009	47.7	2008	4.7
Turkey	52.7	2012	52.7	2011	0.0	51.3	2012	58.0	2011	6.7
United States	71.1	2012	71.3	2012	0.2	56.0	2012	66.1	2012	10.1
Total 12 nations	**56.9**		**61.6**		**4.7**	**45.4**		**54.2**		**8.8**

†the measured value - the self-reported value
*of latest version update

The BMI was first described in 1832 by Adolphe Quetelet, a Belgian mathematician who noticed that, he considered to be 'normal frame' in people, the weight was proportional to the height squared. His statement was 'the weight increases as the square of the height' and that was known to the Quetelet Index. However, It was not used in epidemiologic studies until 1972 by Ancel Keys and introduced in clinical field after more than a decade.[18] BMI provides the most useful measure of corpulence in population-level as it is the same evaluation for both sexes and for all ages of adults, but not for children. However, it should be taken as a rough guide because it may not be in accord with the actual degree of fatness in different individuals.

Other measurements of estimating body fat and its distribution allow measuring skinfold thickness and waist circumference, waist-to-hip circumference ratio, and more technical mensuration such as computed tomography, and magnetic resonance imaging (MRI). Waist circumference, commonly used as BMI, is particularly meaningful for a measure of abdominal adiposity, not for whole body adiposity. The person with the higher circumference of waist has more than a quintuple risk of multiple cardiometabolic risk factors, even adjusting of BMI.[19] Regardless of the measure used in diagnosing obesity, there is irresistible evidence of relevancy, and further, a causal relationship between obesity and various comorbidities and even mortality. For example, despite their higher BMI, athletes have less fat than the general.

1.5 Reporting error in self-reported anthropometric data

So many studies about the accuracy of self-reported anthropometric data recently have been performed, however most of all in western region. There are high correlations between self-reported and measured values for height and weight. That was why many studies have scared up the validity of the self-reported body weight and height.[20-23] On the contrary, the other side takes issue with their discrepancy and systematic errors in self-reported values.[24-30] Self-reported weight and height are unreliable in important population subgroups of usually high obesity prevalence, such as overweight females and middle and order aged. High weight is also a predictor of reporting error in height.[31,32] Other than intentional reporting errors, many people are unaware of their anthropometric data.[33] Especially it was more frequent in women and older. In fact, systematic error can be due to both intentional and unintentional. The error affects reliability, and that should be consequent on validity damage.

In Korea, a few studies comparing self-reported data with directly measured were conducted in clinical circumstances.[23,34] Many research surveys including anthropometric information in public health are conducted in community with questionnaire. The study results using anthropometric information derived from questionnaire and examiner's measuring, such as obesity prevalence, should be different. The magnitude of discrepancy according to distribution of influential factors, such as gender, age and education, would be changed. Accordingly, the measuring tool difference must be alerted before the results are compared and interpreted for any political decision. This point is very important for decision makers to assign a priority to public health policy, practice or intervention.

Epidemiologic study should be a driver to seek solution and medium to influence and shape public health policy. We need to ensure that the understanding about data collecting process and cognitive structure affected by sociocultural anthropology of the population to find the best effective decision. In the age of global pandemic obesity, an accurate assessment of the obesity prevalence and understanding its trends through time and other factors are essential for public health policies and practices to prevent obesity and related chronic diseases.

1.6 Objectives

The study purpose of this dissertation is to explore the phenomenon caused by reporting error on measuring obesity prevalence in middle-aged and order Korean populations. Difference between self-reporting and directly measuring values always is largely controversial in epidemiologic investigation. And older adults are a very heterogeneous population in and of themselves. For these reasons, understanding of the shape and its influence of measuring error on health variables with middle aged persons is necessary for establishing that the measuring from self-report would work well and be more apt for a means of classifying persons as obese with some concern. Consequentially, self-reported or subjective information with understanding its systematic error distribution and mechanism would be an appropriable tool for the measuring aim.

The objective of the first sub-study was to probe the differences between directly measured and self-reported BMI calculations based on several important variables in a sample of middle aged and older Korean individuals. In addition, despite an adequate correlation of self-reported weight and height, we tried to define the validity (sensitivity and specificity) of self-reported BMI for obesity assessment by related factors and to see any dissimilarity between them.

The second objective was to explore the distribution of differences between reported and measured values in weight, height and BMI according to relevant factors. Furthermore, I tried to define how directly measured and self-reported BMI affect the relationship between whether or not obese; obesity diagnosis and relative demographic and socioeconomic factors.

The last part of this study was conducted to validate the change of association from using different measurement. Through comparison between the effect of obesity from reported data and measured to diabetes prevalence, we evaluated whether self-reporting error affected the association with other related factors.

Chapter2. Self-reported anthropometric information cannot vouch for the accurate assessment of obesity prevalence in populations of middle-aged and older Korean individuals

2.1 Introduction

Height and weight are important indicators of population health because of their role in the calculation of the body mass index (BMI: body weight in kilograms divided by the square of height in meters), a common measure of obesity and a simple evaluation of anthropometry and nutrition.[35] The BMI and waist circumference are typically used to assess obesity prevalence in a population, due to practical reasons such as low costs, minimal manipulation, and consent by the examinees.[36] For similar reasons, body weight and height are usually determined through a self-reported questionnaire.

Self-reported and measured values for height and weight are strongly correlated; thus, many studies assume that self-reported data are valid.[20,22,23] However, researchers have expressed concerns regarding discrepancies and systematic errors in self-reported values, as these are unreliable in population subgroups with a high prevalence of obesity (e.g., overweight women and middle-aged and elderly individuals).[24,26-29,37] High body mass is also a predictor of errors in reporting height measurements.[31,32] In addition to intentional reporting errors, many people are unaware of their anthropometric data, particularly women and older adults.[33] In fact, systematic error can result from both intentional and unintentional misreporting, thus affecting reliability and, in turn, validity.

Any change in height that is related to ageing has implications beyond descriptive anthropometry. If height changes with age, indexes of obesity such as the BMI would also change with age, independently of changes in actual obesity levels.[38] Ageing is an important cause of height loss, resulting from postural change such as stooping and hyperkyphosis, and degenerative intervertebral disc disease.[39] Loss of height could also arise from several clinical conditions involving vertebral fractures, spinal compression, stenosis, high body mass, and osteoporosis.[8,40,41] This general decline in stature is likely to result in unintentional errors. The effects of errors would be more complex when resulting from intentional bias related to reporting weight, such as when BMI is used for obesity diagnosis.

To date, our knowledge regarding the accuracy of self-reported anthropometric data is based on Western studies. A review on this topic included 64 studies comparing self-reported and directly measured anthropometric data; 53 of the studies were conducted in North America and Europe, whereas only two were conducted in Asia (Japan). In all 64 studies, only height, weight, and BMI were defined as outcomes.[36] In South Korea, a few studies comparing self-reported data with directly measured data were conducted in clinical settings.[23,34] Lee et al. found reasonable validity of self-reported height and weight, based on a Pearson's correlation coefficient that was greater than 0.9, a Kappa value greater than 0.7, a sensitivity of more than 80%, and a specificity of more than 90%.[23] If anthropometric data are used for diagnosing obesity, rather than defining the average build or standard physique of a population, the actual accuracy of this data must be evaluated according to gold standard information, such as sensitivity and specificity. In the case of weight, whole body imaging and hydrostatic weighing are known as the gold standard; in this study, directly measured weight and height were used as benchmarks against which to compare self-reported values. The most important approach required for defining factors associated with the accuracy of self-reported information (i.e., reporting bias) is the comparison of subjective and objective information.

The evaluation of factors that are possibly related to reporting bias has implications for the actual researcher's understanding of data and the results obtained from those data. This is because self-reports are based on social norms and participants' self-perceptions and personal characteristics.[42] Relatively few studies have been conducted on factors associated with errors of self-reported height and weight in Asia.

Although many studies have focused on the discrepancy between self-reported and directly measured anthropometric data, the adequacy of those data in measuring corpulence has not been established. There would be differences in data indicating obesity prevalence, as obtained through anthropometric information provided in questionnaires on the one hand, and examiners' measurements on the other. Accordingly, differences in measuring tools must be addressed before the results are compared, interpreted, and used as a basis for any policy decisions. This is particularly important for the relevant stakeholders and policy makers when determining priorities for public health policy, practices, or interventions. Therefore, the first objective of this study was to probe differences between directly measured and self-reported BMI, based on several important variables in a sample of middle-aged and older Koreans. In addition, other than the adequate correlation between self-reported and directly measured values in weight and height, we defined the validity (sensitivity and specificity) of self-reported BMI for obesity assessment according to related factors and defined any differences between levels of those factors.

2.2 Methods

2.2.1 Data and Study Population

All participants were drawn from the panel data of the Korean Longitudinal Study of Ageing (KLoSA), which used national multistage cluster sampling to select Koreans aged 45 years and older; the study began in 2006 and is conducted biannually by the Korea Labor Institute, Ministry of Labor.[43] In the study, household interviews were conducted with a computer-assisted personal interviewing technique. The main questionnaire gathered data regarding the participants' demographic background, family structure, health, functional limitations and caregivers, health insurance and health care utilization, expectations, employment, individual income, housing, and assets. The first wave was conducted between July and December of 2006, with an individual response rate of 89.2%, representing 10,254 persons surveyed by trained interviewers. The second wave was conducted from July to October 2008 and included 8,688 (3,767 males; 43.4%) persons. For the biomarker pilot study, we randomly sampled 527 (301 females; 57.1%) participants from the panel study who responded during the second wave of the KLoSA. After excluding cases with incomplete anthropometric information (n = 17), data from 510 participants (290 females; 56.9%) were used for our analyses.

All the participants were 47 years or older at the time of the interview. Written informed consent was obtained before the KLoSA interview and the physical examination. The study protocol for the physical examination was reviewed and approved by the institutional review board of Seoul National University Hospital (College of Medicine).

2.2.2 Measures

BMI and obesity

The BMI, computed as body weight (in kilograms) divided by the square of height (in meters), was reported and measured. Measured BMI was calculated using direct measurements of weight and height; reported BMI was calculated using self-reported weight and height. A trained nurse visited participants and conducted the physical examination, including the direct measurements. Nurses used a scale (Omron Karada Scan HBF 362) for body weight measurement and a measuring tape for height. The measurements were taken while the participants were bare-footed and dressed lightly.

Weight and height were measured twice; the mean of the two values was used to calculate BMI. Self-reported weight and height were obtained from the second-wave KLoSA survey questionnaire.

Based on recommendations from the WHO,(World Health Organization, 1997) overweight and obesity are defined as BMI ≥25.0 kg/m^2 and ≥30.0 kg/m^2, respectively. However, the Korean National Health and Nutrition Examination Survey (KNHANES) defined obesity as BMI ≥25.0 kg/m^2, based on recommendations from the WHO and other groups regarding BMI and morbidity risk among East Asians.[44,45] In addition to that, when obesity is defined as BMI ≥30.0 kg/m^2, the number of obese individuals in our study included four men and 25 women, based on directly measured BMI data. For these reasons, in the present study, we defined obesity as BMI ≥25.0 kg/m^2. Consequently, we could secure ample cases to evaluate the sensitivity and specificity of each variable according to category.

Demographic, socioeconomic, and health-related variables

Participants' socioeconomic characteristics (sex, age, education, marital status, employment, income, and residential region) were obtained from the self-reported KLoSA data. Age was categorized into three groups: 45–64, 65–74, and ≥75 years old. Education was categorized into four groups, determined by the highest level completed: primary (completed primary school or less), middle (completed middle school), high (completed high school), and university (completed university or higher). Marital status was coded as married, separated, divorced, bereaved (or no response), and never married. However, the frequencies of marital status categories other than “married” that were reported were very low; therefore, we reclassified “married” as “living with spouse” and the other categories as “living without spouse.” Working status was classified as employed, not working (but seeking work), retired/housewife as inactive, and was later re-classified as “employed” and “unemployed.” The unemployed group included housewives and retired individuals as well as those who were not working. Equivalent household income was calculated as total household income divided by the square root of the number of household members; these scores were then divided into quartiles. Participants' residential regions were classified into three types: large city, small city, and rural area.

We used self-rated health (SRH) as a generic indicator of health status. Although its accuracy is disputed, SRH is an independent predictor of health status when other health outcomes are taken into account. Response choices for SRH were excellent, good, fair, poor, and very poor. We classified excellent and good as “good,” fair as “moderate,” and poor and very poor as “bad.”

2.3.3 Analyses

A one-way analysis of variance and t-tests were used to determine differences between reported and measured BMI, based on participant characteristics such as age, education, marital status, economic factors, and residence; p-values for trends in each factor were calculated. In addition, Scheffé’s test ($\alpha = 0.1$) was used to verify where those differences are. Sensitivity and specificity values were used to assess the validity of obesity diagnosis, based on a comparison of self-reported BMI and the objective standard of measured BMI.

We developed algorithms and predictive equations using simple linear regression, with age, reported weight, height, and BMI as predictor variables, which enabled us to estimate more accurate BMI values and overweight prevalence. First, we created a sub-sample (Sample 1) by randomly selecting participants from the main study in order to develop predictive equations. Then, we applied these equations to the remaining individuals (Sample 2) and predicted scores for adjusted weight and height based on their reported weight and height. All analyses were conducted separately for men and women, using SAS 9.3 (SAS Institute, Cary, NC) software.

2.4 Results

Table 2.1 presents participants' characteristics and the distribution of discrepancies between reported and measured BMI, based on socio-demographic variables. Participants were 220 men (43.1%) and 290 women. Women were more likely than men to be older and under-educated. More women than men were living without spouses. The proportion of poor SRH was higher in women. In addition, more men than women were employed at the time of the study.

Table 2.1. Participant Characteristics and Differences†between Reported and Measured BMI

Variables	Male					Female					
	N(%)		Difference in BMI			N(%)		Difference in BMI			
			Mean (±SD)		Scheffé's			Mean (±SD)			Scheffé's
N = 510	220	(43.1)	1.3	(1.2)		290	(56.9)	1.8	(1.5)		
Age (mean ±SD)	63.7	(±10.0)				63.8	(±9.9)				
45–54	47	(21.4)	1.6	(1.3)		57	(19.7)	1.5	(1.0)	*	a
55–64	79	(35.9)	1.1	(0.9)		93	(32.1)	1.6	(1.3)		a
65–74	65	(29.5)	1.3	(1.0)		99	(34.1)	2.0	(1.4)		
75–84	23	(10.5)	1.8	(2.0)		37	(12.8)	2.4	(2.0)		b
85+	6	(2.7)	1.5	(1.4)		4	(1.4)	2.6	(3.6)		
Educational level											
Primary school	73	(33.2)	1.4	(1.5)		180	(62.1)	2.0	(1.6)	*	a
Middle school	39	(17.7)	1.4	(0.9)		43	(14.8)	1.7	(1.3)		
High school	77	(35.0)	1.3	(0.8)		53	(18.3)	1.5	(1.0)		
College or over	31	(14.1)	1.3	(1.5)		14	(4.8)	1.0	(0.7)		b
Marital status											
Married	203	(92.3)	1.3	(1.2)		207	(71.4)	1.8	(1.3)		
Separated	6	(2.7)	1.7	(0.8)		4	(1.4)	1.2	(0.9)		
Bereaved	10	(4.5)	2.0	(1.9)		79	(27.2)	2.0	(1.8)		
Unmarried	1	(0.5)	1.1	-			-	-·			
Self-rated health											
Good	83	(37.7)	1.4	(1.2)		88	(30.3)	1.7	(1.3)		
Moderate	84	(38.2)	1.2	(0.9)		101	(34.8)	1.8	(1.4)		
Poor	53	(24.1)	1.5	(1.4)		101	(34.8)	2.0	(1.7)		
Employment status											
Employed	131	(59.5)	1.3	(1.2)		85	(29.3)	1.8	(1.1)		
Unemployed	4	(1.8)	1.0	(0.6)		2	(0.7)	0.9	(1.0)		
Out of labor force	85	(38.6)	1.4	(1.2)		203	(70.0)	1.9	(1.6)		

†Absolute value of the difference between the measured value and the self-reported value
‡Equivalent income: household income/square root of family size
¶Calculated from directly measured height and weight
*Result of ANOVA (or *t*-test) p value <0.05
**Result of ANOVA (or *t*-test) p value <0.001
***Result of ANOVA (or *t*-test) p value <0.0001
a, b, c Result of Scheffé's test (α = 0.1)

Table 2.1.(cont.) Participant Characteristics and Differences†between Reported and Measured BMI

Variables	Male						Female					
	N(%)		Difference in BMI				N(%)		Difference in BMI			
			Mean (±SD)		Scheffé's				Mean (±SD)		Scheffé's	
N = 510	220	(43.1)	1.3	(1.2)			290	(56.9)	1.8	(1.5)		
Income‡												
Bottom quarter	48	(21.8)	1.5	(1.2)			79	(27.2)	1.7	(1.5)		
Second quarter	58	(26.4)	1.3	(1.0)			70	(24.1)	2.2	(1.6)		
Third quarter	59	(26.8)	1.4	(1.3)			67	(23.1)	1.7	(1.4)		
Top quarter	55	(25.0)	1.3	(1.3)			74	(25.5)	1.8	(1.4)		
Region												
Large city	57	(25.9)	1.3	(0.9)	*		81	(27.9)	1.7	(1.3)	*	a
Small city	97	(44.1)	1.2	(1.0)		a	125	(43.1)	1.7	(1.3)		a
Rural area	66	(30.0)	1.6	(1.6)		b	84	(29.0)	2.2	(1.7)		b
Measured BMI¶ (Mean ±SD)	24.0	(±2.8)					25.1	(±3.5)				
<18.5	10	(4.5)	1.2	(1.2)	**		6	(2.7)	1.1	(0.7)	***	ab
<25	124	(56.4)	1.1	(0.9)		a	146	(66.4)	1.4	(1.1)		a
<30	82	(37.3)	1.8	(1.5)		b	113	(51.4)	2.1	(1.6)		b
30≤	4	(1.8)	1.6	(1.1)			25	(11.4)	3.3	(1.6)		c

†Absolute value of the difference between the measured value and the self-reported value
‡Equivalent income: household income/square root of family size
¶Calculated from directly measured height and weight
*Result of ANOVA (or *t*-test) p value <0.05
**Result of ANOVA (or *t*-test) p value <0.001
***Result of ANOVA (or *t*-test) p value <0.0001
a, b, c Result of Scheffé's test (α = 0.1)

Regarding discrepancies between reported and measured BMI, mean measured BMI was higher than the reported means for both sexes (Table 2.2). The discrepancy between self-reported and directly measured data was defined as the absolute value obtained when subtracting the directly measured value from the self-reported value.

The difference in the absolute value is useful for examining the variation relating to the reporting of errors. The mean of the actual BMI difference was lower than that of the absolute value of the difference, indicating that there were many incidents of over-reporting weight, in addition to under-reporting. Measured BMI and residential region were associated with BMI discrepancies among members of both sexes (Table **2.**1). For women, age and education level also influenced BMI discrepancy. Scheffé's test (α = 0.1) was conducted for post-hoc multiple comparisons of group means.

Table 2.2 shows adequate correlations (>0.8) between self-reported and measured values of weight, height, and BMI for men and women, despite substantial differences between self-reported and directly measured BMI values. A lower correlation coefficient was obtained for height among women, at 0.7705. The difference in standard deviations was marginal. Stronger correlation coefficients for weight and BMI were obtained for women, as compared to men. This was unexpected because women tend to under-report their weight more often than do men. In contrast, for height, men obtained a higher correlation coefficient than women did. Self-reported weight was lower than measured weight, at 0.5 kg in men and 1.2 kg in women.

Table 2.2. A Comparison of Self-Reported and Directly Measured Values

Variables	Male (n=220)			Female (n=290)		
	Mean (±SD)		Pearson's Coefficient	Mean (±SD)		Pearson's Coefficient
Weight_r	65.6	(±8.5)	0.9060	57.0	(±8.1)	0.9183
Weight_m	66.1	(±9.1)		58.2	(±9.0)	
Height_r	168.2	(±5.3)	0.8294	155.7	(±4.9)	0.7705
Height_m	165.7	(±6.0)		152.2	(±6.1)	
BMI_r	23.2	(±2.5)	0.8365	23.5	(±3.0)	0.8649
BMI_m	24.0	(±2.8)		25.1	(±3.5)	
Prevalence	N	(%)		N	(%)	
Obesity_r†	43.0	(19.6)		86.0	(29.7)	
Obesity_m‡	86.0	(39.1)		138.0	(47.6)	

† _r: Self-reported

‡ _m: Directly measured

For height, self-reported values were higher by 2.5 cm and 3.5 cm for men and women, respectively. The prevalence of obesity was higher among women than among men (Table 2.2).

Trends relating to error reporting are shown separately for males and females in Figure 2.1, which depicts participants' weight, height, and BMI according to age (Figure 2.1). These results indicate patterns relating to age with regard to error reporting and weight and height among men and women. Middle-aged men (45–55 years old) were more likely to under-report their weight, whereas older men were more likely to over-report it. Women showed a steady under-reporting trend relating to weight by age. Most men and women of all age ranges tended to over-report weight; over-reporting in this regard was higher among older adults than among middle-aged individuals. Based on these error reporting trends, BMI error, as determined through a calculation of reported and measured values, also showed that age patterns affect the estimation of BMI among both men and women.

For all participants, self-reported BMI had a relatively lower sensitivity (54.9%) for diagnosing obesity (BMI ≥25.0 kg/m^2), as compared to directly measured values. With regard to sex, the sensitivity was 46.5% in men and 60.1% in women (Table 2.3), with sex shown as underestimating the true prevalence of obesity by about 50% and 40%, respectively, and missing about 20% of obesity prevalence—more than the total self-reported prevalence in men and approximately 65% of that in women.

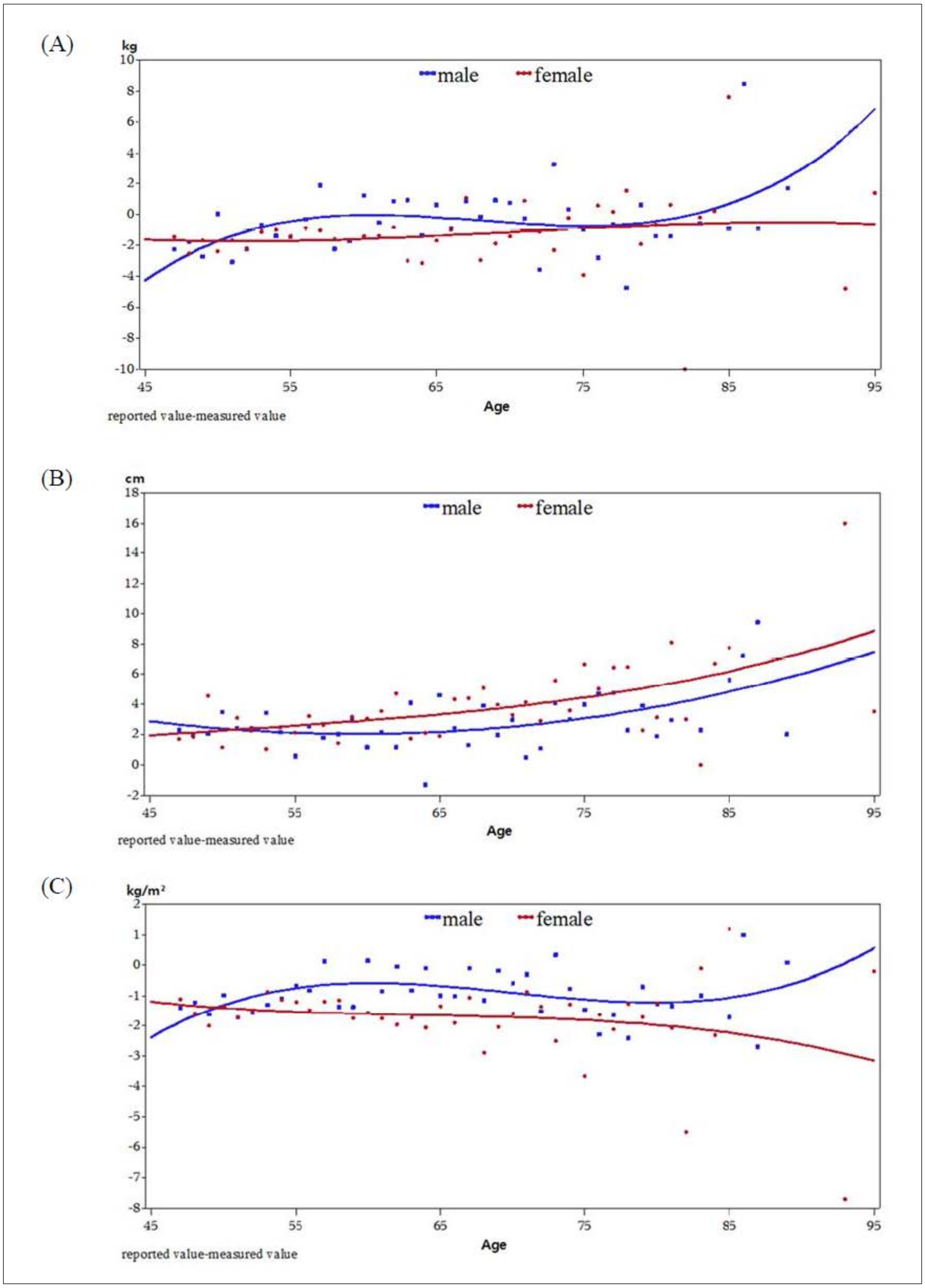

Figure 2.1. Error reporting trends according to sex, in relation to weight (A), height (B), and BMI (C), based on the difference between reported and measured values

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Table 2.3. Sensitivity and specificity of self-reported BMI for obesity diagnosis a according to participants' characteristics.

Variables	Male (n=220)			Female (n=290)		
	N	Sensitivity (%)	Specificity (%)	N	Sensitivity (%)	Specificity (%)
N (Total=510)	220	46.5	97.8	290	60.1	98.0
Total Sensitivity = 54.9						
Total Specificity = 97.9						
Age						
45–54	47	51.9	100.0	57	64.0	100.0
55–64	79	46.9	95.7	93	56.9	100.0
65–74	65	25.0	98.0	99	63.0	96.2
75+	29	63.6	100.0	41	56.3	96.0
Educational level						
Primary school	73	58.3	100.0	180	55.9	97.7
Middle school	39	28.6	92.0	43	73.1	94.1
High school	77	42.9	97.6	53	62.5	100.0
College or over	31	53.9	100.0	14	66.7	100.0
Marital status						
Married	203	48.1	97.6	207	57.3	98.2
Separated/Unmarried	7	20.0	100.0	4	100.0	100.0
Bereaved	10	50.0	100.0	79	65.0	97.4
Self-rated health						
Good	83	42.4	98.0	88	55.6	100.0
Moderate	84	53.9	97.8	101	71.7	97.9
Poor	53	35.7	97.4	101	51.0	96.2
Employment status						
Employed	131	50.0	98.6	85	48.6	96.0
Not employed	89	38.5	96.8	205	64.1	99.0
Income‡						
Bottom quarter	49	46.7	97.0	80	59.5	97.6
Second quarter	57	27.3	100.0	69	50.0	96.9
Third quarter	60	43.5	94.4	69	58.8	100.0
Top quarter	54	65.4	100.0	72	75.9	97.7
Region						
Large city	57	45.8	97.0	81	62.2	100.0
Small city	97	47.4	100.0	125	63.8	98.5
Rural area	66	45.8	95.2	84	51.4	95.9

[†] 25 kg/m^2g≤ BMI

[‡] Equivalent income: household income/square root of family size

age patterns affect the estimation of BMI among both men and women.

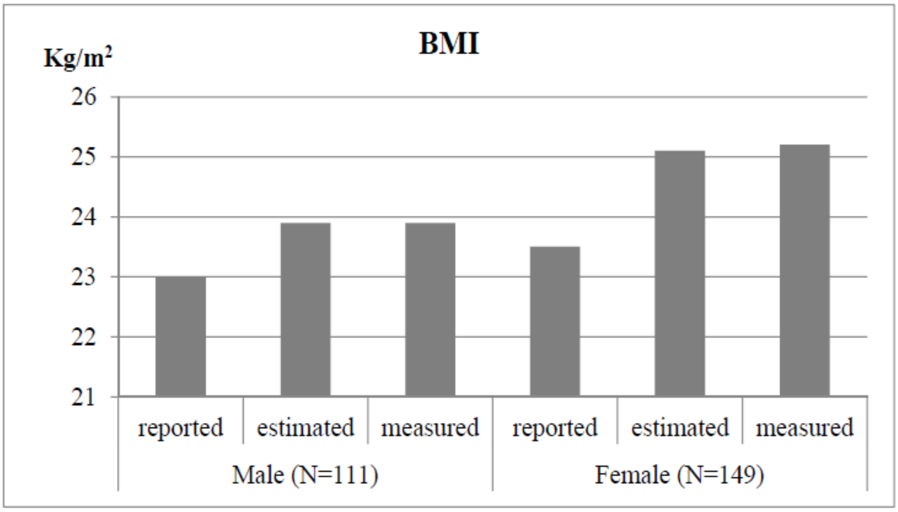
However, the specificity was very high, at 97.8% among men and 98.0% among women. Consequently, both sensitivity and specificity were found to be higher among women than among men, although the former are typically known to display more reporting bias. Furthermore, there were no significant results or trends relating to the sensitivity or specificity of any of the variables.

We tried to estimate the approximate values of directly measured weight, height, and BMI by using predictive equations from a subset of study participants. We created a sub-sample (sample 1, n = 250) by randomly selecting participants from all the study participants (n = 510). Individuals who remained after the random selection were referred to as sample 2 (n = 260). From sample 1, we developed predictive equations on the basis of sex using simple linear regression; the equations included the variables of age, reported weight, reported height, and BMI from reported data. The predictive equation (1) for adjusted weight and height is shown below. Then, we applied this equation to sample 2 and predicted scores of adjusted weight and height on the basis of scores of reported weight and height.

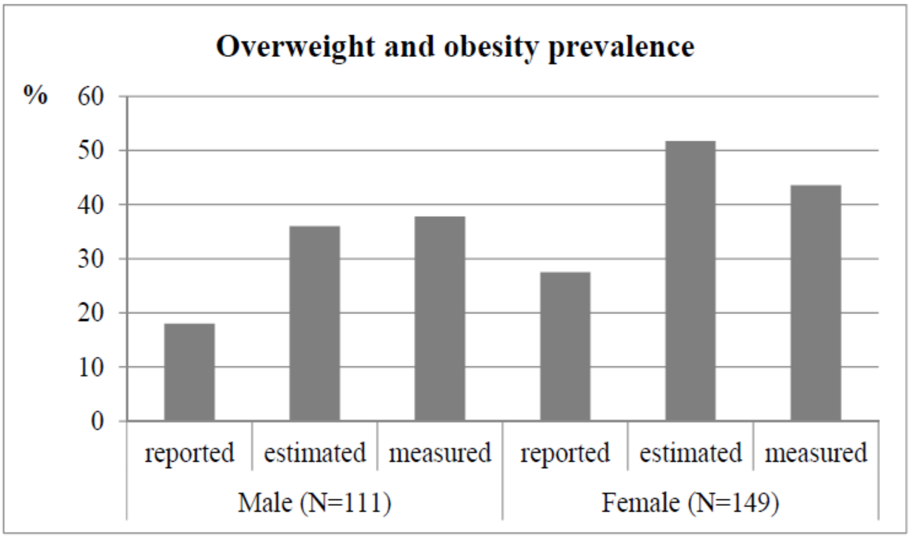
$$y_1 = Intercept + \beta_1 \times Age + \beta_2 \times Reported\ Weight + \beta_3 \times Reported\ Height + \beta_4 \times Reported\ BMI \tag{1}$$

y1: Adjusted Weight or Height

We compared the estimated values with reported and directly measured values of the BMI and the prevalence of overweight and obesity in sample 2. The results (Figure 2.2) show that the estimated values approximated the measured values.



(A) A comparison of reported, estimated, and measured BMI means in sample 2



(B) A comparison of reported, estimated, and measured values on the prevalence of overweight and obesity in sample 2

Figure 2.2 A comparison of reported, estimated, and measured values in sample2.

2.4 Discussion

This study identified a discrepancy between self-reported and measured anthropometric information, suggesting that a misclassification of obesity diagnosis may occur when using self-reported BMI data. Factors associated with the differences were as follows: a) measured BMI of ≥25, b) the residential location of both men and women, c) older age, and d) education level among women. A high number of discrepancies between reported and measured values demonstrate that reported BMI neither accurately nor consistently reflects measured BMI, particularly in older age groups. Age patterns for error reporting in relation to weight and BMI differed according to sex. But age pattern for error reporting relating to height was similar according to sex; the discrepancy gap was different in weight and BMI by sex. The specificity of self-reported BMI in assessing corpulence was high (97.9%); nevertheless, our findings of low sensitivity (54.9%) further highlight the need to exercise extreme caution in categorizing obesity using self-reported BMI. After adjusting for reported information, using algorithms and predictive equations comprising age, reported weight, height, and BMI from simple linear regression, estimated BMI and the prevalence of overweight and obesity more closely matched the directly measured values.

Although estimated values are approximate to directly measured values, estimations of corpulence classification, especially in women, are less accurate than estimations of simple BMI. This finding could be due to our predictor variables not including socioeconomic factors, which have more of an impact on women than on men. This explanation is in accord with the results of previous studies.[24] Nonetheless, the effect of those factors on reporting bias of anthropometric information was not considered important.[46]

While self-reported anthropometric information is widely used in community surveys for obesity classification, concern persists regarding its intrinsically limited accuracy. However, many studies have demonstrated that self-reported BMI is still useful and valid.[47-49] So far, the research does not enable sufficient understanding of the extent of inaccuracies in self-reported BMI and reasons for these. In the meantime, methodological developments have included larger-scale obesity prevalence prediction, using an algorithm of self-reported information from a small sample.[37,47]

Epidemiological studies on the discrepancy in obesity prevalence, as indicated by self-reported and directly measured BMI, have shown a varied degree of differences based on nationality, socioeconomic status, ethnic group, sex, and age, among other variables.[37,50,51] Accordingly, this discrepancy should be viewed differently according to body image or ideal body shape, social context, health literacy, and personal characteristics. A recent Japanese study of individuals aged 70 years and older showed that the sensitivity of a reported obesity classification (overweight: BMI 25 to <30; obese: BMI ≥ 30) was as low as 59.3% and 65.1% for men and women, respectively.[52] Our values for specificity and sensitivity were even lower than those in Japan. In the present study, we defined obesity as BMI ≥ 25.0 kg/m^2

According to literature on the accuracy of self-reported obesity, obesity prevalence was much higher, when considering measured, rather than reported values,[27,28] with significant differences shown, based on demographic and socioeconomic subgroups. In line with previous studies, our results showed that reporting bias was particularly large among participants in the more obese group as compared to the slightly obese group, older participants, and women.

The low sensitivity or high misclassification of obesity diagnosis using self-reported BMI in this study seemed largely attributable to discrepancies in height, rather than weight values. This can be explained as either age-related process of the population or by the length of the period since the last height measurement.[38] The ageing process in bones, discs, joints, and muscles contributes to a height loss of 1 cm every decade after the age of 40 years.[53] Thus, physiological height loss and recall bias could account for the increased discrepancy related to ageing. We conducted further analysis (data not shown) that also identified a higher level of discrepancy in height with an increase in age. Moreover, even a small change in height could have a large effect on the BMI, as it is inversely proportional to the square of height.[54]

Further analysis revealed larger differences between self-reported and directly measured values for women, as compared to men. It is generally known that larger BMI reporting errors in obesity diagnosis are found in older individuals and women. As for diagnostic accuracy, however, in our study, sensitivity was higher in women than in men. One interpretation could be that the misclassification of corpulence, using BMI cut-offs based on self-reported height and weight, is distinct from the misreporting of these values. Further exploration of these dissimilar features is warranted. In addition, the validity and accuracy of this information should ideally be evaluated on the basis of its primary purpose. If we use the information to diagnose obesity, then prevalence rates should be evaluated for accuracy. However, we also need to consider reasons for misreporting. Individuals may be unwilling to disclose their anthropometric information, due to cultural awareness and social and body image perceptions.[46,55] Thus, we can infer that socioeconomic and cultural factors affect measurements of health status, as well as actual health status, which may lead to a duplication of effect. Therefore, when studying any health outcomes, it is necessary to eliminate error, in order to accurately understand such phenomena.

Our data were derived from a population of community-dwelling middle-aged and older Koreans; therefore, our findings may not be generalizable to other populations. Regardless, our findings have implications for understanding the discrepancies between self-reported and directly measured anthropometric data and their influence on assessment of obesity prevalence in middle-aged and older Koreans. Moreover, as factors contributing to this discrepancy may differ, it is necessary to examine the distribution thereof in each population. Our study population has a relatively lower BMI than European or American populations. We speculate that, even among populations with higher BMI, reporting biases may exist. However, the generalizability of our findings must be tested in further studies.

Our findings suggest several opportunities for future research. First, the nature and causes of misreporting or reporting bias in the assessment of obesity in different sociocultural contexts should be investigated. Even among researchers, there is no consensus regarding concerns over reporting errors for anthropometric information and the misclassification of obesity criteria resulting from the use of reported BMI. Second, research should be conducted to identify ways of more accurately estimating obesity within a given population. Studying the relationship between the relevant factors and the dynamics of reporting error and misclassification may help researchers find the solution. Further, research on the determinants and outcomes of misreporting and misclassification of obesity has the potential to aid the development of treatment interventions and policy and practice evaluations.

In conclusion, our results indicate that self-reported anthropometric information cannot guarantee accurate assessment of obesity prevalence in populations of middle-aged and older Koreans. The validity of self-reported weight and height has been questioned, and their application has been cautioned. Using BMI derived from self-reported data for obesity diagnosis, researchers must be mindful of its high specificity and low sensitivity leading underestimation of obesity prevalence when interpreting the results. In other words, it stands to reason that obesity diagnosed by self-reported BMI is to have a possibility of high risk for chronic disease. Even though it is not in the case of obesity, however, it is hard to say the risk is low. To settle the difference we can try to utilize the predictive equation adjusting errors of self-reported BMI, derived from subsample of study population, if possible. Because defining obesity categorically can bring severe misclassification, it is recommended not only categorical analyzing but also dealing BMI value continuously should be required to make up for the weak points of the result interpretation.

Chapter 3 Different measure of obesity leads to relevance change among the Korean middle-aged and older

3.1 Introduction

To diagnose obesity, the validity of self-reported values for weight and height has always been questioned and put to the test.[37,49] Body mass index (BMI; weight in kilogram divided by the square of height in meter) is the most popular measure of obesity because of a limited budget and available practical process and the use of BMI calculated from self-reported data typically, as it is defined arithmetically, has little influence on analyses for discrepancy with directly measured information, but the use of BMI in diagnosing obesity leads to misclassification and underestimation of the true prevalence.

The obesity prevalence has grown up without any reverse around the world. Many health professionals sound a warning of its burden to population and governments, the population needs an effective counterplan to control obesity pandemic and governments require measures and evidences for effective policy decision.[56]

When the prevalence of obesity move up from diagnosed with self-reported data to with directly measured anthropometric data, the relationship among the relative factors will shift. This objective is to examine differences in obesity prevalence diagnosed by BMI calculated from self-reported height and weight by categories in each variable and to define the relationship with relative factors in each case. In addition to that, to identify specific variables that cause reporting errors is included in the objectives.

3.2 Methods

(confer chapter 2.2)

3.2.1 Analyses

The *chi-square test* was used for differences in obesity prevalence diagnosed by BMI calculated from self-reported height and weight by categories in each variable. And multiple logistic regression for obesity in the case of using reported BMI and measured BMI was conducted to define what variables have correlation with obesity prevalence by sex.

To compare difference between reported and measured mean specific variables that cause reporting errors, paired t-test for was used by each group in each variable by gender.

We developed algorithms and predictive equations using simple linear regression, with age, reported weight, height, and BMI as predictor variables, which enabled us to estimate more accurate BMI values and overweight prevalence. First, we created a sub-sample (Sample 1) by randomly selecting participants from the main study in order to develop predictive equations. Then, we applied these equations to the remaining individuals (Sample 2) and predicted scores for adjusted weight and height based on their reported weight and height. All analyses were conducted separately for men and women, using SAS 9.3 (SAS Institute, Cary, NC) software.

3.3 Results

Characteristics of participants and comparison of obesity prevalence from using BMI self-reported height and weight to directly measured, were presented in table 3.1. As a result of χ^2 test for differences in obesity prevalence diagnosed by BMI calculated from self-reported height and weight by category in each variable, in men, the age category of 45-54 showed the highest prevalence of obesity among 220 men (29.8%). Although not significant, the lowest proportion of obesity was shown by men aged 65-74 (7.7%).

Higher prevalence of obesity in employment, income, and region groups were men who are employed (23.7%), receive top-quarter income (30.9%), and live in smaller cities (18.6%), respectively. Differences in obesity prevalence diagnosed by BMI calculated from measured height and weight by categories are also shown in table 3.1. No significant discrepancies occurred by age, self-rated health status, employment, and income, however, the overall prevalence of obesity had risen in each variables, indicating the incidence of the under-reporting. Although, the highest prevalence of education categories on self-reported obesity was men with university or above degree (22.6%), the prevalence of obesity was higher in men with high school degree on measured obesity (45.5%).

In women, proportion of self-reported obesity and measured obesity were 29.7% and 47.6% respectively. Trend relating the variables in women on obesity computed from self-reported height and weight was not shown. Regarding the degree of education women in self-reported obesity, women who had middle school degree showed the highest prevalence of obesity whereas women with university degree or above had lowest obesity rate. The measured obesity showed no difference in highest prevalent category, however, overall prevalence of obesity was significantly higher than reported obesity. This shows that the women tend to under-report their weight and height. In self-rated health group, a large proportion of women considered their health status to be moderate; however, the obesity was the highest in the group. Measured obesity showed the similar result.

Both of the sexes indicated higher obesity prevalence computed using measured height and weight. In men, age was a significant factor identifying the discrepancies between reported and measured obesity. In contrast, age of the women showed no significant trend or differences in reported and measured obesity.

Table 3.1 Characteristics of Participants and obesity prevalence from self-reported height and weight and directly measured

Variables		Male					Female				
		N (%)	Reported obesity[1] n (%)		Measured obesity[2] n (%)		N (%)	Reported obesity[1] n (%)		Measured obesity[2] n (%)	
N	510	220 (43.1)	43 (19.6)		86 (39.1)		290 (56.9)	86 (29.7)		138 (47.6)	
Age	45~54	47 (21.4)	14 (29.8)	*	27 (57.5)	*	57 (19.7)	16 (28.1)		25 (28.1)	
	55~64	79 (35.9)	17 (21.5)		32 (40.5)		93 (32.1)	29 (31.2)		51 (31.2)	
	65~74	65 (29.6)	5 (7.7)		16 (24.6)		99 (34.1)	31 (31.3)		46 (31.3)	
	75~	29 (13.2)	7 (24.1)		11 (37.9)		41 (14.1)	10 (24.4)		16 (24.4)	
Education	primary	73 (33.2)	14 (19.2)		24 (32.9)		180 (62.1)	54 (30.0)	*	93 (51.7)	*
	middle	39 (17.7)	6 (15.4)		14 (35.9)		43 (14.8)	20 (46.5)		26 (60.5)	
	high	77 (35.0)	16 (20.8)		35 (45.5)		53 (18.3)	10 (18.9)		16 (30.2)	
	university	31 (14.1)	7 (22.6)		13 (41.9)		14 (4.8)	2 (14.3)		3 (21.4)	
Living	with spouse	203 (92.3)	40 (19.7)		77 (37.9)		207 (71.4)	57 (27.5)		96 (46.4)	
	without spouse	17 (7.7)	3 (17.7)		9 (52.9)		83 (28.6)	29 (34.9)		42 (50.6)	
Self rated health	good	83 (37.7)	15 (18.1)		33 (39.8)		88 (30.3)	20 (22.7)	*	36 (40.9)	
	moderate	84 (38.2)	22 (26.2)		39 (46.4)		101 (34.8)	39 (38.6)		53 (52.5)	
	bad	53 (24.1)	6 (11.3)		14 (26.4)		101 (34.8)	27 (26.7)		49 (48.5)	
Employment	employed	131 (59.5)	31 (23.7)		60 (45.8)	*	85 (29.3)	19 (22.4)		35 (41.2)	
	not employed	89 (40.5)	12 (13.5)		26 (29.2)		205 (70.7)	67 (32.7)		103 (50.2)	
Income†	bottom quarter	48 (22.3)	8 (16.7)	*	15 (31.3)		80 (27.6)	23 (29.1)		37 (46.8)	
	2nd	58 (25.9)	6 (10.3)		22 (37.9)		69 (23.8)	20 (28.6)		38 (54.3)	

	3rd	59 (27.3)	12 (20.3)	23 (39.0)	69 (23.8)	19 (28.4)	33 (49.3)
	top quarter	55 (24.5)	17 (30.9)	26 (47.3)	72 (24.8)	24 (32.4)	30 (40.5)
Region	Large city	57 (25.9)	12 (21.1)	24 (42.1)	81 (27.9)	28 (34.6)	45 (55.6)
	Smaller city	97 (44.1)	18 (18.6)	38 (39.2)	125 (43.1)	38 (30.4)	58 (46.4)
	Rural area	66 (30.0)	13 (19.7)	24 (36.4)	84 (29.0)	20 (23.8)	35 (41.7)

† equivalent income: household income/sqrt(family size)

[1] Obesity diagnosed by BMI calculated from self-reported height and weight

[2] Obesity diagnosed by BMI calculated from directly measured height and weight

* p value<0.05 from χ^2test for differences by categories in each variable

Table 3.2 Comparison between multiple logistic regression for reported obesity and for measured

Variables		All		Male		Female	
		Reported obesity¹ OR (95% CI)	Measured obesity² OR (95% CI)	Reported obesity¹ OR (95% CI)	Measured obesity² OR (95% CI)	Reported obesity¹ OR (95% CI)	Measured obesity² OR (95% CI)
Sex	Male	0.73 (0.45, 1.19)	0.86 (0.57, 1.31)				
	Female	Ref.	Ref.				
Age	45~54	1.99 (0.83, 4.78)	2.70 (1.23, 5.91)	0.66 (0.15, 2.85)	1.02 (0.30, 3.51)	2.87 (0.87, 9.54)	4.78 (1.50, 15.19)
	55~64	1.50 (0.70, 3.22)	1.86 (0.96, 3.63)	0.45 (0.12, 1.69)	0.59 (0.20, 1.75)	1.92 (0.70, 5.29)	2.59 (1.03, 6.49)
	65~74	1.00 (0.49, 2.03)	0.99 (0.53, 1.82)	0.17 (0.04, 0.71)	0.37 (0.13, 1.06)	1.70 (0.69, 4.17)	1.37 (0.61, 3.06)
	75~	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Education	primary	2.14 (0.84, 5.49)	2.14 (0.96, 4.76)	1.86 (0.53, 6.57)	1.10 (0.39, 3.11)	3.78 (0.70, 20.53)	7.57 (1.68, 34.09)
	middle	2.58 (1.01, 6.60)	2.09 (0.93, 4.70)	1.27 (0.33, 4.95)	1.25 (0.42, 3.72)	6.99 (1.30, 37.68)	8.02 (1.77, 36.36)
	high	1.14 (0.47, 2.73)	1.17 (0.57, 2.44)	1.44 (0.48, 4.35)	1.59 (0.63, 4.01)	1.56 (0.29, 8.29)	1.69 (0.40, 7.08)
	university	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Living	with spouse	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
	without spouse	1.58 (0.90, 2.80)	1.60 (0.96, 2.67)	1.15 (0.27, 4.85)	2.14 (0.69, 6.64)	1.68 (0.86, 3.29)	1.38 (0.73, 2.60)
Self rated health	good	0.98 (0.53, 1.81)	0.99 (0.59, 1.66)	1.08 (0.32, 3.60)	1.31 (0.53, 3.24)	0.90 (0.42, 1.95)	0.91 (0.46, 1.79)
	moderate	1.98 (1.16, 3.37)	1.51 (0.95, 2.42)	2.39 (0.77, 7.37)	2.30 (0.97, 5.46)	1.84 (0.97, 3.50)	1.23 (0.68, 2.24)
	bad	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.

Employment	employed	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.

	not employed	1.15 (0.69, 1.93)	1.02 (0.65, 1.60)	0.52 (0.20, 1.39)	0.58 (0.28, 1.21)	1.63 (0.82, 3.25)	1.35 (0.73, 2.50)
Income†	bottom quarter	0.58 (0.30, 1.10)	0.94 (0.52, 1.69)	0.42 (0.13, 1.39)	0.64 (0.24, 1.72)	0.60 (0.26, 1.38)	1.02 (0.47, 2.21)
	2nd	0.47 (0.25, 0.89)	1.15 (0.66, 2.00)	0.25 (0.08, 0.81)	0.88 (0.37, 2.10)	0.63 (0.28, 1.45)	1.37 (0.63, 2.96)
	3rd	0.58 (0.32, 1.06)	0.99 (0.58, 1.69)	0.53 (0.21, 1.37)	0.76 (0.33, 1.73)	0.62 (0.28, 1.40)	1.21 (0.57, 2.56)
	top quarter	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Region	Large city	1.49 (0.84, 2.66)	1.57 (0.95, 2.59)	1.40 (0.52, 3.77)	1.26 (0.57, 2.81)	1.50 (0.71, 3.14)	1.75 (0.89, 3.45)
	Smaller city	1.21 (0.70, 2.07)	1.25 (0.79, 1.98)	0.85 (0.35, 2.07)	0.92 (0.45, 1.91)	1.39 (0.69, 2.82)	1.44 (0.76, 2.70)
	Rural area	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.

† equivalent income: household income/sqrt(family size)

[1] obesity diagnosed by25kg/m² ≤ BMI calculated from self-reported height and weight

[2] obesity diagnosed by 25kg/m² ≤ BMI calculated from directly measured height and weight

Multiple logistic regression for obesity in the case of using reported BMI and measured BMI was conducted to define what variables have correlation with obesity prevalence by sex. The results are presented in table 3.2.

Regarding relevancy on variable with adjustment of sexes in overall population, reported and measured obesity prevalence showed lower prevalence in men than women. The discrepancies occurred in measured obesity prevalence, low age showed higher obesity rate but not statistically significant. Even after adjusting age, sex, and other socioeconomic status, self-rated health group presented statistically significance in moderate health status group than bad health status group.

Analyzing after age and socioeconomic status were adjusted with sexes, in men, each variable was difficult to identify the statistical trend. However, in women, obesity prevalence was reported higher as the age decreased, reported obesity was not significant but measured obesity was. Furthermore, lower educational level showed higher obesity prevalence, but it also was only significant in measured obesity. Especially in women, after adjusting other variables, despite of statistical significance, on every variables in reference group, the measured obesity showed greatly larger odd ratio than reported obesity. Trend, and effect of measurement, and discrepancy on significant variables by sexes were difficult to define in multiple logistic regression analysis. The reporting bias seems to be not affected by a specific variable, but by all individual middle aged and above.

By computing the directly measured weight, height, and BMI into quartile, I compared difference between reported and measured mean by analyzing the data using paired t-test in each group (table 3.3).

As a result, in men, mean difference in weight indicated significance in each categories and for height, most of categories showed strong significance. Combination of this discrepancy of weight and height distinguish the difference in BMI and mean. In women, although mean difference in weight in each category presented stronger significance than men, for height, both men and women showed strong significance in most of categories. Therefore, in women, BMI and mean differences were shown much stronger than men.

By equations of regression(eq.3.1~3.8), there was an attempt to examine the effect of the correlation of height difference and weight difference on age status (figure 3.1, figure 3.2). Using absolute value difference and arithmetic value difference between self-reported and directly measured, I compared effect’s size with directivity in the cases of including and excluding age adjustments.

$$y_1 = Intercept + \beta_1 \times height\ absolute\ difference + \beta_2 \times weight\ absolute\ difference + \beta_3 \times education + \beta_4 \times marital\ status + \beta_5 \times income + \beta_6 \times region$$

(Eq.3.1)

$$y_1 = Intercept + \beta_1 \times height\ absolute\ difference + \beta_2 \times weight\ absolute\ difference + \beta_3 \times education + \beta_4 \times marital\ status + \beta_5 \times income + \beta_6 \times region + \beta_7 \times age$$

(Eq.3.2)

$$y_1 = Intercept + \beta_1 \times height\ absolute\ difference + \beta_2 \times weight\ absolute\ difference + \beta_3 \times measured\ BMI + \beta_4 \times education + \beta_5 \times marital\ status + \beta_6 \times income + \beta_7 \times region$$

(Eq.3.3)

$$y_1 = Intercept + \beta_1 \times height\ absolute\ difference + \beta_2 \times weight\ absolute\ difference + \beta_3 \times measured\ BMI + \beta_4 \times education + \beta_5 \times marital\ status + \beta_6 \times income + \beta_7 \times region + \beta_8 \times age$$

(Eq.3.4)

y_1: *BMI absolute difference*

$$y_2 = Intercept + \beta_1 \times height\ difference + \ \beta_2 \times weight\ difference + \ \beta_3 \times education + \ \beta_4 \times marital\ status + \beta_5 \times income + \ \beta_6 \times region$$

(Eq.3.5)

$$y_2 = Intercept + \beta_1 \times height\ difference + \ \beta_2 \times weight\ difference + \ \beta_3 \times education + \ \beta_4 \times marital\ status + \beta_5 \times income + \ \beta_6 \times region + \beta_7 \times age$$

(Eq.3.6)

$$y_2 = Intercept + \beta_1 \times height\ difference + \ \beta_2 \times weight\ difference + \ \beta_3 \times measured\ BMI + \ \beta_4 \times education + \beta_5 \times marital\ status + \ \beta_6 \times income + \beta_7 \times region$$

(Eq.3.7)

$$y_2 = Intercept + \beta_1 \times height\ difference + \ \beta_2 \times weight\ difference + \ \beta_3 \times measured\ BMI + \ \beta_4 \times education + \beta_5 \times marital\ status + \ \beta_6 \times income + \beta_7 \times region + \beta_8 \times age$$

(Eq.3.8)

y_2: *BMI difference*

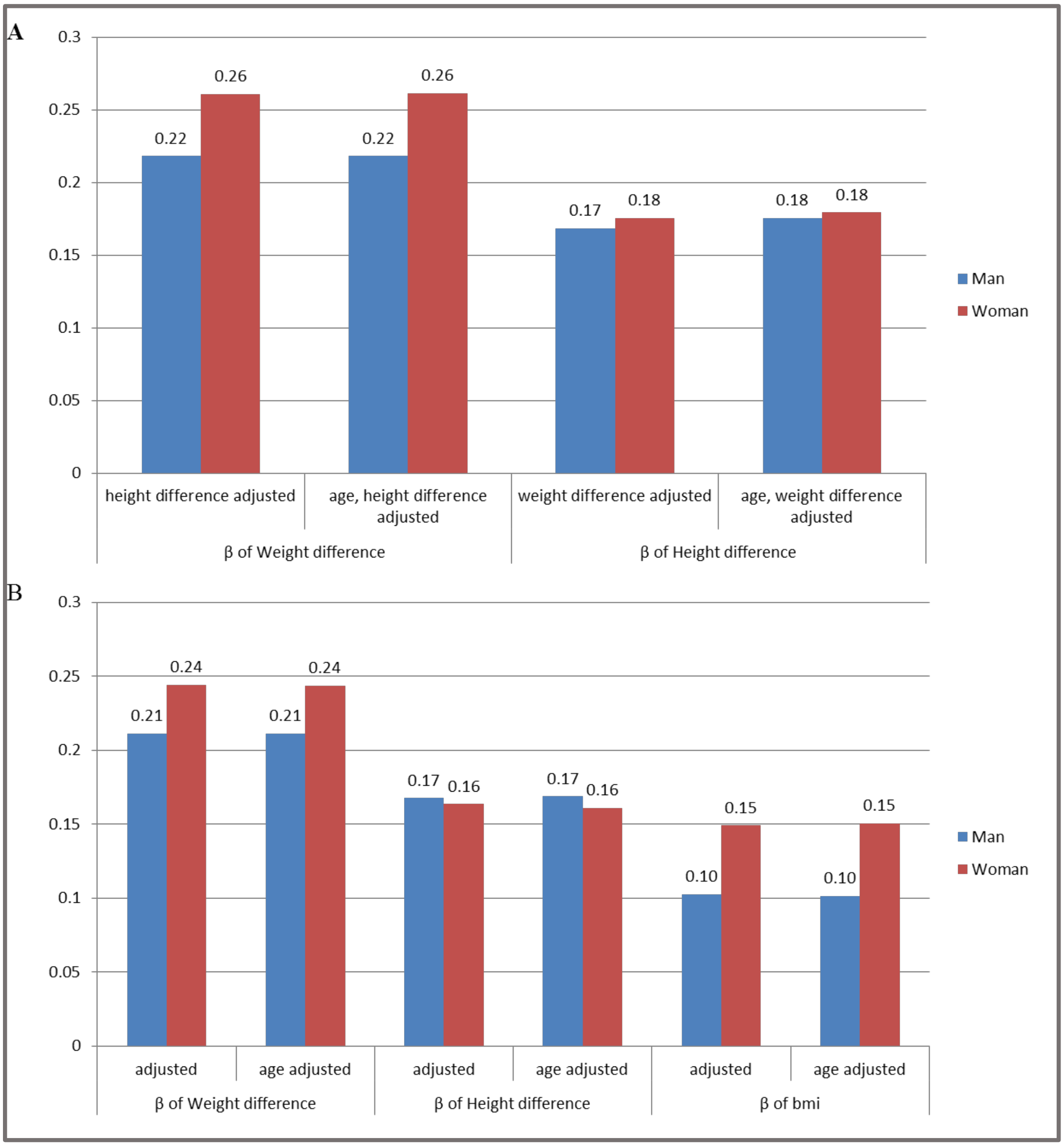


Figure 3.1 Effect of absolute difference

A. Effect of weight absolute difference and height absolute difference for BMI absolute difference calculated from the equation of regression, Eq. 3.1 and Eq. 3.2, in the cases of including and excluding age adjustments.

B. Effect of weight absolute difference, height absolute difference, and measured BMI for BMI absolute difference calculated from the equation of regression, Eq. 3.3 and Eq. 3.4, in the cases of including and excluding age adjustments.

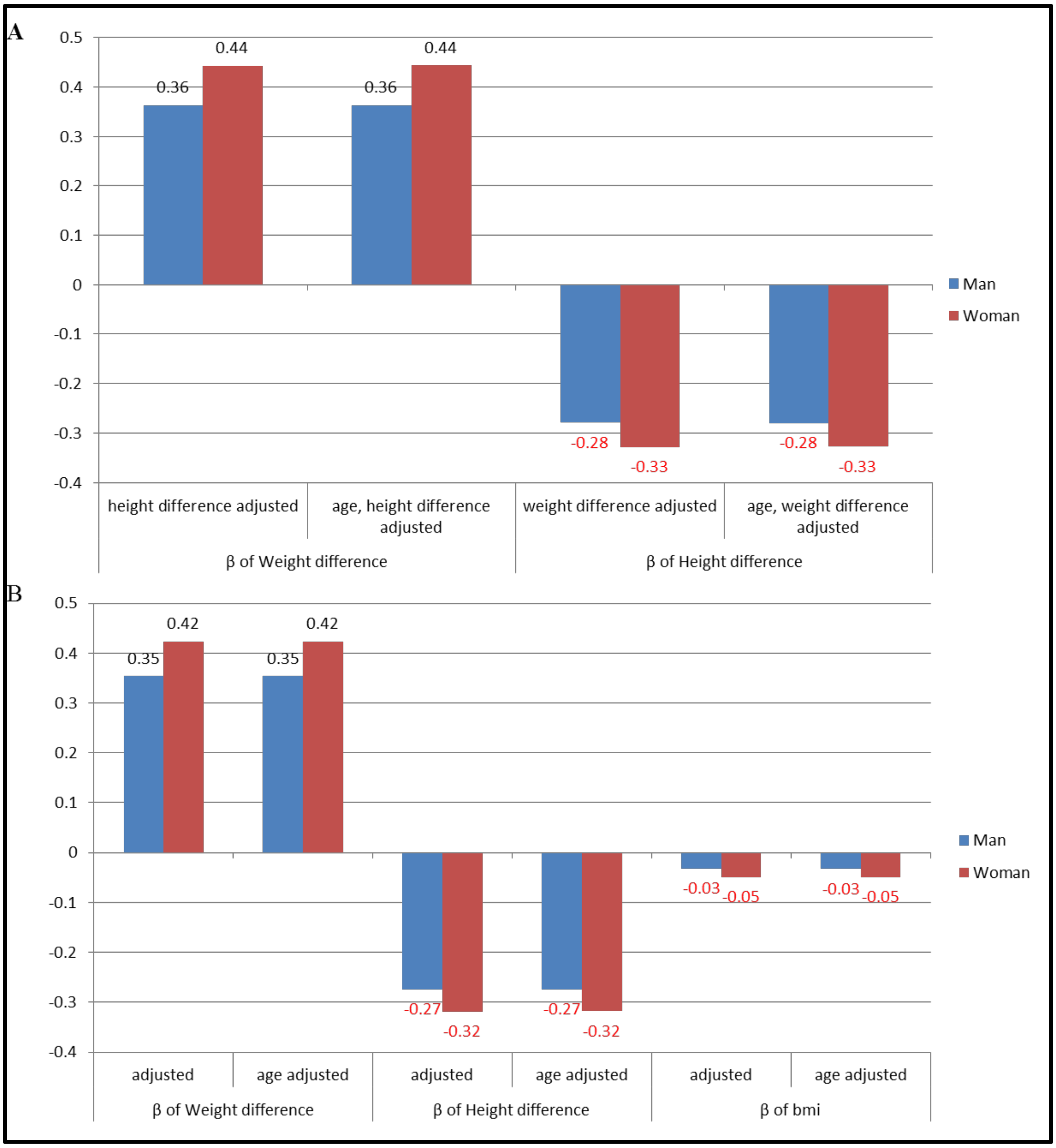


Figure 3.2 Effect of difference

A. Effect of weight difference, height difference for the BMI difference in the cases of including and excluding age adjustments.

B. Effect of weight difference, height difference, and measured BMI that influences BMI difference calculated from the equation of regression, Eq. 3.7 and Eq. 3.8, in the cases of including and excluding age adjustments.

Result of analyzing BMI difference altered from y1, BMI absolute difference used in Figure 3.1 shows increased β in each regression variable. Thus, influence by directivity of reporting error for weight and height on difference of BMI is greater than degree of reporting error.

3.4 Discussion

Participants were consisted of 220 men (43.1%) and 290 women (56.9), and both of the sexes indicated higher obesity prevalence computed using measured height and weight. In men, age was a significant factor identifying the discrepancies between reported and measured obesity. Reported obesity of men aged 45-54 was 29.8% whereas measured obesity of those was 57.5%. In contrast, age of the women showed no significant trend or differences in reported and measured obesity. Women and men indicated difference in significance of education on reporting their ‘true’ weight and height. In men, level of education reported no differences on report and measured obesity, however, women showed significant difference between level of education and obesity prevalence. Women who had middle school degree showed highest obesity rate in reported obesity (46.5%), nevertheless, men with middle school degree had shown the lowest obesity proportion (15.4%). In men, employment and income status showed significant difference in obesity prevalence. In men, employed (45.8%) and top quarter income (30.9%) had significantly higher obesity rate.

Result of multiple logistic regression analysis for obesity prevalence conducted previously, trend, and effect of measurement, and discrepancy on significant variables by sexes were difficult to define. Thus, from the first hypothesis, I reconsidered the assumption of existence of specific variables that cause reporting errors. Starting this research, since obesity was considered to be a main cause of numerous health problems and it is not only a health field concern but social for several decades, my assumption was that there is a tendency of corpulent individual to report their weight lower and heights higher except for the remarkably tall person. This tendency would continue to apply on women strongly affected by social preference of appearance and obesity, middle aged participants and older, relatively younger groups, and higher income and education level groups. Therefore, there was an assumption that related variables of reported and measured obesity would appear differently. Matter of fact, actual result showed no consistent statistical significance.

I reached the conclusion that the reporting bias is not affected by a specific variable, but by all individual middle aged and above. By computing the directly measured weight, height, and BMI into percentile, I compared difference between reported and measured mean by analyzing the data using paired t-test in each group.

The test was duplicated to measure discrepancy of each variables including diagnose of obesity that was categorized into underweight, normal, overweight, and obese (Obesity and overweight population were combined as a result of limited obese population in accordance with WHO standard (30 kg/m^2 <) in Asia), age, level of education, marital status, self-rated health, income, and residential region.

Generally, it is known that level of education is inversely proportional to reporting error. By conducting stratified analysis on age and level of education, reporting error rises only when age of primary educated group increases. In men aged 45-54, with the advancement of education, reporting error complying with educational degrees increased, whereas men aged above 75, it decreased.

At the explorations for effect's size with directivity in the cases of including and excluding age adjustments, height error is non-differential and weight is differential. Basis of attempting this analysis was the hypothesis of age mainly causing reporting error in middle aged and older population, however, there was an uncertainty that the result was age dependent. The reason was that age effect strongly acts as a dragger of education and income status for middle aged and older population. Hence, it can be explained that the effect of age was countervailing as model already includes socioeconomic status. The effect of directivity is larger than the level of difference. Thus, influence by directivity of reporting error for weight and height on difference of BMI is greater than degree of reporting error.

Reporting bias of anthropometric information in middle aged and older population is social norm, consisting of age associated decline, simply put, atrophy bias ($bias_a$) resulted from the age change of body shape and composition due to desirability bias ($bias_d$) and aging from negative perception on obesity (eq. 3.9).

$$bias_T = bias_d + bias_a$$

(Eq.3.9)

$$bias_T(Wt): bias_d(Wt) \gg bias_a(Wt)$$
$$bias_T(Ht): bias_d(Ht) \ll bias_a(Ht)$$
$$bias_T(BMI): bias_d(BMI) \gg bias_a(BMI)$$
(Eq.3.10)

According to previous studies, reporting bias shows significant difference in all older age group due to the reporting bias on weight is dependent on social norm and reporting bias of height is caused by not recognizing the age associated decline (table 3.3). Therefore, result of our research, desirability bias ($bias_d$) is greater on weight and BMI[51,52] and atrophy bias ($bias_a$) is high on height (Eq. 3.10).

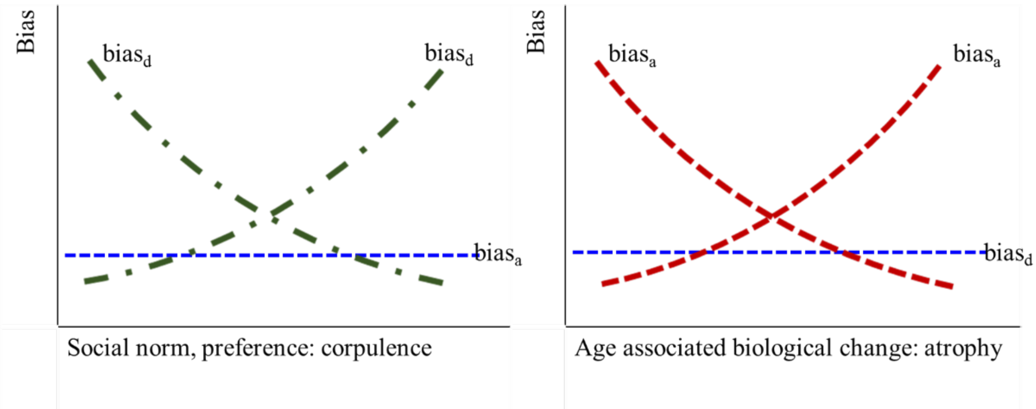


Figure 3.3 Estimation of trend of bias

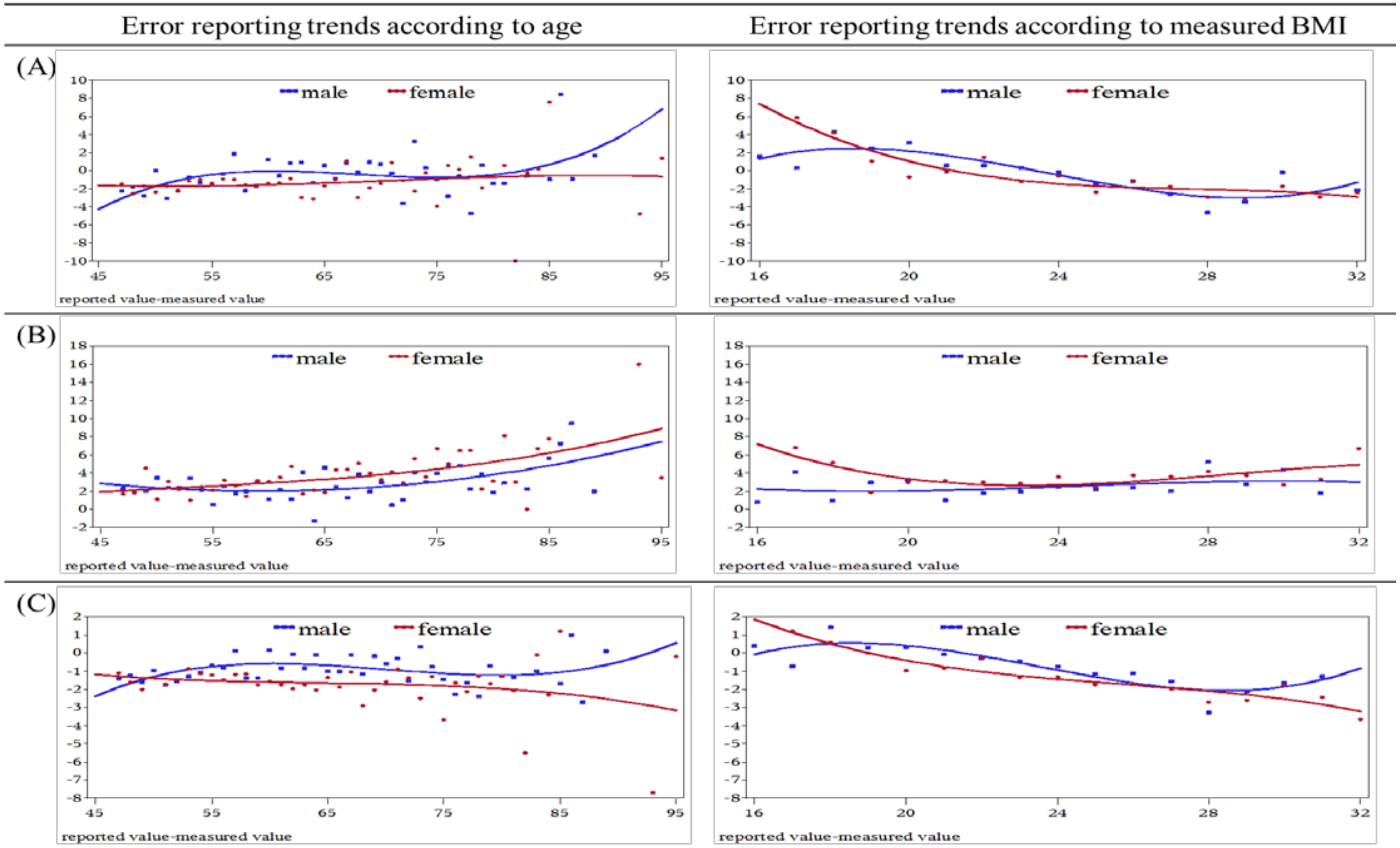


Figure 3.4 Error reporting trends according to sex, age, and measured BMI in relation to weight (A), height (B), and BMI (C), based on the difference between reported and measured values

Figure 4.1 demonstrates expected trend of bias on reporting error which desirability bias or atrophy bias in reported anthropometric information that fully interacts. However, it actually shows different aspects as several factors correlate.

By selecting measured BMI (obese level) and age for social norm and age associated decline respectively, comparison was performed on trend of each bias level as selected measures grow (Figure 3.4). As a result, bias of weight is relatively stable on age growth and the result shows desirability bias complying with social norm due to difference rising negatively on increasing BMI.

For height difference rises as age increases but with BMI growth, it remains stable. Bias of height is caused by atrophy, thus, only by this effect, non-differential bias acts on BMI and obesity diagnose. BMI bias on level of -1 and -2 in male and female, respectively, is consistent regardless of age up to age of 85 and age-related rise. Equal to weight, desirability bias is shown as a result of difference increasing negatively on BMI growth (Figure 3.4).

It is necessary that the transition of age shown in this research is only resulted from participants being middle and older population. In case of teenager population being target of this research, although there is a difference based on age distribution, age can be a causal factor of desirable bias depending on period of recognizing the social norm.

As a result of analyzing socioeconomic status and trends of discrepancies between self-reported and directly measured values in weight, height, and BMI on obesity level, certain biases responded socially and biologically. Through this process of observation, I concluded that anthropometric information is consisted of desirability bias ($bias_d$) and atrophy bias ($bias_a$) and socioeconomic status and aging status among related factors directly affects $bias_d$ and $bias_a$ respectively.

However, interaction between socioeconomic status and $bias_d$ along with aging, and between status and $bias_a$, do not separate form. Multi-interaction is achieved in different levels by sociocultural, racial, and ecogeographical context in each population group.

Social norm changes frequently by various knowledge and power dynamics of an interest group and speed and degree of aging process progression on race and genetics is modified due to nutrition and behavior. As a result, aspect of bias and factor's influence is adjusted as well. This change of effect is occasionally larger than random error, thus, it brings significant difference due to result of association and is sometimes non-differential while remaining at the level of random error. In addition, confounding effect of relating variables works greater than property of bias to decide it. For example, despite of degree discrepancies, somatic atrophy caused by aging occurs to every individual, but their cognitive character may produce error. Conclusively, in case of systematic error being lower than random error, verifying conceptual model through actual data analyzing is challenging. Conceptual model can be proved by empirical test and needed to be accepted as a theory. Therefore, effort of measuring trend of bias and developing modification method to understand characteristics of population is desired.

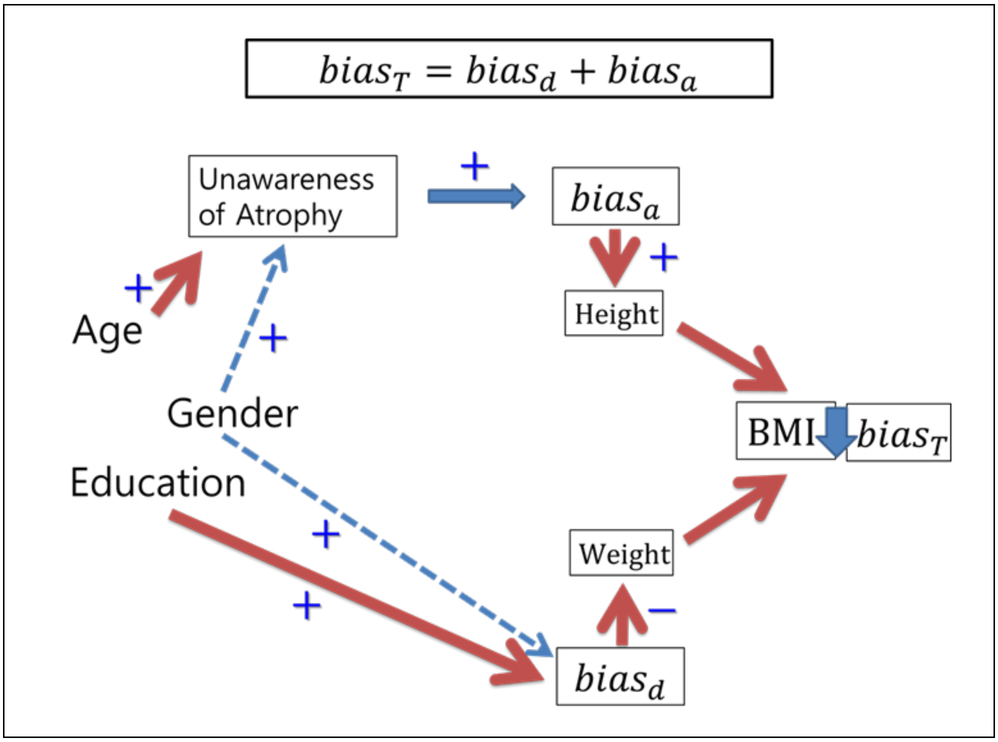


Figure 3.5 Conceptual model for self-reporting bias in anthropometric information

Figure 3.4 shows a concept of self-reporting bias in anthropometric information and influence direction and strength of affecting factors particularly in Korean middle aged and older population.

This research showed each characteristics of self-reporting error in weight and height drawing BMI and result proof and assumption on interactive mechanism of occurred error in the process of obesity prevalence in Korean middle aged and older population. Conducting this research on socioculturally, racially, and ecogeographically diverse population will provide critical baseline data enhancing flaws of well-known self-reported anthropometric information. Cost-efficient and simple methods will be applied in order to predict precise health status and it will lead to improvement in efficiency of measurement tool.

Chapter4. Self-reporting error makes difference in the effect of obesity on chronic conditions among middle aged and order Korean

4.1 Introduction

So far, we confirmed that diagnosis of obesity using self-reported anthropometric information cannot detect many obese people. Such misclassification tendency was discrepant according to the characteristics of those surveyed.[27,28,31] For all that, self-reporting through questionnaire or interview has the advantages of low cost and better availability; moreover, they are easy to administer and are a good method for large numbers of individuals like a community.[36]

It is important to estimate the prevalence of obesity by different demographic, socioeconomic groups. Because health policies, interventions, and programs can be better effectual when they are targeted at the vulnerable populations and adopted practical strategy. A most problematic source of bias in surveys of obesity and BMI is under-reporting. It is likely to affect descriptive analysis, and further, can distort relationships.

Therefore, we had needed to make sure whether different measurement would draw different information or value about our pertinent details. And consequentially, the association change among relevant factors would be broken out. This question put an end to long misgiving about self-reported anthropometric information. The answer will give researchers scope for practical employment of self-reported data. This study was motivated to ascertain whether different measurement connect different association. To achieve goal, we selected obesity and several chronic conditions.

Obesity is a well-recognized risk factor for hypertension and Type II diabetes mellitus (non-insulin dependent diabetes), and increases risk for coronary disease, unexplained heart attack, dyslipidemia, infertility, and a higher prevalence of colon, prostate, endometrial, breast cancer.[57] This study was conducted to validate the change of association from using different measurement; the effect change of obesity to chronic conditions as diagnosis on obesity. Chronic conditions are based on objective data; from actual health examination and subjective data; from respondent's self-reporting information.

4.2 Method

4,2,1 Data and Study population

The Korean longitudinal study of ageing (KLoSA), a national representative large population-based cohort study of adults 45 years of age and older (confer chapter 2.2).

Among its panels who responded to the second wave main survey, we randomly recruited 527 peoples with written informed consent. Among 527 participants (301 women, 57.1%), 17 were excluded because they were not taken their height and weight to calculate BMI.

The second wave of KLoSA was appropriated for self-reported information of socioeconomic and demographic details including health behavior, body weight and height. Actual health examination for directly measured information was implemented by a trained nurse through home visiting. The visiting nurse made up performance battery, pathologic laboratory test using blood and urine and physical examination including weight and height.

WHO has defined overweight and obesity as BMI $\geq$25.0 kg/m^2 and $\geq$30.0 kg/m^2 respectively.[58] But in this study, obesity was defined BMI $\geq$25.0 kg/m^2 depending on the Asia specific cut points,[59] and the other recommendation about risky BMI for morbidity among East Asians[44,45]. When obesity is defined BMI $\geq$30.0 kg/m^2, the obese are just 4 persons for men, 25 for women among this study subjects using measured BMI. As the case stands, we defined obesity as BMI $\geq$25.0 kg/m^2.

We defined diabetes as fasting(8 hours and more) glucose of $\geq$126 mg/dl (7.0 mmol/l) or random plasma glucose of $\geq$200 mg/dl (11.1 mmol/l)[60,61] or with medications to diabetes or if fasting time is less than 8 hours and more than 2, plasma glucose of $\geq$140 mg/dl. Hypertension was classified as systolic blood pressure $\geq$140 millimetres of mercury (mmHg), or diastolic pressure $\geq$90 mmHg or with medications to hypertension.[62] Hypercholesterolemia was classified as total cholesterol ≥230mg/dl or with medications to it.[63] Other demographic, socioeconomic and health related variables have been already described in chapter 2.2.

4.2.2 Analyses

All statistical analyses were carried using SAS 9.3 (SAS Institute, Cary, NC) for Windows.

Frequency analysis was taken for descriptive study. And chi square-test was used to explore the differences of disease prevalence by each category in participants' characters such as age, education, marital status, economic factors and residence and *p* for trend in each factor was tested.

Because of limited number of cases, multiple logistic regression to determine the association between obesity and outcome depending on measuring methods for anthropometric information, was conducted only for hypertension. The model adjusted sex, age, education, and income, by sex and obesity measuring method.

A multiple logistic regression analysis was used to compute the odds ratios for obesity. The multiple logistic regression equation assumes the natural log of odds has linear relation to explanatory variables. Logit-transformed probability in this study was

$$\text{logit}(p) = \log(p/(1-p)) = \beta 0\ (+\ \beta 1 * \text{sex}) + \beta 2 * \text{age} + \beta 3 * \text{education} + \beta 4 * \text{income} + \beta 5 * \text{obesity}$$

obesity: from self-reported BMI or measured BMI (Eq. 4.1),

and in terms of probabilities, exponential functions are used.

$$p= \exp(\beta0\ (+\ \beta1*sex) + \beta2*age + \beta3*education + \beta4*income + \beta5*obesity) / (1+\exp(\beta0\ (+\ \beta1*sex) + \beta2*age + \beta3*education + \beta4*income + \beta5*obesity))$$

P: probability of hypertension (Eq. 4.2)

In addition to that, the Cochran–Mantel–Haenszel (CMH) test was used for evaluation the effect of hypertension on the reporting error influenced by obesity that could be controlled.

4.3 Results

Table 4.1 shows the characteristics of participants and the prevalence distribution of chronic conditions; diabetes mellitus, hypercholesterolemia and hypertension, by the level of socio-demographic and related variables. The prevalence of diabetes was 15.9% in both gender. There were significant trend between diabetes prevalence in self-rated health, working status, residence area, and measured obesity in all population. The prevalence of hypercholesterolemia was just 12.6%, 64 cases. There were no significant variables for chai square test. The prevalence of hypertension were 51.8% in men and 51.0% in women. The level of obesity from both method and residence region were significant in chai square test.

Therefore hypertension had most cases, obesity misclassification and hypertension were tested in statistical significance. Table 4.2 presents the distribution of obesity prevalence from measured and reported BMI, and its differences, depending on hypertension. Relative difference of obesity prevalence in with and without hypertension are -40.3% and -46.7 respectively. The relative differences depending on hypertension after controlling obese level were not significant from Cochran–Mantel–Haenszel test.

As results of multiple logistic regression to assess the association between obesity and hypertension, compared obesity from reported with measured BMI, odds ratios were considerably changed by BMI measuring method and sex. For all, both men and women, odds ratio of measured obesity was higher than reported. Considered separately by sex, odds ratio of reported obesity was relatively high in both sexes. (Table 4.3)

As presented before in chapter 2, adjusted BMI from equation of regression with sex, age, measured weight, height, and BMI, were tested for comparison with measured and reported. Table 4.4 and figure 4.2 show the odds ratio of obesity for hypertension from measured, adjusted and reported BMI by sex in subsample. All the odds ratio of obesity to hypertension were statistically significant.

Table 4.1 Characteristics of participants and chronic conditions' prevalence

Variables		N	Diabetes Mellitus n (%)		Hypercholesterolemia n (%)	Hypertension n (%)	
All		510	81 (15.9)		64 (12.6)	262 (51.4)	
Sex	male	220	35 (15.9)		20 (9.1)	114 (51.8)	
	female	290	46 (15.9)		44 (15.2)	148 (51.0)	
Age	45~54	104	11 (10.6)		19 (18.3)	49 (47.1)	
	55~64	172	27 (15.7)		17 (9.9)	91 (52.9)	
	65~74	164	29 (17.7)		21 (12.8)	88 (53.7)	
	75~	70	14 (20.0)		7 (10.0)	34 (48.6)	
Education	primary	253	47 (18.6)		34 (13.4)	129 (51.0)	
	middle	82	15 (18.3)		11 (13.4)	43 (52.4)	
	high	130	12 (9.2)		14 (10.8)	68 (52.3)	
	university	45	7 (15.6)		5 (11.1)	22 (48.9)	
Living	with spouse	410	62 (15.1)		46 (11.2)	208 (50.7)	
	without spouse	100	19 (19.0)		18 (18.0)	54 (54.0)	
Self rated health	good	171	16 (9.4)	*	25 (14.6)	80 (46.8)	
	moderate	185	32 (17.3)		20 (10.8)	95 (51.4)	
	bad	154	33 (21.4)		19 (12.3)	87 (56.5)	
Employment	employed	216	20 (9.3)	**	25 (11.6)	101 (46.8)	
	not employed	294	61 (20.8)		39 (13.3)	161 (54.8)	
Income†	bottom quarter	127	21 (16.5)		14 (11.0)	61 (48.0)	
	2nd	128	21 (16.4)		21 (16.1)	67 (52.3)	
	3rd	126	18 (14.3)		15 (11.9)	74 (58.7)	
	top quarter	129	21 (16.3)		14 (10.9)	60 (46.5)	
Region	large city	138	31 (22.5)	*	19 (13.8)	83 (60.1)	*
	smaller city	222	33 (14.9)		30 (13.5)	112 (50.5)	
	rural area	150	17 (11.3)		15 (10.0)	67 (44.7)	
Smoking	never	346	55 (15.9)		49 (14.2)	175 (50.6)	
	current	79	11 (13.9)		6 (7.1)	47 (59.5)	
	past	85	15 (17.7)		9 (11.4)	40 (47.1)	
Obesity†	underweight	22	2 (9.1)		0 (0.0)	5 (22.7)	***
	healthy weight	359	49 (13.7)		50 (13.9)	168 (46.8)	
	overweight	124	29 (23.4)		13 (10.5)	86 (69.4)	
	obese	5	1 (20.0)		1 (20.0)	3 (60.0)	
Obesity‡	underweight	16	1 (6.3)	*	0 (0.0)	3 (18.8)	***
	healthy weight	270	31 (11.5)		35 (13.0)	110 (40.7)	
	overweight	195	43 (22.1)		25 (12.8)	130 (66.7)	
	obese	29	6 (20.7)		4 (13.8)	19 (65.5)	

*p value<0.05 from χ^2 test
**p value<0.001 from χ^2 test
***p value<0.0001 from χ^2 test
† based on BMI from reported height and weight, diagnosed with WHO criteria
‡ based on BMI from measured height and weight, diagnosed with WHO criteria

Table 4.2 Distribution of obesity prevalence from measured and reported BMI, and its differences depending on hypertension

Variables		Hypertension(+)					Hypertension(-)				
		N	Obesity† (%)	Obesity‡ (%)	Difference[a] (%)	Difference[b] (%)	N	Obesity† (%)	Obesity‡ (%)	Difference[a] (%)	Difference[b] (%)
N	510	262	56.9	34.0	-22.9	-40.3	248	30.2	16.1	-14.1	-46.7
Sex	male	114	**50.0**	**25.4**	-24.6	-49.1	106	27.4	13.2	-14.2	-51.7
	female	148	**62.2**	**40.5**	-21.6	-34.8	142	32.4	18.3	-14.1	-43.5
Age	45~54	49	**71.4**	42.9	-28.6	-40.0	55	30.9	16.4	-14.6	-47.1
	55~64	91	**57.1**	31.9	-25.3	-44.2	81	38.3	21.0	-17.3	-45.2
	65~74	88	**46.6**	28.4	-18.2	-39.0	76	27.6	14.5	-13.2	-47.6
	75~	34	**61.8**	41.2	-20.6	-33.3	36	16.7	8.3	-8.3	-50.0
Education	primary	129	58.1	36.4	-21.7	-37.3	124	33.9	16.9	-16.9	-50.0
	middle	43	69.8	41.9	-27.9	-40.0	39	25.6	20.5	-5.1	-20.0
	high	68	48.5	25.0	-23.5	-48.5	62	29.0	14.5	-14.5	-50.0
	university	22	50.0	31.8	-18.2	-36.4	23	21.7	8.7	-13.0	-60.0
Income†	bottom quarter	61	54.1	**36.1**	-18.0	-33.3	66	28.8	13.6	**-15.2**	**-52.6**
	2nd	67	55.2	**25.4**	-29.9	-54.1	61	37.7	14.8	**-23.0**	**-60.9**
	3rd	74	54.1	**28.4**	-25.7	-47.5	52	30.8	19.2	**-11.5**	**-37.5**
	top quarter	60	65.0	**48.3**	-16.7	-25.6	69	24.6	17.4	**-7.3**	**-29.4**

† based on BMI from measured height and weight, diagnosed with WPRO WHO criteria
‡ based on BMI from reported height and weight, diagnosed with WPRO WHO criteria
[a] reported obesity rate-measured obesity rate
[b] (reported obesity rate-measured obesity rate)/measured obesity rate
Bold type statistically significant in chai square test

Table 4.3 Odds ratio of obesity for hypertension from measure and reported BMI by sex

Sex	Measured obesity		Reported obesity	
	OR	(95%CL)	OR	(95%CL)
All	3.283	(2.250, 4.791)	2.932	(1.892, 4.544)
Men	2.611	(1.452, 4.696)	3.801	(2.248, 6.428)
Women	2.271	(1.088, 4.739)	3.400	(1.913, 6.044)

Table 4.4 Odds ratio of obesity for hypertension from measured, expected and reported BMI by sex in subsample.

Sex	Measured obesity		Expected obesity		Reported obesity	
	OR	(95%CL)	OR	(95%CL)	OR	(95%CL)
All	4.436	(2.573, 7.646)	3.776	(2.190, 6.511)	5.649	(2.889, 11.045)
Men	3.772	(1.665, 8.550)	2.621	(1.189, 5.776)	4.190	(1.341, 13.093)
Women	5.443	(2.439, 12.147)	5.066	(2.288, 11.218)	7.003	(2.898, 16.921)

Odds ratio of adjusted obesity was the lowest. In particular, the difference between adjusted and measured obesity in men was the highest. By gender, odds ratio in men was generally lower than women.

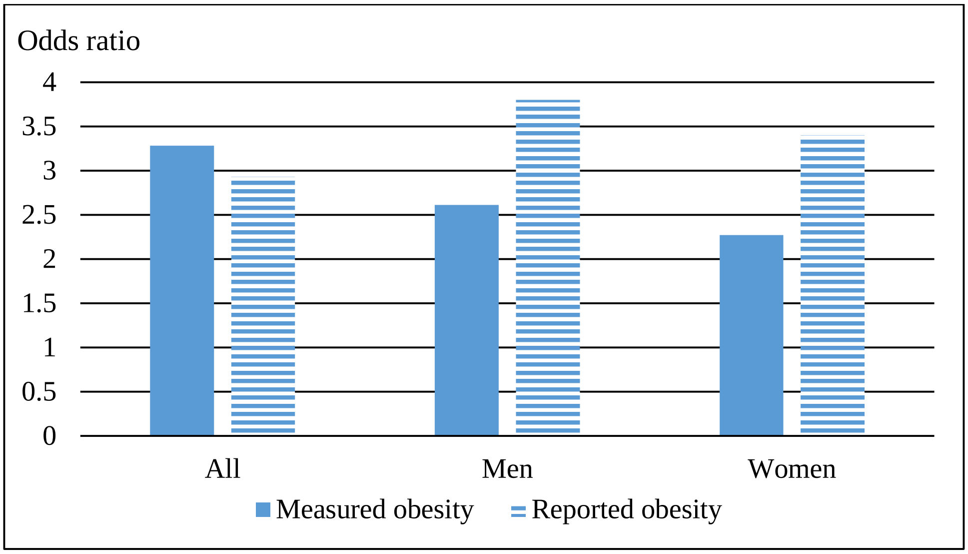


Figure 4.1 Comparison in odds ratio of obesity for hypertension from measure and reported BMI by sex

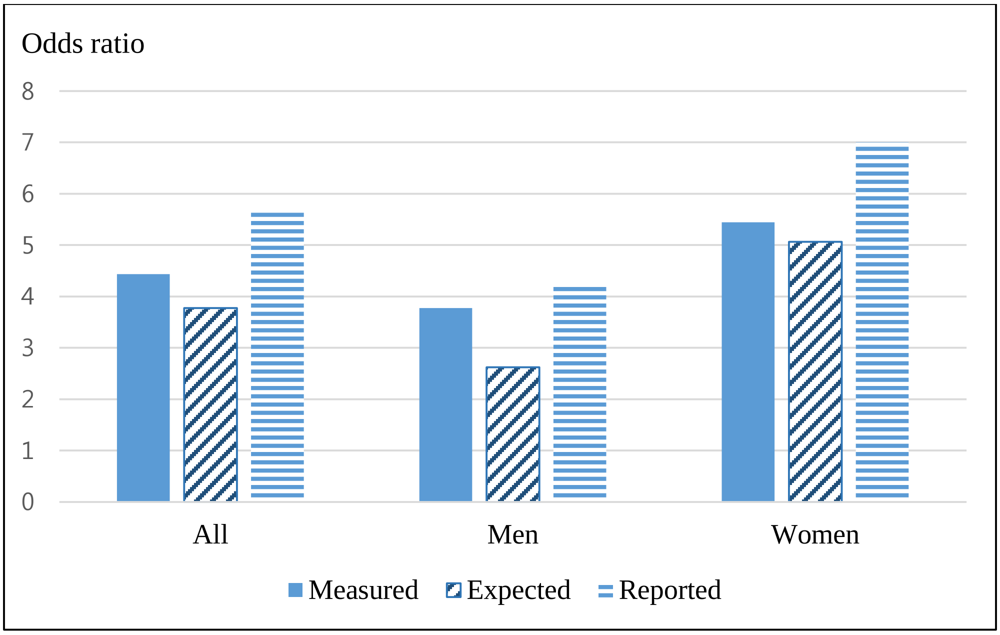


Figure 4.2 Comparison in odds ratio of obesity for hypertension from measured, expected and reported BMI by sex in subsample

4.4 Discussion

Overall, in this population, the prevalence of diabetes was 15.9% (n=81), hypercholesterolemia 12.6% (n=64), and hypertension 51.4% (n=261). When compared the association from using measured obesity with from reported obesity in chai square test, diabetes prevalence had change by only measured obesity level. Hypertension had difference of prevalence in both reported and measured obesity. On the contrary, hypercholesterolemia had no difference with any variable including both obesity. As results of multiple logistic regression, diabetes and hypertension presented statistical significance in both measured and reported obese level. Adjusting BMI using equation of regression was available to predict obesity prevalence. This method needs major concern in inference about related factors and measuring the risk.

For the prevalence of obesity, it was higher in women than in men in both cases of reported and measured. The discrepancy of obesity prevalence from reported and measured BMI was higher in men. (Table 2.2) For hypertension, relative difference of misclassification of obesity was 6.4% (Table 4.2) by with hypertension. However, it was not significant statistically.

Odds ratio of obesity adjusted sex, age, education and income to hypercholesterolemia showed no more risk; rather, it was lower. Actually in the 2X2 table of obesity and hypercholesterolemia (Table 4.5), hypercholesterolemia prevalence was higher in not obese, except women's measured obesity. It is assumed that just small sample size and selection bias for participation to health examination should be.

Table 4.5 Hypercholesterolemia prevalence by obesity and sex.

		Men		Women	
		N	Hypercholesterolemia (%)	N	Hypercholesterolemia (%)
Obesity_m	Yes	86	8.14	138	15.94
	No	134	**9.7**	152	14.47
Obesity_r	Yes	43	4.65	86	13.95
	No	177	**10.17**	204	**15.69**

m measured
r repored

In terms of other exploratory analysis, multiple logistic regression was conducted to assess the effect of each obesity level on chronic conditions by BMI measurement. Obesity level classified in compliance with WPRO WHO criteria.[59] Each disease's trend in prevalence and odds ratio were not changed exceedingly by BMI measurement. (Figure 4.3, 4.4) But the discrepancy in odds ratio was different by sex and disease from 0.1 to 1.2. (Table 4.6) Then, these difference of odds ratio suggest there is potential confounder in the evaluation of obesity effect using reported BMI.

To elucidate how to increase the difference in odds ratio of obesity in the contrast measured and reported, hypertension prevalence was explored by obesity measurement and obesity or not. Fundamentally, obesity prevalence increased in measured regardless of disease because measured obesity was nearly double of reported. (Table 4.7)

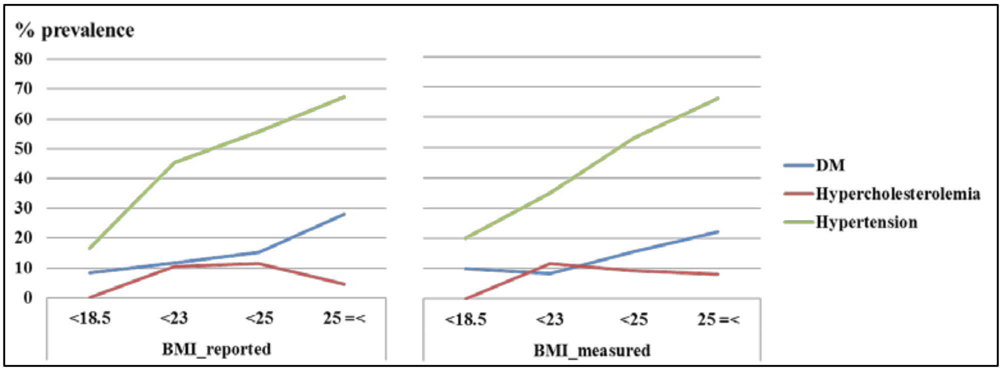


Figure 4.3 Influence of self-reporting error on the prevalence of chronic disease by obesity level among middle aged and order Korean

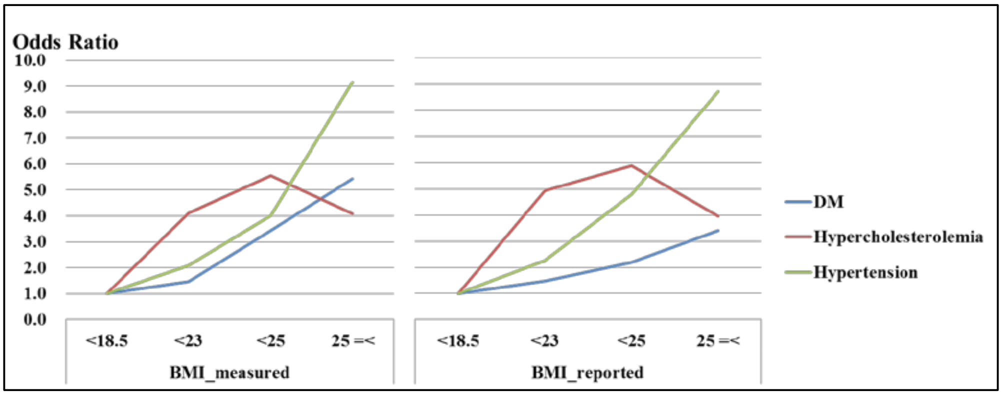


Figure 4.4 Influence of self-reporting error on the effect of chronic disease by obesity level among middle aged and order Korean

Table 4.6 Odds ratio of obesity (25≤BMI) for each chronic condition by sex and BMI measuring method.

Variables		Measured obesity		Reported obesity	
		OR	(95%CL)	OR	(95%CL)
Diabetes Mellitus	All	**2.360**	**(1.429, 3.897)**	**1.976**	**(1.173, 3.328)**
	Men	**2.200**	**(1.020, 4.743)**	**2.484**	**(1.071, 5.757)**
	Women	**2.223**	**(1.116, 4.429)**	1.482	(0.747, 2.940)
Hypercholesterolemia	All	0.901	(0.527, 1.541)	0.787	(0.421, 1.470)
	Men	0.568	(0.205, 1.573)	0.389	(0.096, 1.578)
	Women	0.899	(0.457, 1.771)	0.819	(0.392, 1.709)
Hypertension	All	**3.283**	**(2.250, 4.791)**	**2.932**	**(1.892, 4.544)**
	Men	**2.611**	**(1.452, 4.696)**	**3.801**	**(2.248, 6.428)**
	Women	**2.271**	**(1.088, 4.739)**	**3.400**	**(1.913, 6.044)**

Table 4.7 Frequency change of obesity in hypertension by measurement.

All		Obesity					
		Measured		Reported		Difference	
		N	%	N	%	N	%
Obesity+	Hypertension+	149	66.5	89	69.0	60	-2.5
	Hypertension-	75	33.5	40	31.0	35	2.5
	Difference	74	33.0	49	38.0	25	-5
Obesity-	Hypertension+	113	39.5	173	45.4	-60	-5.9
	Hypertension-	173	60.5	208	54.6	-35	5.9
	Difference	-60	-21	-35	-9	-25	-11.8

With change of obesity measurement from direct measure to self-reporting, the difference of proportion between with and without hypertension in obese population increased. But on the other hand, in not obese population, the difference between proportion of hypertension and non-hypertension decreased in reported data. As a result, a relative risk of hypertension due to obesity should be overestimated in reported data. Compared by gender, these relative risk change should make bigger difference in women. The risk change of obesity for health outcome will vary according to the actual prevalence of obesity and affected disease, sensitivity and specificity of the measuring tool, and many other factors for measurement error. We cannot expect where the measuring error for exposure and disease lead to.[64] Actually, in most epidemiologic studies, measurement error rarely was accounted for when interpreting results.[65]

Sex and age are strong predictors for reporting error in classification of obesity.[49,66,67] Since it is highly likely that any problem with large under-reporting error push back after one with relatively small error in prioritizing tasks of health policy, in comparing it with any disease, under-estimation of obesity prevalence using self-reported anthropometric information is at issue for prioritization.[68] As a result of this research, even though diagnosis of obesity from self-reported information has low sensitivity, these results suggest that obesity classification using BMI from self-reported weights and heights would be satisfactory for the monitoring of obesity prevalence in Korean middle and order population. That is to say, obesity prevalence using self-reported information merely decrease the magnitude of problem, would not affect the trend and statistical significance with the level of other related factors.

Therefore it is available to watch related or effected factors to obesity through monitoring and comparing obesity by time, region, and demographic peculiarity and so on. For example, if as years go by obesity prevalence goes up, whether use reported or measured, the risk of chronic diseases in the population will increase. These inferences are not easy to make errors even self-reported weight and height were used.

It goes without saying that any inference could fall into occasional inaccuracies.

Any evaluation, diagnosis or observation is not from only the own results of objective population. When we do evaluate the results of objective population, we compare the two or more; the present with the past, the objective with the other populations like the cases with the controls in clinical research. And decision making must explain the comparison process. Without separated and integrated concerning for comparing population, times, period, and data collecting method, the efficiency and rationale of the decision are impossible.

Until now, many studies have worked for validity or accuracy of self-reported data. There has been, however, few study tried to define association change derived from different measurement of BMI and obesity. As already been conducted, estimated BMI using regressive equation (Eq.2.1) from directly measured to reported value reused for effect comparison by gender (Appendix 1 & 2). The results present that there is no definite effect change of obesity and other related variables on diabetes prevalence. Using estimated BMI showed more similar association pattern with in the cases of measured BMI rather than self-reported. As things stand, a simplified estimating equation also can be used. These results suggest that among some of objective population, just about 5%, building an estimating equation for reduction of discrepancy between reported and directly measured data is utilizable for more accurate assessment of association among the related factors with obesity prevalence.

In Korea, there are many health related surveys. The Korean National Health and

Nutrition Examination Survey (KNHANES) is leading nation representative health survey that adopts directly measuring methods to community dwelling people. The other cross-sectional or longitudinal designed surveys, such as KLoSA, Community Health Survey (CHS) by each municipality, Korea Health Panel (KHP) and so on, collect reporting data in many ways. Almost data form these surveys have a problem pressing for solution. Many responsible those who have something to do still struggle with tasks like reporting error, response rate, omissions, training personnel and so forth.

Except for systematic reporting error, community population-based research on health related details is faced with other evidence of biases that may affect results to varying degrees. One of potential bias, which is often unheeded in epidemiology even it has been dealt with in a field of survey methodology, comes from self-selected study participants. Subjects who participate in surveys may be at less risk of disease or at better health status than those who decline. Similarly to observations in adult populations, studies of children have also brought obvious evidence of self-selection. Epidemiological surveys involving obesity, and other features of health may be subsequently missing an important portion of the population distribution. This is particularly in nationwide or community based survey.[69,70] Whether such selection tendencies influence results of association studies depends on how the biases interrelate to the related factors and outcome variables has been studied. Probably, biased participation is likely to affect descriptive epidemiology, such as prevalence and means, but will also change analytical association.[71]

When we work statistical analysis, we adopt measurement error perspective. We take reported data on true value and error term like white noise.[72] White noise is meaningless because it lacks a distinct difference, and this allows people not to pay attention to it. So error term makes people feel more comfortable. We are girt with various survey related human health. Since it is impossible to set survey without error, researchers try to decrease error through finding distinct difference underlain in error term rather than to make more exact one. The more interpretation on error, we can step closer to actual association and real problem.

Finally, the evaluation of effect of obesity from self-reported BMI on chronic conditions, is relevant for estimation of health risk itself and its trend depending upon obese level, compared with effect of obesity from measured BMI. But, for estimation to the magnitude of the risks, we have to be concerned about not only under-estimation but also over-estimation.

This study population was just 510 persons. Even though self-reporting error comes from multi-directional and diverse elements, all possible covariates could not be included in the analyzing model because of sample size. Therefore, the results of this study has potential instability. A larger study based in community is needed to explain a more precise estimate of effect of reporting error in obesity classification

Chapter 5. Discussion and conclusion

These studies represent the overall look at the examination of the relationship between self-reported and directly measured height, weight and BMI in community-dwelling Korean middle aged and older. Generally, the data show tendencies to underestimate weight and BMI and overestimate height, although the degree of the tendency has altered in a few subgroups of some variables.

In the older population, the impact of obesity on health is controversial. Obesity has been regarded as an important risk factor for various chronic status such as diabetes mellitus, dyslipidemia, hypertension, cardiovascular disease and cognitive impairment as they should lead to decline in quality of life and eventual premature death for a long time.[73,74] However, the risk associated with BMI rise actually increases with age, just up to 75 years. From the standpoint of the medicine, the health effects caused by obesity increase linearly with growing BMI until the 75 years old.[7] After that time sarcopenia with ageing makes some beneficial effects of obesity. High BMI values are tied in slow bone loss and sluggish muscle mass decrease.[75] And the other possible account for the poor or contrary associations between high BMI and health related outcomes is premature death before age 75, so obese elderly survived may have certain resistance to the impact of obesity.[6] A key to the settlement of these phenomenon is ageing effect on body composition and fat redistribution.[12,76,77]

In addition to the characteristics of the effect mechanism of obesity in elderly, we have to consider the growth of older population worldwide and the increasing obesity prevalence in older people. Both facts predict a sudden rise in burden of obesity complications in public health sphere. Therefore, a correct grasp on the existing state of obesity prevalence during middle age may contribute to the estimate of medical complications and increased health expenditures that should occur during old age in the population.[78]

Body mass index (BMI) has various deficiencies as a measure of obesity, especially when the BMI measure is based on self-reported height and weight. BMI is an indirect measure of body fat compared with more direct approaches such as bioelectrical impedance. Moreover, BMI does not necessarily reflect the changes that occur with age. The proportion of body fat increases with age, whereas muscle mass decreases, but corresponding changes in height, weight and BMI may not reflect changes in body fat and muscle mass. Both the sensitivity and specificity of BMI have been shown to be poor. Additionally, the relation between BMI and percentage of body fat is not linear and differs for men and women.[79]

In terms of the accuracy of measurements, surely directly measured anthropometric information is more valid than self-reported. The consequences of the errors in the measurement of obesity with BMI depend on whether they are differential or non-differential. Differential misclassification, a potentially greater problem in case–control and cross-sectional studies than in prospective cohort studies, can produce a bias toward or away from the null. Non-differential misclassification produces a bias toward the null for a dichotomous exposure; for measures of exposure that are not dichotomous, the bias may be away from the null. Using BMI as a measurement of obesity can introduce important bias in estimating the effects related to obesity.[80]

These advanced measurements such as Bioelectrical Impedance Analysis (BIA) and Dual energy X-ray absorptiometry (DXA), however, require too much cost and complicated procedures to apply to community population. So BMI from self-reported anthropometric information is employed as usual worldwide, even though BMI cannot reflect body composition and distribution of adipose tissue. For that reason, the researchers should reveal the spread of errors and a scheme for systematic bias inherent in each target population based on demographic structures and the prevalence.

It is not startling news that the discrepancy among the estimates from different measurements. We have listened to the pros and contras of the use of subjective data.[72,81] These results about errors on self-reporting anthropometric information are particularly meaningful for Korean meddle aged and older on the surface. In Korea, the expansion of older population and an increase of obesity prevalence in younger population have been attracting public concern for population health, notably chronic conditions.[82] Therefore, it is indispensable that the estimates upon which decision-makings become evidences are as accurate as possible. There is a clear discrepancy between objective data and subjective, or self-reported, and more factors involve through variant ways in older population. Many researching bodies, however, still tend to choice more to conduct survey than direct examination. Over such situation, researchers need to give and to serve more concrete comprehension and interpretation in the context of data and population.

Self-report measures are the most common ways to collect anthropometric data. They have consistently been associated with morbidity and mortality.[83] However, Self-reporting has certain limitations: questions may be misunderstood; participants may not accurately recall past events and response bias e.g. social preference or response acquiescence does happen.[84] An improvement of accuracy in data should be dealt by improving the quality of reporting in future studies of this area, making recommendations based on more inclusive information about whether self-report measures can be used and they can be in what circumstances, subsequently have got to explicate adjusting method or explanation frame to increase the accuracy of self-reported data in conditions where direct measurement is not possible.

Certain study suggested that exposure or disease misclassification should not be non-differential if the latter cannot be deduced logically from the true situation even classification errors are independent.[85] Conventionally, non-differential exposure misclassification abates test power and leans study estimation towards the null value.[86] But that is just heuristic. A rule of thumb, or simplification reduces the challenge for searching solutions in inveterate bias that are difficult and poorly understood. Heuristics do not guarantee optimal, or feasible solutions. Sometimes they are used with no theoretical bases.

Certain real data are analyzed to explained that the possible consequences of correlated non-differential misclassifications are not wholly theoretical.[87] Non-differential exposure misclassification always produces an underestimate of the true value is incorrect. One reason for this incorrect belief is a failure to understand that bias is not the only, or even necessarily, the main, source of error in an estimate. Bias is not the ratio of the observed estimate from one study to the true value, because the observed estimate also incorporates random errors.[86]

For population and community based large study, the design of validation studies therefore requires great care, as well as thoughtful considerations concerning the sample size of the study, to enable the potential sources of errors, attributable to study subjects' individual characteristics and/or particular types of obesity, to be investigated in depth.

Investigating actual phenomenon is eventually helpful to find solution by understanding it and defining problems and causes around it. Figure 3.3 explained just the true situation deriving reporting bias of self-reported anthropometric information for obesity classification even there was lack of integrated sociocultural aspect. Researchers have to continue studying until adequate algorithm for understanding the true situation is built and it explains fairly error term.

It is important to evaluate the burden of obesity by various socio-demographic subpopulations so that effective policies not only in health sector but social integrate, service programs, and interventions can be more properly targeted at the exact risk populations. The Results of these studies have more relevant in community based research than clinical or designated group at the certain risk of disease. When an available information is only self-reported data, it is required to reckon the items discussed at this study as crucial and potential to evaluate their results and those validity.

Accurate estimation of any health related status through epidemiologic research affects health policy. Self-reported height and weight data collected on a large scale in population, are often used to inform regional and national estimates of overweight and obesity, and then are used by decision makers for strategic placement of priorities in health policy and resource allocation. Therefore, responsible researchers should stay awake to keep sound quality of data, analysis, and interpretation, and finally, would present adequate implication for actual status.

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국문초록

측정도구의 차이에 따른 비만 유병률과 만성질환에 대한 비만 영향의 차이 : 체중과 신장의 자가보고와 직접측정 비교

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인체계측자료의 자가보고와 직접측정의 값은 높은 상관성에도 불구하고 그 차이와 계통 오차에 대해 다양한 인구집단을 대상으로 여전히 많은 논쟁의 주제로 등장하고 있다. 특히 우리나라에서 중노년인구의 증가와 비만과 만성질환의 증가는 정확한 비만유병률의 측정과 그 관련 요인들을 규명하고 이를 개별 보건사업의 대상자 선정, 사업전략, 평가에 근거자료로 제공하도록 하는 요구를 증가시켰다.

연구의 자료는 한국중고령자 패널연구(Korean Longitudinal Study of Ageing(KLoSA))의 2차 조사에 참여한 대상자 중 제주도를 제외한 전국의 47세 이상 510명(여성 290명; 56.9%)을 대상으로 인구학적 특성과 사회경제적 요인, 신체계측과 임상병리학적 검진을 포함한 건강수준 등을 조사한 결과이다.

본 연구의 첫 번째 목표는 자가보고 자료를 이용한 비만 진단의 타당성을 평가하는 것이다. 두 번째 목표는 자가보고 자료와 직접측정 자료를 각각 이용하여 비만을 평가 하였을 때, 각각의 경우에 비만유병 관련요인의 변화를 비교하여 조사수행의 수행과정과 경제적 제한으로 인해 빈번히 사용되는 자가보고 인체계측자료의 사용 시 문제점과 해결방안을 탐색하는 것이다.

자가보고 자료를 이용하여 비만율(남자 19.6%, 여자 29.7%)을 평가한 결과, 직접 측정한 인체계측자료를 이용한 경우(남자 39.1%, 여자 47.6%)에 비해 매우 낮은 유병률을 보였다. 직접측정자료를 이용한 비만진단과 비교하여 자가보고 자료를 이용한 비만 진단의 민감도는 남자 46.5%, 여자 60.1%로 매우 낮았으나, 반대로 특이도는 각각 97.8%와 98%로 매우 높았다.

비만유병 관련요인의 변화를 비교한 결과, 자가보고 자료로 진단된 비만율은, 남성에서는 교육수준이 낮을수록 높아지는 경향을 보이고, 소득이 높은 집단이 가장 높았지만 통계적으로 유의하지는 않았다. 여성에서는 연령이 낮을수록, 교육수준이 낮을수록, 대도시 지역일수록 더 높았으나 역시 통계적 유의성은 없었다. 직접측정자료를 이용한 비만율은 남성에서는 어떠한 변수에 대해서도 경향성이나 통계적 유의한 결과를 확인할 수 없었으나, 여성에서는 연령이 높을수록, 교육수준이 낮을수록 비만율이 높아지고 통계적으로 유의함을 알 수 있었다.

이러한 연구 결과를 토대로 체중과 신장의 보고오류의 경향을 각각 성별, 연령별, 비만도별로 분석한 결과 각각 다른 경향을 보이고 있음을 알게 되었다. 체중과 신장의 보고오류가 결국 BMI를 이용한 비만진단의 오류에 영향을 미치고 그 과정에 특정한 현상을 파악할 수 있었다. 비만을 기피하는 사회적 요구에 맞추려는 의도적 오류와 노령화 과정에서 일어나는 근골격계 위축에 의한 위축오류가 복합적으로 자가보고와 직접계측 자료의 차이를 만든다. 체중의 차이는 주로 의도적 오류에서 비롯되며, 신장의 차이는 신체의 위축성변화를 인지하지 못함으로 해서 생긴다. 따라서 체중의 차이는 성별, 연령, 교육수준 등에 의해 영향을 받고 신장의 차이는 모든 대상자들에게서 고루 나타나며 단지 연령이 증가함에 따라 그 차이가 커진다.

이번 연구는 비만진단에 사용되는 BMI를 산출하는 데 사용되는 체중과 신장의 각각의 자가보고 오류 특성을 밝히고, 그것이 우리나라 중고령자에서 비만유병률을 측정하는 데 발생시키는 상호작용기전에 대한 가정과 이를 증명하는 결과를 보여주었다. 사회문화적, 인종적, 생태지리적으로 다양한 인구집단에서 이와 같은 연구를 진행하는 것은 이미 잘 알려진 자가보고 인체계측자료 이용의 문제점을 보완하는 데 중요한 기초자료를 제공할 것이다.