**TITLE PAGE**

**Title: The Association between Waist-to-Hight ratio, waist circumference,and Body Mass Index as Risk Factors for Chronic Renal Insufficiency among Type 2 Diabetes and Hypertension patients**

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**ABSTRACT**

**Background**: **C**hronic renal insufficiency (CRI) is increasingly common in the United States. CRI is the one of the main causes of morbidity, disability and mortality worldwide. Obesity, a major health problem reaching global epidermic proportions, is also associated with morbidity and mortality. The relationship of Waist-to-Hight ratio,waist circumference, and Body Mass Index as Risk Factors for Chronic Renal Insufficiency is somewhat controversial. While it is established that obesity increases the risk of hypertension, diabetes and dyslipidemia, it is not clear if excess Waist-to-Hight ratio,waist circumference, and Body Mass Index influences renal insufficiency risk independently.

**Objective:** To investigate the association between Waist-to-Hight ratio,waist circumference, and Body Mass Index as risk factors for chronic renal insufficiency among Type 2 Diabetes and Hypertension patients

**Methods**: A analytic study was conducted all information were collected from medical records of all patients diagnosed with Hypertension during 2012. The type of type 2 Diabetes, Hypertension and Diabetes with Hypertension patients. Complications was based on Renal insufficiency was the main outcome of this study.

**Results:** A total of patients with DM, HT and DM with HT are 61,602 with study participants. The CRI risk factors of the 21,078(34.2%) male and 40,524(65.8%) female. Male and female in the sample were comparable in terms of age mean±sd (61.1±11.3) years, prevalence of diabetes (28.5% vs. 71.5%), hypertension(37.7% vs.62.3%),and diabetes with hypertension (31.1% vs. 65.6%), high WHtR (2.0% vs. 98.0%), high WC (49.5% vs. 50.5%),and overweight(37.0% vs. 63.0%), obese I (32.9 vs. 67.1%), obese II (24.0% vs. 76.0%) respectively.

BMI for adjustment other factors***.*** The logistic regression model the factors that with CRI, presented as adjusted odds ratio (ORs) and 95%CI .Its showed that BMI<18.5 (adj.ORs=1.46; 95%CI: 0.83 to 2.58; p-value=<0.001), BMI 23.0- 24.9 (adj.ORs=0.88; 95%CI: 0.66 to 1.19 ; p-value=<0.001), BMI 25.0- 29.9 (adj.ORs=0.60; 95%CI: 0.47 to 0.77 ; p-value=<0.001), BMI ≥30.0 (adj.ORs=0.26; 95%CI: 0.20 to 0.35 ; p-value=<0.001) respectialy.

WC for adjustment other factors.The logistic regression model the factors that with CRI, presented as adjusted odds ratio (ORs) and 95%CI. Its showed that high WC (adj.ORs=0.85; 95%CI: 0.71 to 1.03; p-value=<0.001).

Waist-to-hight for adjustment other factors.The logistic regression model the factors that with CRI, presented as adjusted odds ratio (ORs) and 95%CI (Table 5)(fig.4). Its showed that high Waist-to-hight (adj.ORs=0.99; 95%CI: 0.75 to 1.31; p-value=<0.001).

**Conclusions**: In summary, in agreement with the findings in the general population, the present study shows that WHtR,WC and BMI is associated with Chronic Renal Insufficiency in individuals. In previous study, associations found between WHtR, WC and BMI and some CVD risk factors were similar to those observed for visceral fat, suggesting that WHtR, WC and BMI is a simple and economic tool to be used more often in epidemiological research also involving patients with CRI. Prospective studies are necessary to evaluate the reproducibility of WC and the ability of this method to predict outcomes in patients with CRI

**Key words:** Renal insufficiency, Waist-to-Hight ratio, Waist circumference,and Body Mass Index, type 2 Diabetes, Hypertension

**INTRODUCTION**

**C**hronic renal insufficiency (CRI) is increasingly common in the United States .With the exponential growth of hypertensive type 2 diabetes mellitus and other risk factors in developed and developing countries, it has become evident that CRI is now a global public health problem (Whaley-Connell et al., 2008). In 2000, approximately 400,000 people were treated by means of kidney replacement therapy (dialysis or transplantation) for end-stage renal disease (ESRD) in the United States (Snyder et al., 2009). By 2030, this number is expected to increase to more than 2 million. The estimated prevalence of earlier CRI stages (stages 1 through 4) in US adults was 24 to 28 million in 2000 based on the National Health and Nutrition Examination Survey (NHANES) (Falodia & Singla, 2012a). In Thailand the trend of CRI was same as other developing countries, in 2004 the prevalence of CRI stage 3 to 5 was 8.45%, in 2008 increase to 17.5%.

The most common risk factors for CRI include type 2 diabetes mellitus, hypertension, cardiovascular disease (CVD), family history of CRI, and age older than 60 years (Locatelli et al., 2008). Major outcomes of CRI include CVD, progression to kidney failure, and development of complications of impaired kidney function, such as anemia, disorders of mineral metabolism, and secondary hyperparathyroidism. Collectively, these outcomes contribute to overall high mortality and a significant health care burden associated with CRI (Plantinga et al., 2011)*.* Obesity also increases the risk of CVD-related mortality in the general population (Elsayed et al., 2008). During the past 20 years, the prevalence of obesity in adults has increased dramatically in the United States, with the latest data from the National Center for Health Statistics showing that 30% of US adults (>60 million persons) are obese (Zoccali, Seck, & Mallamaci, 2011). In light of the rapidly increasing prevalence of overweight and obese patients with CRI (Postorino, Marino, Tripepi, & Zoccali, 2009). the putatively additive effects of obesity and renal dysfunction in contributing to inflammation (Falodia & Singla, 2012b). lipid and carbohydrate abnormalities (Ramkumar, Cheung, Pappas, Roberts, & Beddhu, 2004), and increasing CVD (He et al., 2012) have garnered recent research interest. However, this research is hampered by a lack of a reliable marker of obesity in the CRI patient group. Although most studies to date used body mass index (BMI), the high prevalence of fluid overload in the CRI patient group and the increasingly evident differences between various fat tissue deposits (Elsayed et al., 2008)make this a less ideal marker.

Computed tomography (CT) and magnetic resonance imaging are considered the methods of choice to assess visceral fat (Seibert, Pereira, Ajzen, & Koch Nogueira, 2013; Yamaguchi, Oguni, Konishi, & Mino, 1996). However, for clinical and epidemiological purposes, they are relatively impractical, expensive, and also not always available, limiting their use. A number of alternative more practical methods were developed to assess intra-abdominal fat. Among them, waist circumference (WC), a simple and inexpensive method, was shown to be a reliable predictor of visceral fat in patients with multiple disease states (Falodia & Singla, 2012a; Kramer et al., 2011; Madero et al., 2007). Additionally, in the general population, WC is strongly and independently associated with multiple traditional risk factors for CVD, including diabetes, hypertension, and dyslipidemia. The relationship of waist circumference and chronic renal insufficiency is somewhat controversial. While it is established that obesity increases the risk of hypertension, diabetes and dyslipidemia, it is not clear if excess Waist-to-Hight ratio, waist circumference, and Body Mass Index influences renal insufficiency risk independently. Therefore, the aim of the present study is to evaluate the association between investigate the association between Waist-to-Hight ratio,waist circumference, and Body Mass Index as risk factors for chronic renal insufficiency among Type 2 Diabetes and Hypertension patients

**MATERIALS AND METHODS**

***Study design***

A cross sectional analytical study utilized data that is part of the study: “An Assessment on Quality of Care among Patients Diagnosed with Type 2 Diabetes and Hypertension Visiting Ministry of Public Health and Bangkok Metropolitan Administration Hospitals in Thailand (Thailand DM/HT)” which was conducted in 2012.The sampling method was stratified cluster sampling with probability proportional to size Hospitals in care of Ministry of Public Health and Bangkok Metropolitan Administration in Thailand.

***Assessment of Kidney Function***

The eGFR (estimate glomerular filtration rate) (mL/minute/1.73m2) was recalculated as gender, age in year and serum creatinine in mg/dL by Chronic Kidney Disease Epidemiology Collaboration formula (CKD-EPI). The CKD-EPI formulas, expressed as two equations, were

For male:



For female:



Chronic renal insufficiency classification and clinical consequences was defined by using the criteria recommended by the Clinical Practice Guidelines for Chronic Kidney Didease: Evaluation, Classification and Stratification. The eGFR was used to measure the severity of kidney damage. Because it was normally about 100 it gives an approximate “% kidney function”. The K/DOQI CKD stages distinguish 5 grades of severity which can be useful in planning management. The eGFR was created to 5 stages that follow as **table 1**.

**Table 1.** Classification and Stratification of the Kidney Disease Outcomes Quality Initiative stages of kidney disease

|  |  |  |
| --- | --- | --- |
| CKD-KDOQI classification | eGFR (ml/min/1.73 m2) | Description |
| Stage1 | ≥90 | Kidney damage, with normal |
| Stage2 | 60-89 | Kidney damage, with mild decrease |
| Stage3 | 30-59 | Kidney damage, with moderate decrease |
| Stage4 | 15-29 | Kidney damage, with severe decrease |
| Stage5 | <15 | Kidney failure or need for dialysis |

***Anthropometric Measurements***

Anthropometric measurements included body weight, height and WC. WC was measured at the umbilicus level at the end of expiration using a flexible plastic tape measure while subjects were standing with their weight equally distributed on both feet and the head facing straight forward and record with centimeter (cm); normal (male WC≤90 cm.; female WC≤80 cm) and high (male WC>90 cm.; female WC>80 cm). BMI was calculated as body weight divided by squared height (kg/m2). BMI of underweight (bmi<18.5 kg/m2) ; normal (bmi 18.5-22.9 kg/m2) ; Overweight and obesity(bmi>=23.0 kg/m2). Waist-to-Hight ratio was calculated as waist circumference divided by height. Waist-to-Hight ratio of normal (WHtR<0.5); high (WHtR≥0.5).

The quality control scheme for anthropometry involved equipment calibration and monitoring, as well as between-technician and within technician assessments of reliability.

***Baseline Covariates***

Other baseline characteristics included demographics (age and gender), lifestyle characteristics (smoking), past medical history (the type 2 Diabetes, Hypertension and Diabetes with Hypertension patients) and laboratory variables (fasting blood glucose (FBG) , total cholesterol (TC), triglyceride(TG), HDL cholesterol(HDL-C), LDL cholesterol (LDL-C), and hemoglobin(Hgb). Cigarette smoking use were dichotomized as current users and nonusers. Laboratory variables was defined as fasting plasma glucose of normal (<100 mg/dl); impair (100-126 mg/dl); high (≥126 mg/dl), total cholesterol of normal (<170 mg/dl); high (≥170 mg/dl), triglyceride of normal (<150 mg/dl); high (≥150 mg/dl), HDL cholesterol of normal (male HDL≥40 mg/dl;female HDL≥50mg/dl); low (male HDL<40mg/dl; female HDL<50mg/dl), LDL cholesterol of normal (<100 mg/dl); higk (≥100 mg/dl), hemoglobin of normal (male hgb ≥14g/dl; female Hgb≥12g/dl); low (male Hgb <14g/dl; female HGB<12g/dl) and hematocrit of normal (male HCT ≥42g/dl; female HCT≥37g/dl); low (male Hgb <14; female Hgb<12). The complication of cardiometabolic such as cardiovascular disease (CVD) complication (angina pectoris, congestive heart failure ,myocardial infarction and ischemic heart disease); cerebrovascular accident (CVA) complication (cerebrovascular accident, cerebral infarction, ischemic stroke, hemorrhagic stroke, stroke not specified, cerebral hemorrage and transient ischemic attack)

***Study Sample***

From pooled sampling of 61,706 individuals ; 28,938were exclude for DM and DM with HT; 23,269 were exclude for not estimate GFR. Of the remaining 9,499 individuals for Study participants (Fig 1).

***Study outcome***

The primary study outcome was chronic renal insufficiency. Values of the variable are 0 means No (patients not have chronic renal insufficiency) and 1 means Yes (patients with chronic renal insufficiency).

***Statistical analysis***

Demographic characteristics were described using frequency and percentage for categorical data such as gender, age group,WC group, BMI group, Cigarette smoking use, fasting plasma glucose group, total cholesterol group, triglyceride group, HDL cholesterol group, LDL cholesterol group, hemoglobin group and hematocrit group.

Using mean, standard deviation, median, minimum, and maximum to described continuous data such as age, BMI, fasting plasma glucose level, total cholesterol level, triglyceride level, HDL cholesterol level, LDL cholesterol level, hemoglobin level.

To investigate factors that associated with chronic renal insufficiency, adjusted odds ratios (ORs) and their 95% confidence intervals (95%CIs) were estimated using multiple logistic regression.

All test statistics were p-value of less than 0.05 was considered statistical significant.

All analyses were performed by using STATA version 12.0 (AtataCorp, College Station, TX).

***Ethical Consideration***

The permission to study was granted by each of sampled hospitals. Obtaining written informed consent of all participating patients was done prior to access to their medical records. Data collection was done by participating hospital’s authorized skilled personnel who had been trained to protect the privacy of personal health information from unauthorized use, and deliberately engaged in the study.

***Research frame***

112,976 were excluded

* Year 2010,2011; No data.

3,373,089 patients who visiting Hospitals in care

61,602 patients were DM,HT and

DM with HT in year 2012

Study participants

(n=61,602)

174,578 patients were randomized

**Fig. 1.**  Identification of patients for inclusion

**RESULTS**

***Baseline characteristics of the participants***

A total of patients with DM, HT and DM with HT are 61,602 with study participants (Fig 1). The basic characteristics and the prevalence of cardiometabolic risk factors of the 21,078(34.2%) male and 40,524(65.8%) female. Male and female in the sample were comparable in terms of age mean±sd (61.1±11.3) years, prevalence of diabetes (28.5% vs. 71.5%), hypertension(37.7% vs.62.3%),and diabetes with hypertension (31.1% vs. 65.6%), high WHtR (2.0% vs. 98.0%), high WC (49.5% vs. 50.5%),and overweight(37.0% vs. 63.0%), obese I (32.9 vs. 67.1%), obese II (24.0% vs. 76.0%) respectively. The study sample are presented in Table 2.

**Table 2.** Basic characteristic of study population

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Characteristic | Total | male | | female | |
| number | % | number | % |
| Age (year) | 61,602 | 21,078 | 34.2 | 40,524 | 65.8 |
| <60 | 26,785 | 8,276 | 30.9 | 18,506 | 69.1 |
| ≥60 | 34,817 | 12,799 | 36.7 | 22,018 | 63.2 |
| mean (standard deviation) | 61.5(11.3) | |  |  |  |
| median (min:max) | 61(20:107) | |  |  |  |
| Diabetes mellitus | 8,565 | 2,445 | 28.5 | 6,120 | 71.5 |

**Table 2.** Basic characteristic of study population (cont.)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Characteristic | Total | male | | female | |
| number | % | number | % |
| Hypertension | 32,722 | 12,324 | 37.7 | 20,398 | 62.3 |
| Diabetes mellitus with Hypertension | 20,323 | 6,313 | 31.1 | 14,010 | 65.6 |
| BMI (kg/m2) | 55,811 | 19,186 | 34.4 | 36,625 | 65.6 |
| underweight (<18.5) | 2,984 | 1,177 | 39.4 | 1,807 | 60.6 |
| normal (18.5-22.9) | 15,126 | 5,837 | 38.6 | 9,289 | 61.4 |
| overweight (23.0-24.9) | 10,679 | 3,949 | 37.0 | 6,730 | 63.0 |
| obese I (25.0-29.9) | 19,572 | 6,432 | 32.9 | 13,140 | 67.1 |
| obese II (≥30.0) | 7,450 | 1,791 | 24.0 | 5,659 | 76.0 |
| WC (cm) | 41,670 | 21,082 | 50.6 | 20,588 | 49.4 |
| normal (male ≤90 .; female ≤80) | 12,437 | 6,623 | 53.3 | 5,814 | 46.7 |
| high (male >90 ; female >80 ) | 29,233 | 14,459 | 49.5 | 14,774 | 50.5 |
| mean ( standard deviation) | 86.9(10.2) | |  |  |  |
| median (Min:Max) | 87(50:120) | |  |  |  |
| WHtR | 30,731 | 682 | 2.22 | 30,043 | 97.8 |
| normal (<0.50) | 5,873 | 191 | 3.2 | 5,682 | 96.8 |
| high (≥0.50) | 24,858 | 491 | 2.0 | 24,367 | 98.0 |
| FBG (mg/dl) | 50,098 | 16,991 | 33.9 | 33,107 | 66.1 |
| normal ( <100) | 16,188 | 5,752 | 35.5 | 10,436 | 64.5 |
| impair (100-125) | 16,394 | 5,944 | 36.3 | 10,450 | 63.7 |
| high( ≥126) | 17,516 | 5,295 | 30.2 | 12,221 | 69.8 |
| mean ( standard deviation) | 155.9(60.7) | |  |  |  |
| median (Min:Max) | 141(50:762) | |  |  |  |
| TC (mg/dl) | 49,074 | 16,737 | 34.1 | 32,337 | 65.9 |
| normal (<170) | 16,030 | 6,298 | 39.3 | 9,732 | 60.7 |
| high ( ≥170) | 33,044 | 10,439 | 31.6 | 22,605 | 68.4 |
| mean (standard deviation) | 191.5(44.3) | |  |  |  |
| median (min:max) | 187(53:697) | |  |  |  |
| TG (mg/dl) | 51,520 | 17,568 | 34.1 | 33,952 | 65.9 |
| normal (<150) | 28,559 | 9,808 | 34.3 | 18,751 | 65.7 |
| high (≥150) | 22,961 | 7,760 | 33.8 | 15,201 | 66.2 |
| mean (standard deviation) | 162.8(94.8) | |  |  |  |
| median (min:max) | 140(35:1,000) | |  |  |  |
| LDL-C (mg/dl) | 50,063 | 17,037 | 34.0 | 33,026 | 66.0 |
| normal (<100) | 19,055 | 6,959 | 36.5 | 12,096 | 63.5 |
| high (≥100) | 31,008 | 10,078 | 34.0 | 33,026 | 66.0 |
| mean (standard deviation) | 113.5(37.1) | |  |  |  |
| median (min:max) | 110(10:300) | |  |  |  |
| HDL-C (mg/dl) | 51,514 | 21,078 | 40.9 | 30,436 | 59.1 |
| normal (male ≥40; female ≥50) | 32.088 | 19,142 | 59.6 | 12,946 | 40.4 |
| low(male <40; female <50) | 19,426 | 1,936 | 10.0 | 17,496 | 90.0 |
| mean (standard deviation) | 47.6(13.5) | |  |  |  |
| median (min:max) | 46(10:150) | |  |  |  |
| Hgb (g/dl) | 30,402 | 21,078 | 69.3 | 9,324 | 30.7 |
| normal (male ≥14; female ≥12) | 24,683 | 19,971 | 80.9 | 4,712 | 19.1 |
| low (male <14; female <12) | 5,719 | 1,107 | 19.4 | 4,612 | 80.6 |
| Smoking status | 44,461 | 15,421 | 34.7 | 29,040 | 65.3 |
| smoker | 6,029 | 5,433 | 90.1 | 596 | 9.9 |
| non smoker | 33,432 | 9,988 | 26.0 | 28,444 | 74.0 |

**Table 2.** Basic characteristic of study population (cont.)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Characteristic | Total | male | | female | |
| number | % | number | % |
| eGFR (mL/minute/1.73m2) |  |  |  |  |  |
| stage 1 (≥90) | 1,422 | 1,422 | 100.0 | 0 | 0.0 |
| stage 2 (60-89) | 46,272 | 19,656 | 42.48 | 26,616 | 57.52 |
| stage 3 (30-59) | 13,908 | 0 | 0.0 | 13,908 | 100.0 |
| stage 4 (15-29) | 0 | 0 | 0.0 | 0 | 0.0 |
| stage 5 (<15) | 0 | 0 | 0.0 | 0 | 0.0 |
| mean (standard deviation) | 68.4(10.1) | |  |  |  |
| median (min:max) | 65.6(44.9: 107.9) | |  |  |  |
| History of CVD complications |  |  |  |  |  |
| Angina pectoris | 127 | 47 | 37.0 | 80 | 63.0 |
| Congestive Heart Failure | 307 | 92 | 30.3 | 214 | 69.7 |
| Myocardial Infarction & Ischemic Heart  Disease | 882 | 333 | 37.8 | 549 | 62.2 |
| History of CVA complications |  |  |  |  |  |
| CerebroVascular Accident | 387 | 175 | 45.2 | 212 | 54.8 |
| Cereblal Infarction | 119 | 51 | 42.9 | 68 | 57.1 |
| Ischemic Stroke | 123 | 60 | 48.8 | 63 | 51.2 |
| Hemorrhagic Stroke | 18 | 5 | 27.8 | 13 | 72.2 |
| Stroke not specified | 62 | 25 | 40.3 | 37 | 59.7 |
| Cereblal Hemorrage | 13 | 6 | 46.2 | 7 | 53.8 |
| Transient Ischemic Attack | 52 | 26 | 50.0 | 26 | 50.0 |

Abbreviation : BMI body mass index, WC waist circumference, WHtR waist-to-hight ratio, FBG fasting blood glucose, TC total cholesterol, TG triglycerides, LDL-C low-density lipoprotein cholesterol, HDL-C high-density lipoprotein cholesterol, Hgb hemoglobin, eGFR estimate glomerular filtration rate

***Factors associated with CRI***

***Univariate Analysis***

The strongest factor that associated to CRI that is the patients who had low Hgb (OR = 10.27; 95%CI: 7.28 to 14.53; *p* < 0.001) and other strongest factor was low HDL-C (OR = 8.04; 95%CI: 6.57 to 9.84; *p* < 0.001), history of CVD complication (OR = 3.11; 95%CI: 2.12 to 4.56; *p* < 0.001), history of CVA complication (OR = 1.53; 95%CI: 1.07 to 2.20; *p* =0.012), high WHtR (OR = 1.67; 95%CI: 1.41 to 1.98; *p* < 0.001), BMI<18.5 (OR = 1.19; 95%CI: 0.86 to 1.64; *p* < 0.001), impair FBG (OR = 1.06; 95%CI: 0.92 to 1.24; *p* < 0.001) , high FBG (OR = 0.80; 95%CI: 0.69 to 0.92; *p* < 0.001) respectively. Others factors and factor were not significant*( p*>0.05) presented in table 3.

**Table 3.**  Crude odds ratios of having renal insufficiency and their 95% confidence intervals for each factor

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Factors | number | %  CRI | Crude OR | 95% CI | p-value |
| BMI (kg/m2) |  |  |  |  | <0.001 |
| normal (18.5-22.9) | 15,125 | 98.3 | 1 |  |  |
| underweight (<18.5) | 2,984 | 98.5 | 1.19 | 0.86 to 1.64 |  |
| overweight (23.0-24.9) | 10,678 | 97.9 | 0.83 | 0.69 to 0.99 |  |
| obese I (25.0-29.9) | 19,569 | 97.5 | 0.70 | 0.60 to 0.82 |  |
| obese II (≥30.0) | 7,450 | 96.3 | 0.46 | 0.39 to 0.55 |  |
| WC (cm) |  |  |  |  | 0.331 |
| normal (male ≤90 .; female ≤80) | 12,436 | 96.7 | 1 |  |  |
| high (male >90 ; female >80 ) | 29,229 | 96.5 | 0.94 | 0.84 to 1.06 |  |
| WHtR |  |  |  |  | <0.001 |
| normal (<0.50) | 5,873 | 96.7 | 1 |  |  |
| high(≤0.50) | 24,858 | 98.0 | 1.67 | 1.41 to 1.98 |  |
| FBG (mg/dl) |  |  |  |  | <0.001 |
| normal ( <100) | 16,188 | 97.8 | 1 |  |  |
| impair (100-125) | 16,394 | 98.0 | 1.06 | 0.92 to 1.24 |  |
| high( ≥126) | 17,516 | 97.3 | 0.80 | 0.69 to 0.92 |  |
| TC (mg/dl) |  |  |  |  | 0.993 |
| normal (<170) | 16,030 | 97.7 | 1 |  |  |
| high ( ≥170) | 33,041 | 97.7 | 1.00 | 0.88 to 1.14 |  |
| TG (mg/dl) |  |  |  |  | <0.001 |
| normal (<150) | 28,557 | 98.13 | 1 |  |  |
| high (≥150) | 22,960 | 97.16 | 0.65 | 0.58 to 0.73 |  |
| LDL-C (mg/dl) |  |  |  |  | 0.613 |
| normal (<100) | 19,055 | 97.7 | 1 |  |  |
| high (≥100) | 31,003 | 97.7 | 1.03 | 0.91 to 1.16 |  |
| HDL-C (mg/dl) |  |  |  |  | <0.001 |
| normal (male ≥40; female ≥50) | 32,088 | 95.9 | 1 |  |  |
| low(male <40; female <50) | 19,426 | 99.5 | 8.04 | 6.57 to 9.84 |  |
| Hgb (g/dl) |  |  |  |  | <0.001 |
| normal (male ≥14; female ≥12) | 24,683 | 94.4 | 1 |  |  |
| low (male <14; female <12) | 5,719 | 99.4 | 10.27 | 7.28 to 14.53 |  |
| Smoking status |  |  |  |  | <0.001 |
| non smoker | 38,429 | 98.6 | 1 |  |  |
| smoker | 6,028 | 94.9 | 0.26 | 0.23 to 0.30 |  |
| History of CVD complications |  |  |  |  | <0.001 |
| no | 58,159 | 97.6 | 1 |  |  |
| yes | 3,443 | 94.9 | 3.11 | 2.12 to 4.56 |  |
| History of CVA complications |  |  |  |  | 0.012 |
| no | 59,582 | 97.7 | 1 |  |  |
| yes | 2,020 | 98.5 | 1.53 | 1.07 to 2.20 |  |

***Multivariate Analysis***

***BMI for adjustment other factors***

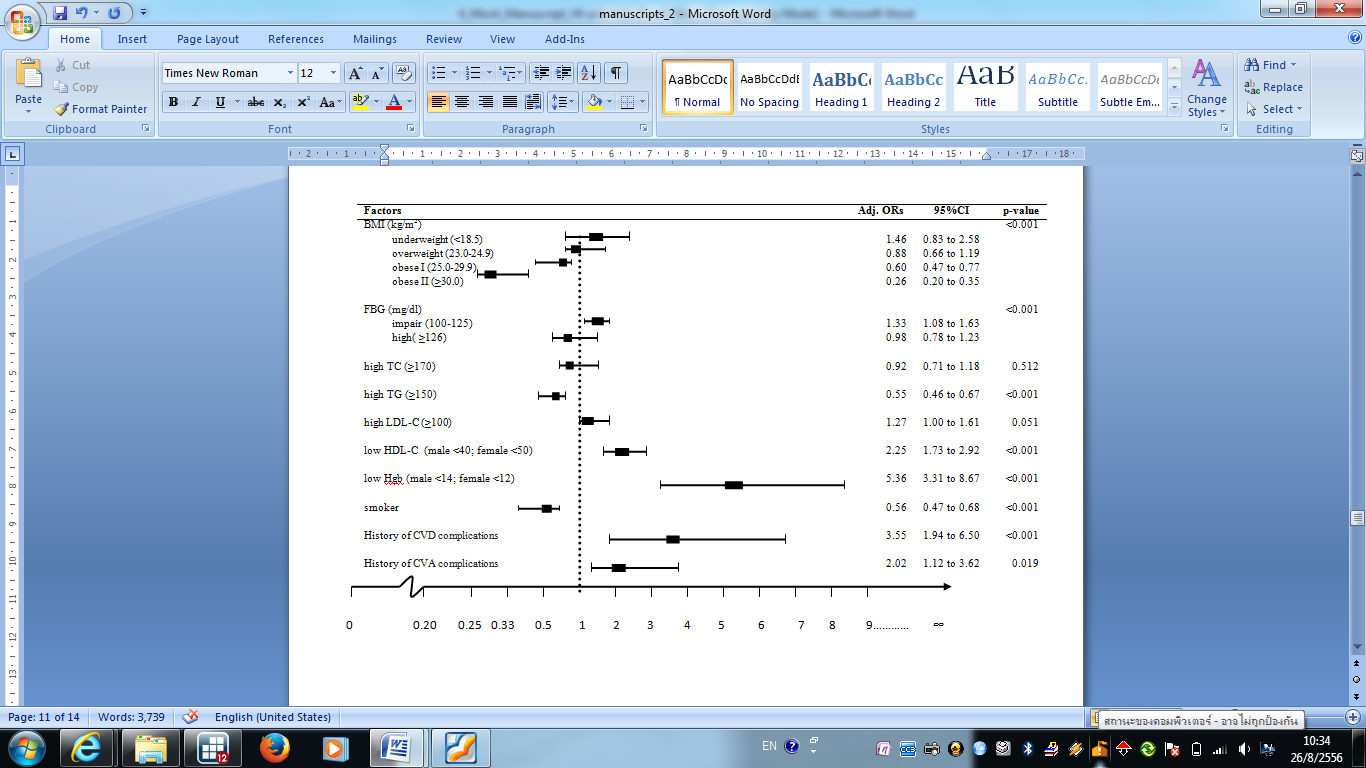
All the variables with a significant impact (p<0.25) in the univariate analysis were considered for the multivariate analysis. After adjustment other factors***.*** The logistic regression model the factors that with CRI, presented as adjusted odds ratio (ORs) and 95%CI (Table 4) (fig.2).. Its showed that BMI<18.5 (adj.ORs=1.46; 95%CI: 0.83 to 2.58; p-value=<0.001), BMI 23.0- 24.9 (adj.ORs=0.88; 95%CI: 0.66 to 1.19 ; p-value=<0.001), BMI 25.0- 29.9 (adj.ORs=0.60; 95%CI: 0.47 to 0.77 ; p-value=<0.001), BMI ≥30.0 (adj.ORs=0.26; 95%CI: 0.20 to 0.35 ; p-value=<0.001) respectialy. The strongest factor was low Hgb (adj.ORs=5.36; 95%CI: 3.31 to 8.67; p-value<0.001), history of CVD complication (adj.ORs=3.55; 95%CI: 1.94 to 6.50; p-value<0.001), low HDL-C (adj.ORs=2.25; 95%CI: 1.73 to 2.92; p-value<0.001), history of CVA complication (adj.ORs=2.02; 95%CI: 1.12 to 3.62; p-value=0.019), impair FBG (adj.ORs=1.33; 95%CI: 1.08 to 1.63; p-value<0.001), high FBG (adj.ORs=0.98; 95%CI: 0.78 to 1.23; p-value<0.001),smoker (adj.ORs=0.56; 95%CI: 0.47 to 0.68; p-value<0.001), and high TG (adj.ORs=0.55; 95%CI: 0.46 to 0.67; p-value<0.001) respectialy. Others factors that were not significant factors, *p*>0.05.

**Table 4.**  Adjust odds ratios of BMI for having renal insufficiency and their 95% confidence intervals for each factor

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Factors | number | % CRI | Crude ORs | Adjust ORs | 95%CI | p-value |
| BMI (kg/m2) |  |  |  |  |  | <0.001 |
| normal (18.5-22.9) | 15,125 | 98.3 | 1 | 1 |  |  |
| underweight (<18.5) | 2,984 | 98.5 | 1.19 | 1.46 | 0.83 to 2.58 |  |
| overweight (23.0-24.9) | 10,678 | 97.9 | 0.83 | 0.88 | 0.66 to 1.19 |  |
| obese I (25.0-29.9) | 19,569 | 97.5 | 0.70 | 0.60 | 0.47 to 0.77 |  |
| obese II (≥30.0) | 7,450 | 96.3 | 0.46 | 0.26 | 0.20 to 0.35 |  |
| FBG (mg/dl) |  |  |  |  |  | <0.001 |
| normal ( <100) | 16,188 | 97.8 | 1 | 1 |  |  |
| impair (100-125) | 16,394 | 98.0 | 1.06 | 1.33 | 1.08 to 1.63 |  |
| high( ≥126) | 17,516 | 97.3 | 0.80 | 0.98 | 0.78 to 1.23 |  |
| TC (mg/dl) |  |  |  |  |  | 0.512 |
| normal (<170) | 16,030 | 97.7 | 1 | 1 |  |  |
| high ( ≥170) | 33,041 | 97.7 | 1.00 | 0.92 | 0.71 to 1.18 |  |
| TG (mg/dl) |  |  |  |  |  | <0.001 |
| normal (<150) | 19,055 | 97.7 | 1 | 1 |  |  |
| high (≥150) | 31,003 | 97.7 | 1.03 | 0.55 | 0.46 to 0.67 |  |
| LDL-C (mg/dl) |  |  |  |  |  | 0.051 |
| normal (<100) | 19,055 | 97.7 | 1 | 1 |  |  |
| high (≥100) | 31,003 | 97.7 | 1.03 | 1.27 | 1.00 to 1.61 |  |
| HDL-C (mg/dl) |  |  |  |  |  | <0.001 |
| normal (male ≥40; female ≥50) | 32,088 | 95.9 | 1 | 1 |  |  |
| low(male <40; female <50) | 19,426 | 99.5 | 8.04 | 2.25 | 1.73 to 2.92 |  |
| Hgb (g/dl) |  |  |  |  |  | <0.001 |
| normal (male ≥14; female ≥12) | 24,683 | 94.4 | 1 | 1 |  |  |
| low (male <14; female <12) | 5,719 | 99.4 | 10.27 | 5.36 | 3.31 to 8.67 |  |

**Table 4.**  Adjust odds ratios of BMI for having renal insufficiency and their 95% confidence intervals for each factor (cont.)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Factors | number | % CRI | Crude ORs | Adjust ORs | 95%CI | p-value |
| Smoking status |  |  |  |  |  | <0.001 |
| non smoker | 38,429 | 98.6 | 1 | 1 |  |  |
| smoker | 6,028 | 94.9 | 0.26 | 0.56 | 0.47 to 0.68 |  |
| History of CVD complications |  |  |  |  |  | <0.001 |
| no | 58,159 | 97.6 | 1 | 1 |  |  |
| yes | 3,443 | 94.9 | 3.11 | 3.55 | 1.94 to 6.50 |  |
| History of CVA complications |  |  |  |  |  | 0.019 |
| no | 59,582 | 97.7 | 1 | 1 |  |  |
| yes | 2,020 | 98.5 | 1.53 | 2.02 | 1.12 to 3.62 |  |



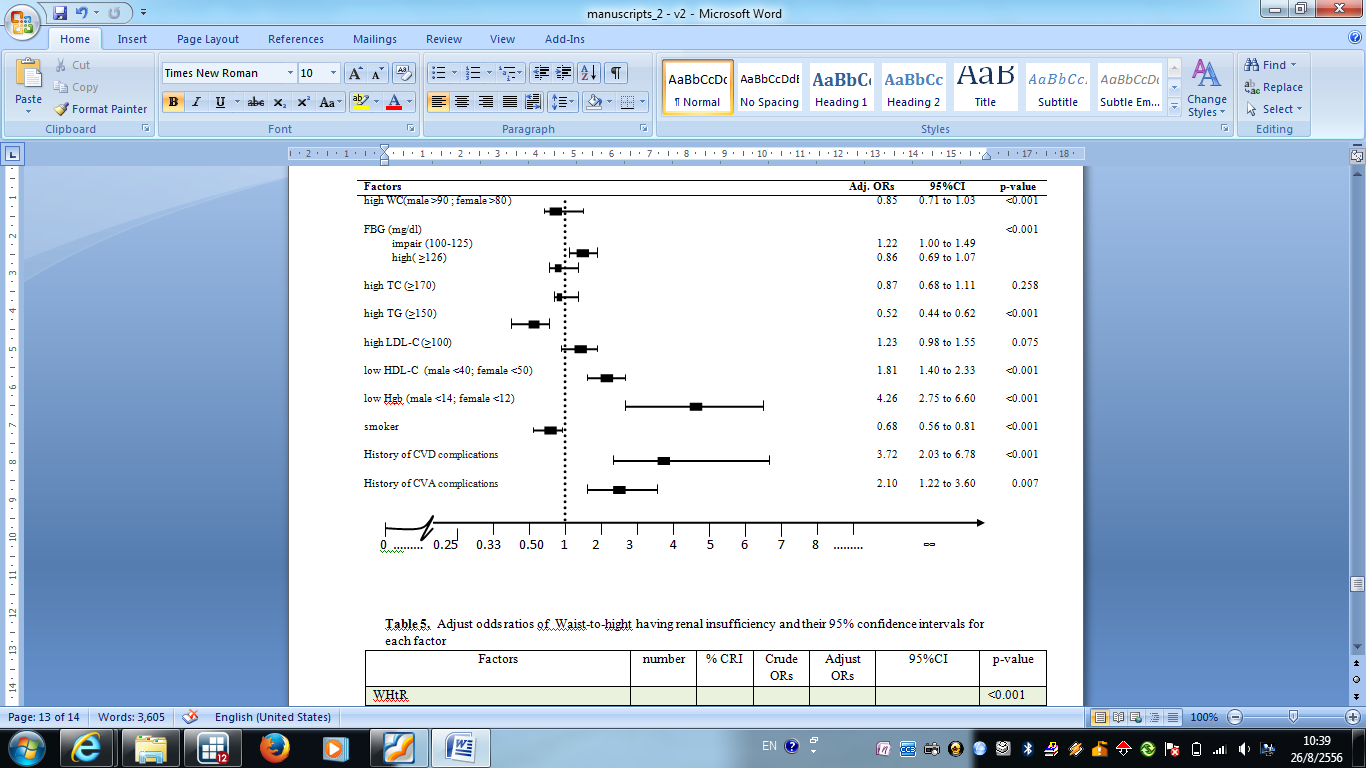
**Fig. 2** Forest plotof adjustedodds ratio for compare having WC for each factor

***WC for adjustment other factors***

The logistic regression model the factors that with CRI, presented as adjusted odds ratio (ORs) and 95%CI (Table 5)(fig.3). Its showed that high WC (adj.ORs=0.85; 95%CI: 0.71 to 1.03; p-value=<0.001). The strongest factor was low Hgb (adj.ORs=4.26; 95%CI: 2.75 to 6.60; p-value<0.001), history of CVD complication (adj.ORs=3.72; 95%CI: 2.03 to 6.78; p-value<0.001), ), history of CVA complication (adj.ORs=2.10; 95%CI: 1.22 to 3.60; p-value<0.001), low HDL-C (adj.ORs=1.81; 95%CI: 1.40 to 2.33; p-value<0.001), impair FBG (adj.ORs=1.22; 95%CI: 1.00 to 1.49 ; p-value<0.001), high FBG (adj.ORs=0.86; 95%CI: 0.69 to 1.07; p-value<0.001), smoker (adj.ORs=0.68; 95%CI: 0.56 to 0.81; p-value<0.001), and high TG (adj.ORs=0.52; 95%CI: 0.44 to 0.62; p-value<0.001) respectialy. Others factors that were not significant factors, *p*>0.05.

**Table 5.**  Adjust odds ratios of Waist Circumference having renal insufficiency and their 95% confidence intervals for each factor

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Factors | number | % CRI | Crude ORs | AdjustORs | 95%CI | p-value |
| WC (cm) |  |  |  |  |  | <0.001 |
| normal (male ≤90 .; female ≤80) | 12,436 | 96.7 | 1 | 1 |  |  |
| high (male >90 ; female >80 ) | 29,229 | 96.5 | 0.94 | 0.85 | 0.71 to 1.03 |  |
| FBG (mg/dl) |  |  |  |  |  | <0.001 |
| normal ( <100) | 16,188 | 97.8 | 1 | 1 |  |  |
| impair (100-125) | 16,394 | 98.0 | 1.06 | 1.22 | 1.00 to 1.49 |  |
| high( ≥126) | 17,516 | 97.3 | 0.80 | 0.86 | 0.69 to 1.07 |  |
| TC (mg/dl) |  |  |  |  |  | 0.258 |
| normal (<170) | 16,030 | 97.7 | 1 | 1 |  |  |
| high ( ≥170) | 33,041 | 97.7 | 1.00 | 0.87 | 0.68 to 1.11 |  |
| TG (mg/dl) |  |  |  |  |  | <0.001 |
| normal (<150) | 19,055 | 97.7 | 1 | 1 |  |  |
| high (≥150) | 31,003 | 97.7 | 1.03 | 0.52 | 0.44 to 0.62 |  |
| LDL-C (mg/dl) |  |  |  |  |  | 0.075 |
| normal (<100) | 19,055 | 97.7 | 1 | 1 |  |  |
| high (≥100) | 31,003 | 97.7 | 1.03 | 1.23 | 0.98 to 1.55 |  |
| HDL-C (mg/dl) |  |  |  |  |  | <0.001 |
| normal (male ≥40; female ≥50) | 32,088 | 95.9 | 1 | 1 |  |  |
| low(male <40; female <50) | 19,426 | 99.5 | 8.04 | 1.81 | 1.40 to 2.33 |  |
| Hgb (g/dl) |  |  |  |  |  | <0.001 |
| normal (male ≥14; female ≥12) | 24,683 | 94.4 | 1 | 1 |  |  |
| low (male <14; female <12) | 5,719 | 99.4 | 10.27 | 4.26 | 2.75 to 6.60 |  |
| Smoking status |  |  |  |  |  | <0.001 |
| non smoker | 38,429 | 98.6 | 1 | 1 |  |  |
| smoker | 6,028 | 94.9 | 0.26 | 0.68 | 0.56 to 0.81 |  |
| History of CVD complications |  |  |  |  |  | <0.001 |
| no | 58,159 | 97.6 | 1 | 1 |  |  |
| yes | 3,443 | 94.9 | 3.11 | 3.72 | 2.03 to 6.78 |  |
| History of CVA complications |  |  |  |  |  | 0.007 |
| no | 59,582 | 97.7 | 1 | 1 |  |  |
| yes | 2,020 | 98.5 | 1.53 | 2.10 | 1.22 to 3.60 |  |

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**Fig. 3** Forest plotof adjustedodds ratio for compare having WC for each factor

**Waist-to-hight *for adjustment other factors***

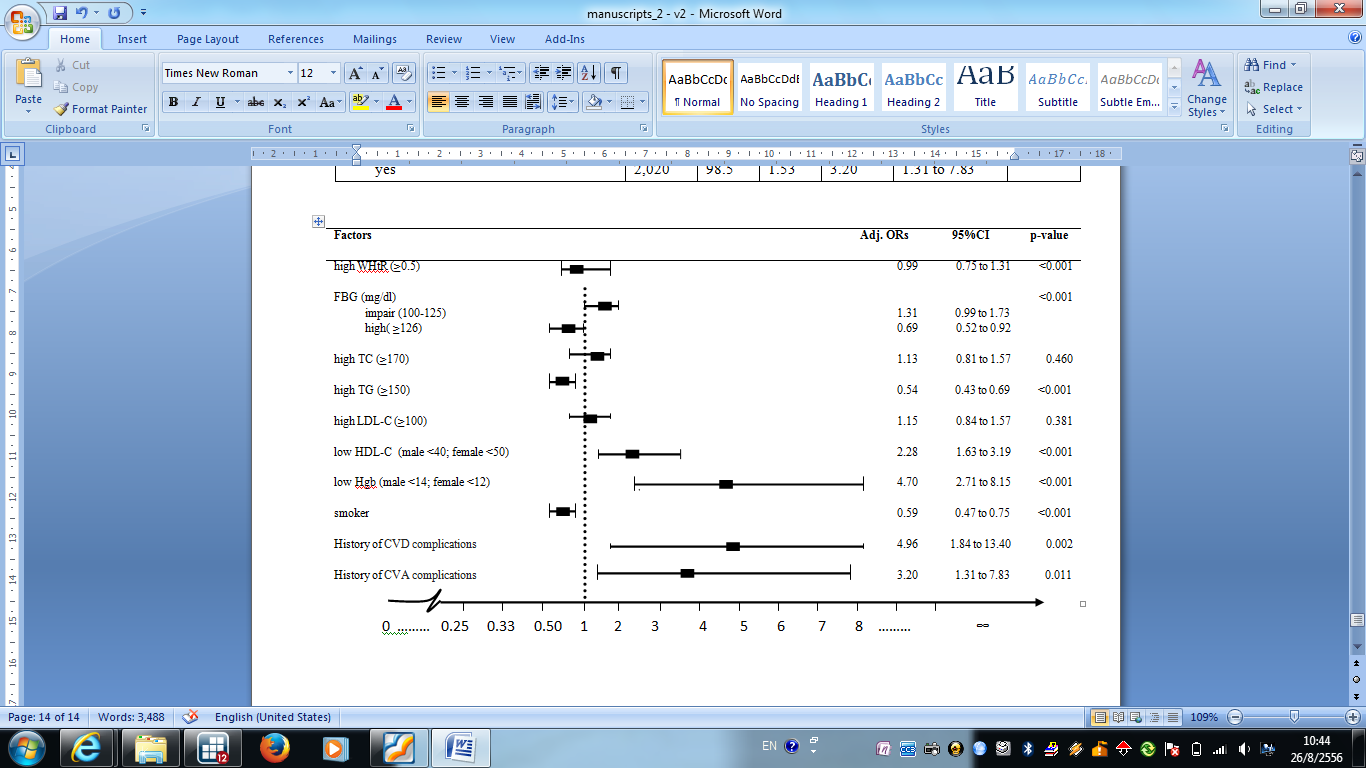
The logistic regression model the factors that with CRI, presented as adjusted odds ratio (ORs) and 95%CI (Table 5)(fig.4). Its showed that high Waist-to-hight (adj.ORs=0.99; 95%CI: 0.75 to 1.31; p-value=<0.001). The strongest factor was history of CVD complication (adj.ORs=4.96; 95%CI: 1.84 to 13.40; p-value<0.001), low Hgb (adj.ORs=4.70; 95%CI: 2.71 to 8.15; p-value<0.001), history of CVA complication (adj.ORs=3.20; 95%CI: 1.31 to 7.83; p-value=0.011), low HDL-C (adj.ORs=2.28; 95%CI: 1.63 to 3.19; p-value<0.001), impair FBG (adj.ORs=1.31; 95%CI: 0.99 to 1.73 ; p-value<0.001), high FBG (adj.ORs=0.69; 95%CI: 0.52 to 0.92; p-value<0.001), smoker (adj.ORs=0.59; 95%CI: 0.47 to 0.75; p-value<0.001), and high TG (adj.ORs=0.54; 95%CI: 0.43 to 0.69; p-value<0.001) respectialy. Others factors that were not significant factors, *p*>0.05.

**Table 6.**  Adjust odds ratios of Waist-to-hight having renal insufficiency and their 95% confidence intervals for each factor

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Factors | number | % CRI | Crude ORs | Adjust ORs | 95%CI | p-value |
| WHtR |  |  |  |  |  | <0.001 |
| normal (<0.50) | 5,873 | 96.7 | 1 | 1 |  |  |
| high(≤0.50) | 24,858 | 98.0 | 1.67 | 0.99 | 0.75 to 1.31 |  |
| FBG (mg/dl) |  |  |  |  |  | <0.001 |
| normal ( <100) | 16,188 | 97.8 | 1 | 1 |  |  |
| impair (100-125) | 16,394 | 98.0 | 1.06 | 1.31 | 0.99 to 1.73 |  |
| high( ≥126) | 17,516 | 97.3 | 0.80 | 0.69 | 0.52 to 0.92 |  |

**Table 6.**  Adjust odds ratios of Waist-to-hight having renal insufficiency and their 95% confidence intervals for each factor (cont.)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Factors | number | % CRI | Crude ORs | Adjust ORs | 95%CI | p-value |
| TC (mg/dl) |  |  |  |  |  | 0.460 |
| normal (<170) | 16,030 | 97.7 | 1 | 1 |  |  |
| high ( ≥170) | 33,041 | 97.7 | 1.00 | 1.13 | 0.81 to 1.57 |  |
| TG (mg/dl) |  |  |  |  |  | <0.001 |
| normal (<150) | 28,557 | 98.13 | 1 | 1 |  |  |
| high (≥150) | 22,960 | 97.16 | 0.65 | 0.54 | 0.43 to 0.69 |  |
| LDL-C (mg/dl) |  |  |  |  |  | 0.381 |
| normal (<100) | 19,055 | 97.7 | 1 | 1 |  |  |
| high (≥100) | 31,003 | 97.7 | 1.03 | 1.15 | 0.84 to 1.57 |  |
| HDL-C (mg/dl) |  |  |  |  |  | <0.001 |
| normal (male ≥40; female ≥50) | 32,088 | 95.9 | 1 | 1 |  |  |
| low(male <40; female <50) | 19,426 | 99.5 | 8.04 | 2.28 | 1.63 to 3.19 |  |
| Hgb (g/dl) |  |  |  |  |  | <0.001 |
| normal (male ≥14; female ≥12) | 24,683 | 94.4 | 1 | 1 |  |  |
| low (male <14; female <12) | 5,719 | 99.4 | 10.27 | 4.70 | 2.71 to 8.15 |  |
| Smoking status |  |  |  |  |  | <0.001 |
| non smoker | 38,429 | 98.6 | 1 | 1 |  |  |
| smoker | 6,028 | 94.9 | 0.26 | 0.59 | 0.47 to 0.75 |  |
| History of CVD complications |  |  |  |  |  | 0.002 |
| no | 58,159 | 97.6 | 1 | 1 |  |  |
| yes | 3,443 | 94.9 | 3.11 | 4.96 | 1.84 to 13.40 |  |
| History of CVA complications |  |  |  |  |  | 0.011 |
| no | 59,582 | 97.7 | 1 | 1 |  |  |
| yes | 2,020 | 98.5 | 1.53 | 3.20 | 1.31 to 7.83 |  |



**Fig. 4** Forest plotof adjustedodds ratio for compare having WHtR for each factor

**DISCUSSION**

In the present study, we show that the BMI was associated with the development of decreased kidney function. Additionally, high WC was associated with increase risk of the composite outcome of decrease kidney function and mortality, whereas increased BMI appeared protective for this out come. Given epidemic rates of obesity and progressively increasing rate of CRI and kidney damage, the ability to identify risk factors for developing kidney disease is critical to addressing this public health problem.

Obesity is associated with many factors that cause both kidney disease and kidney disease progression, including diabetes, hypertension, and CVD. Most public health literature in the Thailand focuses on the use of BMI to identify obesity and its sequelae because BMI correlates with body fat in most individuals.

However, BMI has limitation; notably, BMI does not distinguish between weight from muscle and fat, between visceral and subcutaneous fat, and between peripheral and central adiposity. Although alternate measures of obesity exist, including WC, WHtR, WHR, the public health community’s focus remains on BMI as the primary marker of obesity. This likely reflects ease of measurement, as well as predictive ability in younger and healthier individuals.

In defining obesity, several recent guidelines also incorporate waist circumference, potentially a better marker of visceral fat in individuals with CRI. Although WHtR is a less well-studied marker, in present study showed that WHtR was independently and more consistently predictive of CVD complication and CVA complication than WC or BMI. The WHtR is an alternative anthropometric index of central obesity that circumvents the limitations of WC by adjusting for variations in height and providing a universal cutoff value equally appropriate for use among Asian and Caucasian, as well as men and women. Ashwell and Hsieh suggest the following message: ‘‘Keep your waist circumference to less than half your height.’’ Some authors suggest that WHtR may be the best simple anthropometric index for predicting a wide range of cardiometabolic risk factors associated with central obesity.

In this study, we found an association between WHtR, WC and BMI and incident CRI . We found that increase BMI was protective for a composite outcome that included moetality. Conversely, we found that decrease BMI was risk factor for this same composite outcome.We found that increase WC and increase WHtR was protective for a composite outcome CRI. This finding may foreshadow the altered risk factor relationship seen in patients with chronic disease status, including heart failure and kidney failure requiring dialysis, in whish greater BMI is associated improve survival.

***Strength of the study***

* Nationally representative sample
* Real situations (uncontrolled conditions)
* Saving for time and budget

***Limitation of the study***

* Insufficient data and missing values in medical records (secondary data)
* Information bias could occur from data recording by medical staffs
* Recall bias from self-directed questionnaire by patients

***Conclusions***

In summary, in agreement with the findings in the general population, the present study shows that WHtR,WC and BMI is associated with Chronic Renal Insufficiency in individuals. In previous study, associations found between WHtR, WC and BMI and some CVD risk factors were similar to those observed for visceral fat, suggesting that WHtR, WC and BMI is a simple and economic tool to be used more often in epidemiological research also involving patients with CRI. Prospective studies are necessary to evaluate the reproducibility of WC and the ability of this method to predict outcomes in patients with CRI.

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