Association of Metabolic Syndrome Parameters with Kidney Stones in Indonesia

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INTRODUCTION

Kidney stone disease is common throughout the world with the lifetime risk in the United States exceeding 10.94% in men and 9.4% in women (Chen et al., 2018). This disease increased morbidity and major cause urinary tract stones death in the world. The study on 1999-2013 in England and Wales, kidney stones and ureter stones accounted for 91% of all urinary tract stones death (Kum et al., 2016). In addition, kidney stones contribute to chronic kidney disease (16.8%) (Vupputuri et al., 2004), stroke (4.37%) (Lin et al., 2016), and coronary heart disease (15.7%) (Ferraro et al., 2013). Kidney stones was contributed to 0.5% of all inpatient hospital stays, with the average length of inpatient stay being 2.8 days (Kum et al., 2016). The annual cost of kidney stones, inflation-adjusted for 2014, has been estimated at US$2.81 billion in USA. The cost of kidney stones is projected to increase to US$1.24 billion per year by 2030 (Antonelli et al., 2014).

The prevalence of kidney stones has increased in recent years. The recent study of The National Health and Nutrition Examination Survey (NHANES) reported that prevalence of kidney stones in the United States from 2007-2010 was 8.8% (Scales et al., 2012). The prevalence rate in Italy 2011 was 7.5% (Croppi et al., 2012). The prevalence of kidney stones in China was 3.5% in 2012, increasing...
to 7.47% in 2013 (Wang et al., 2017). Number of kidney stones incidence in Indonesia based on hospital data was 37,636 new cases in 2012, with 58,959 visits. Number of patients hospitalized was 19,018 people and 378 people were deaths. The prevalence of kidney stones increased in 2013. Based on survey data of Riset Kesehatan Dasar (Riskesdas or Indonesian Basic Health Research) 2013, the prevalence of kidney stones diagnosed by doctors was 0.6%. The prevalence of kidney stone disease based on increases with age and decline at age 65 years (Indonesia Health Ministry, 2013).

In Northwest Russia prevalence rates of the metabolic syndrome among men were 11.5% and women were 11.5% by the National Cholesterol Education Program (NCEP), increasing at ages >60 years to 24.2% in men and 44.8% in women (Sidorovkova et al., 2010). In Malaysia, 54.7% of men and 45.3% of women meet the metabolic syndrome criteria established by the National Cholesterol Education Program Adult Treatment Panel III (NCEPATP III) (Moy & Bulgiba, 2010). Prevalence of metabolic syndrome in Indonesia is still not clear. Nevertheless, Riskesdas 2013 results show that the prevalence related to metabolic syndrome parameters such as central obesity (26.6%), overweight (13.5%), obesity (15.4%), hypertension (25.8%), high total cholesterol (39.5%), low high density lipoprotein (22.9%), high low-density lipoprotein (115.9%), high triglyceride (119.9%) and elevated fasting blood glucose (6.9%) (Indonesia Health Ministry, 2013).

The increased prevalence of kidney stones is often associated with metabolic syndrome, in epidemiological studies (Cho et al., 2013; Farahdika & Azam, 2015) Several studies have suggested that metabolic syndrome, which is a condition clinically defined by a clustering of central obesity, elevated body mass index (BMI), elevated blood pressure (BP), elevated total cholesterol, elevated low-density lipoprotein (LDL), elevated triglyceride, low high density lipoprotein (HDL) and elevated fasting plasma glucose (FPG), was linked directly to the formation of kidney stones (Jeong et al., 2011; Torricelli et al., 2014; Yoshimura et al., 2016). A recent Korean study reported that metabolic syndrome had a significant relation with the presence of kidney stones (OR 1.1; CI 95% 1.02-1.20; p=0.01) (Kim et al., 2013). In Indonesia, there has not been studied yet the relationship between metabolic syndrome parameters and the incidence of kidney stones. Therefore, we investigated the association between kidney stones and metabolic syndrome parameters in large sample size and community-based studies which data obtained from secondary data of Riskesdas 2013 to assess the association between kidney stones and metabolic syndrome parameters in differences gender.

METHODS

This cross-sectional study was used secondary data of Riskesdas 2013. Riskesdas was a community-based health research covering all regions of Indonesia to be implemented every 5-6 years and the latest is Riskesdas 2013. Riskesdas is a research that collects baseline data and health indicators that represent the national, provincial and district/city description. Riskesdas 2013 was used cross sectional design, where the number of respondents from 33 provinces and 497 provinces in Indonesia are 1,027,763 respondents. Riskesdas 2013 was approved by Health Research Ethics Committee (KEPK) National Institute of Health Research and Development (NIHRD), Ministry of Health Indonesia with the number protocol was 01.1206.207. Detailed information on the design and method of data collection can be accessed in report of Riskesdas 2013 (Kementerian Kesehatan RI, 2013).

The population in this study were respondents at the Riskesdas 2013 ± 15 years old who taken measurement anthropometric (height, body weight, waist circumference (WC) and BP (systolic and diastolic)) and biomedical such as total cholesterol, HDL-cholesterol, LDL-cholesterol, triglyceride, and fasting plasma glucose.

The survey included questions about respondents' characteristics such as age, sex, employed status, the level of education. In addition, parameters of syndrome metabolic such as central obesity, BMI, hypertension, total cholesterol, HDL, LDL, triglyceride, and fasting plasma glucose were taken measurements.

A total of 49,931 respondents were taken biomedical measurements. In subsequent analysis after biomedical data is combined with interview data, the number of patients who were excluded was 11,532. We also excluded another 12,335 respondents with missing data for central obesity, BMI, hypertension, total cholesterol, HDL, LDL, triglyceride, and fasting plasma glucose. A total of 26,063 patients were included in the final analyses (Fig.1).

Central obesity was defined waist circumference >90 cm in men and >80 cm in women. Measurement of waist circumference was starting from the midpoint and then parallel/horizontal circle around the waist and the abdomen back to the midpoint at the beginning of measurement. For measuring the body weight and height of each subject, subjects wore indoor clothing and no shoes. Blood pressure was measured using automatic blood pressure monitors (Omron IA1), which blood pressure is measured after the respondent had been sitting upright for at least 10 minutes. BMI was calculated as weight in kilograms divided by square of height in meters, categorized as obese if BMI >25 kg/m (Perkumpulan
Measurement of fasting blood was taken after the respondent fasted for at least 8 hours and maximum 14 hours and only allowed to drink fresh water. Total cholesterol, HDL-cholesterol, LDL-cholesterol, and triglyceride were measured by the electrochemical method using the TRX 7010 autoanalyzer.

Metabolic syndrome was diagnosed according to the National Cholesterol Education Program Adult Treatment Panel III (NCEP ATP III) and Perkumpulan Endokrinologi Indonesia (PERKENI, The Indonesian Society of Endocrinology) criteria that have been adapted for Indonesian people. Metabolic syndrome in our study were defined as those who satisfied at least three of the following five parameters: waist circumference >90 cm for men and >80 cm for women according to PERKENI criteria for central obesity, hypertension is defined BP>140/90 mmHg, hyperglycemia or fasting blood glucose ≥126 mg/dL, low HDL-cholesterol (male <40 mg/dL and women <50 mg/dL), and hypertriglyceridemia (triglyceride ≥150 mg/dL)(NCEP-ATP III,2003).

Elevated total cholesterol (≥200 mg/dL) and LDL-cholesterol (≥150 mg/dL) were categorized as risk of kidney stones. Respondents are categorized as obese if they have BMI> 25kg/m² (Perkumpulan Endokrinologi Indonesia, 2015; Kum et al., 2016).

The diagnosis of kidney stones was determined who respondents had been diagnosed with kidney stone disease by a doctor based on Riskesdas 2013 interview, with the question: "Have you ever diagnosed kidney stones by a doctor?". Kidney stones were defined as the respondent’s answer "Yes" to this question.

We compared the demographic and clinical characteristics in entire respondents, male, and female. These variables were expressed as absolute values and percent and compared between the kidney stones group and non-kidney stones group by using a chi-square test. We estimated the odds ratios (OR) and 95% confidence intervals (CI) between kidney stones and parameters of kidney stones based on both univariate and multivariate logistic regression analysis. Multivariate analysis was used to find dominant factor associated with the risk kidney stones after adjustment confounding variables such as age. Statistical analyses were carried out using SPSS version 16.0, which p values less than 0.05 was considered significant.

RESULTS AND DISCUSSION

The number of respondents analyzed were 26,063 with the number of kidney stones was 226 (0.9%) respondents. The number of male respondents was 10,565 and female was 15,598 respondents. Male respondents had a higher prevalence of metabolic syndrome and kidney stones than females. The prevalence of metabolic syndrome in respondents with kidney stones was higher than respondents without kidney stones (27.9% vs.15.9%, p<0.001). The prevalence of age, sex, central obesity, employment status, BMI, blood pressure, total cholesterol, LDL cholesterol, triglycerides, fasting blood glucose, and metabolic syndrome was significantly different between the two groups in entire respondents. Kidney stones were significantly higher in the respondents with metabolic syndrome than those without metabolic syndrome (p<0.001). Respondent distribution by demographic characteristics presented in Table 1.
| Variable                                    | Total Male | Female | Total (%)                |
|---------------------------------------------|------------|--------|--------------------------|
| Age (>43 y)                                 | 167 (73.9) | 12.396 | 107 (73.3)               |
| Education level (Illiterate, primary school, secondary school) | 169 (74.8) | 0.854 | 97 (66.4)               |
| Employment Status (Unemployed)              | 163 (72.1) | 0.038 | 128 (87.7)               |
| Central Obesity (WC>90 cm for men and WC>80 cm for women) | 86 (38.1) | 0.004 | 32 (21.9)               |
| BMI (≥25 kg/m²)                             | 81 (35.8) | 0.009 | 40 (27.4)               |
| Hypertension (BP≥140/90 mmHg)               | 108 (47.8) | <0.001 | 69 (47.3)               |
| Total Cholesterol (≥200 mg/dL)              | 101 (44.7) | 0.003 | 58 (39.7)               |
| HDL-Cholesterol (<40 mg/dL for male, <50 mg/dL for female) | 98 (43.4) | 0.165 | 58 (39.7)               |
| LDL-Cholesterol (≥100 mg/dL)                | 188 (83.2) | 0.023 | 120 (82.1)              |
| Triglyceride (≥150 mg/dL)                   | 78 (34.5) | <0.001 | 57 (39.0)               |
| FPG (≥126 mg/dL)                            | 25 (11.1) | 0.029 | 11 (7.5)                |
| Metabolic Syndrome                         | 63 (27.9) | <0.001 | 35 (23.9)               |
| Total (%)                                   | 226 (0.9) | 25.837 | 146 (1.4)               |
higher risk for kidney stones (OR 2.7; 95% CI 1.9-3.9; p<0.001 in male respondents and OR 2.2; 95% CI 1.4-3.4; p=0.001).

Table 3 shows the results of crude and multivariable-adjusted OR for kidney stones according to metabolic syndrome parameter. Compared to the non-metabolic syndrome group in female respondents, metabolic syndrome had a significantly higher prevalence of kidney stones after adjustment for age (OR 7.1; CI 95% 2.9-17.0; p<0.001). After adjustment for age, triglyceride was associated with risk of kidney stones (OR 2.4; 95% CI 1.2-4.5; p=0.009) in female respondents. Central obesity, BMI, total cholesterol, HDL-cholesterol, LDL-cholesterol, and fasting plasma glucose were not associated with kidney stones in female respondents. After adjustment for age, central obesity was associated with risk of kidney stones (OR 2.0; 95% CI 1.1-3.6; p=0.020) in male respondents. BMI, total cholesterol, HDL-cholesterol, LDL-cholesterol, triglycerides and fasting plasma glucose were not associated with kidney stones in male respondents. Of the eight parameters, only hypertension was a factor significantly related with the presence kidney stones in both male and female respondents after adjustment for age (in male: OR 1.6; 95% CI 1.1-2.3; p=0.014, in female: OR 2.0; 95% CI 1.1-3.5; p=0.012).

Note: Criteria for metabolic syndrome were used as defined by the National Cholesterol Education Program Adult Treatment Panel III, and PERKATUAN ENDOKRINOLOGI INDONESIA.

Abbreviations: WC=waist circumference; BMI=body mass index; HDL=high-density lipoprotein; LDL=low-density lipoprotein; FPG=fasting plasma glucose; CI=confidence interval; OR=odds ratio.

Table 4 shows the variables associated with kidney stones by metabolic syndrome parameters are listed in Table 2. Note: Criteria for metabolic syndrome were used as defined by the National Cholesterol Education Program Adult Treatment Panel III, and Persatuan Endokrinologi Indonesia.

Abbreviations: BMI=body mass index; BP=blood pressure; HDL=high-density lipoprotein; LDL=low-density lipoprotein; FPG=fasting plasma glucose; CI=confidence interval; OR=odds ratio.

Central obesity, BMI, hypertension, total cholesterol, HDL-cholesterol, LDL-cholesterol, triglycerides were significantly associated with kidney stones in male respondents (p<0.05). FPG was not associated with kidney stones in male respondents (p=0.774). In male respondents, the OR were as high as 2.0 (95% CI, 1.5 to 2.8) for blood pressure >140/90 mmHg and 1.9 (95% CI, 1.3 to 2.6) for respondents with triglyceride ≥150 mg/dL. Central obesity (OR 2.9; 95% CI 1.8-4.6; p<0.001), BMI (OR 1.9; 95% CI 1.3-3.1; p=0.002), hypertension (OR 1.6; 95% CI 1.02-4.5; p=0.049), total cholesterol (OR 1.8; 95% CI 1.2-2.8; p = 0.009), and fasting blood glucose (OR 2.6, 95% CI 1.5-4.7; p<0.001) were associated with kidney stones in female respondents. HDL-cholesterol, LDL-Cholesterol and triglycerides were not associated with kidney stones in female respondents. Respondents with metabolic syndrome are at higher risk for kidney stones (OR 2.7; 95% CI 1.9-3.9; p<0.001 in male respondents and OR 2.2; 95% CI 1.4-3.4; p=0.001).

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Table 4 shows the variables associated with
which associated with the risk of kidney stones in male respondents. Metabolic syndrome was dominant factor which associated with the risk of kidney stones in female respondents.

This study uses a cross-sectional design with the large sample and community-based study covering all regions in Indonesia. We found that age was confounding factors included for the associated metabolic syndrome parameters with kidney stones. This results was consistent with study in a screened population between January 2006 and December 2006 (34,895 respondents) at the Asan Medical Center, Korea which reported that age also to be confounding factors included for the relationship between metabolic syndrome and kidney stones (Jeong et al., 2011). Kidney stones are more common in middle-aged adults, with the highest prevalence rates occurring in adults aged 45 to 59 years (Chen et al., 2018).

The results of the study show that kidney stones in a multivariate analysis after adjustment for age.

Note: Criteria for metabolic syndrome were used as defined by the National Cholesterol Education Program Adult Treatment Panel III and Persatuan Endokrinologi Indonesia.

Abbreviations: WC: waist circumference; BP: blood pressure; CI: confidence interval; OR: odds ratio.

Central obesity, hypertension, and triglyceride were known to be significant risk factors associated with kidney stones in male respondents (OR 1.9; 95% CI 1.3-2.9; p=0.003, OR 1.5; 95% CI 1.1-2.2; p=0.014, OR 1.6; 95% CI 1.1-2.2; p=0.008, respectively). Hypertension (OR 1.8; 95% CI 1.1-3.1; p=0.029), triglyceride (OR 2.2; 95% CI 1.2-4.1; p=0.009), and metabolic syndrome (OR 6.1; 95% CI 3.4-11.3; p<0.001) were known to be significant risk factors associated with kidney stones in female respondents. Central obesity was dominant factor which associated with the risk of kidney stones in male respondents. Metabolic syndrome was dominant factor which associated with the risk of kidney stones in female respondents.

This study uses a cross-sectional design with the large sample and community-based study covering all regions in Indonesia. We found that age was confounding factors included for the associated metabolic syndrome parameters with kidney stones. This results was consistent with study in a screened population between January 2006 and December 2006 (34,895 respondents) at the Asan Medical Center, Korea which reported that age also to be confounding factors included for the relationship between metabolic syndrome and kidney stones (Jeong et al., 2011). Kidney stones are more common in middle-aged adults, with the highest prevalence rates occurring in adults aged 45 to 59 years (Chen et al., 2018).

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stone is more prevalent among male than among female. Mini review reported that male was significantly associated with risk of kidney stone (Chen et al., 2018). Previous study report that male-to-female ratios generally vary 3:1 (Ferrari, 2007). Kirejczyk & Porowski (2014) have found higher urinary excretion of stone promoters such as calcium, oxalate, urine acid, and sodium among men than women. On the contrary, women presented higher urinary excretion of citrate which inhibits stone formations.

The results showed central obesity was associated with risk of kidney stone in male respondents. Central obesity is determined by waist circumference. This results are consistent with those of an earlier study, that found a significant association between central obesity and kidney stones (Rendina et al., 2009; Cho et al., 2013). Study at three hospitals in South Korea reported that elevated waist circumference was identified as significant risk factors associated with kidney stones (p<0.001) (Cho et al., 2013). Study in Spinelli Hospital, southern Italy also reported that central obesity was significantly associated with nephrolithiasis (OR adjusted 2.8; 95% CI 1.2–6.4) (Rendina et al., 2009). Central obesity is a predisposing factor of insulin resistance (Otsuki et al., 2011). Insulin resistance in the kidneys will cause ammonia genesis process in the kidneys decreases, causing a decrease in ammonium excretion. This decrease in ammonium excretion causes an increase in H⁺ ions in the tubular lumens. This increase in H⁺ ions causes a decrease in urinary pH resulting in the formation of uric acid stones (Hess, 2012).

Multivariate analysis after adjustment for confounding variable showed that no statistically significant association between BMI and the risk of kidney stones. This results was consistent with study in China (Zhao et al., 2012). However, some studies show different results. Study cohort in Japan reported that increased BMI was associated with the risk of kidney stones. The risk of kidney stone formation was much higher in people with BMI 23.8-35.6 kg/m² compared with people with BMI 15.9-21.6 kg/m² (Kum et al., 2016; Yoshimura et al., 2016). A cohort study in the United States in postmenopausal women also suggests that increased BMI is associated with kidney stones (p<0.001) (Sorensen et al., 2014). The mechanism whereby obesity increases the risk of incident stone formation is uncertain. However, hyperinsulinemia is associated with obesity and has a significant effect on urine composition (Taylor et al., 2005). Elevated BMI is one of many markers of obesity and is associated with a systemic inflammatory state in patients with metabolic syndrome (Rendina et al., 2009). Insulin resistance, also associated with obesity, can also alter the composition of the urine. Insulin resistance may manifest in the kidney as a defect in ammonium production and the ability to excrete acid (Krivosikova et al., 1998).

However, the results of this cross-sectional study in the general population and large number of samples was reported that no association between BMI and kidney stones.

Hypertension was a metabolic syndrome parameter that has been common knowledge was associated with risk of kidney stones (Rendina et al., 2009; Jung et al., 2011). Hypertension was common in many patients with kidney stones formers (Kittanamongkolchai et al., 2017). This study also showed that hypertension was associated with the risk of kidney stones in male and female respondents. This result was consistent with previous study. Screening test study at a health promotion center in Seoul, Korea (116,536 respondents) reported that hypertension was a significantly related factor to the presence of kidney stones (male; OR 1.08; 95% CI 1.01–1.15; p=0.043, female; OR 1.24; 95% CI 1.08–1.42; p=0.002) (Kim et al., 2013). A cross sectional study in Texas reported that hypertension was identified as a significant risk factor associated with kidney stones (Hazard Ratio=1.50; 95% confidence
suggesting that patients with high total cholesterol
alysis and lipid profile evaluation within 3 months
with kidney stones who underwent 24-hour urin-
alyzed, 2018). Retrospectively study identified patients
significantly with uric acid stone formation (Cai et
Musa & Idris, 2015). Study are consistent with cross-sectional stu-
dsociated with LDL-cholesterol (Torricelli et al., 2014).

HDL-cholesterol was not associated with kidney stones in this study. The results of this stu-
dy are consistent with cross-sectional studies in a screened population at the Asan Medical Center,
Korea with a total of 34,895 respondents. The study reported that after adjustment for age and sex,
HDL-cholesterol were not associated with kidney stones (p=0.2) (Jeong et al., 2011). Although low
HDL-cholesterol was not associated with the risk of kidney stones, after analyzed, low HDL-cholesterol
was associated with metabolic syndrome (p value <0.001). Elevated HDL-cholesterol is a key mediator
of the atherogenicity in metabolic syndrome. Metabo-
lic syndrome was a direct factor affecting the inci-
dence of kidney stones (Kim et al., 2013). There has
been considerable interest in the relationship be-
 tween HDL and insulin resistance. In the presence of
insulin resistance, HDL cholesterol levels often are
reduced. The reduction in HDL is widely believed
to be the consequence of inflammatory cytokines
(Eren et al., 2012). The reduced of HDL-cholesterol
in the metabolic syndrome are believed to play a role
in the predisposition to atherosclerosis since HDL
normally has antiatherosclerosis properties. These
have been attributed to its ability to play a role in
reverse cholesterol transport, to its ability to inhibit
oxidation, and to the anti-inflammatory properties
of HDL (Hoofnagle et al., 2010).

Elevated total cholesterol and LDL-cho-
lesterol as the component of dyslipidemia were
associated with kidney stones (Torricelli et al., 2014;
Musa & Idris, 2015) This study did not show that to-
tal cholesterol and LDL-cholesterol were significant-
ly related factors with the presence of kidney stones.
This result was consistent with cross-sectional stu-
dies in Korea (Kim et al., 2013), doesn't find the asso-
ciation between LDL-cholesterol and the risk of
kidney stones. Reported in a cross-sectional study
of 100 patients at the Khartoum Sudanese Hospi-
tal, LDL-cholesterol was associated with the risk of
kidney stones (p<0.001) (Musa & Idris, 2015). Stu-
dy in Italy reported that total cholesterol were not
significantly with uric acid stone formation (Cai et
al., 2018). Retrospectively study identified patients
with kidney stones who underwent 24-hour urin-
alysis and lipid profile evaluation within 3 months
suggesting that patients with high total cholesterol
had high uric acid (p value <0.001) (Torricelli et al.,
2014).

Elevated triglyceride was associated with
the risk of kidney stones after adjustment for age in
male and female respondents. This result was con-
sistent with previous study in South Korea (Cho et
al., 2013). Elevated triglyceride was causing sodium,
oxalate, and uric acid significantly higher with a lo-
wer pH. It was associated with kidney stones (Torri-
celli et al., 2014).

Elevated fasting plasma glucose was a meta-
 bolic syndrome parameter was associated with risk
of kidney stones (Jeong et al., 2011). Elevated fasting
plasma glucose was associated with insulin resistance.
It was causes low urinary pH, the risk of kidney
stones (Cameron et al., 2012). This study reported
different result. Elevated fasting plasma glucose was
not associated with kidney stones. This results of
this study was consistent with cross-sectional stu-
dies in Korea which large number of samples also
reported that elevated fasting plasma glucose was
not associated with kidney stones (p=0.771) (Kim et
al., 2013). Screening population at the Asan Medi-
cal Centre hospital, Korea suggesting that elevated
fasting plasma glucose were associated with kidney
stones (Jeong et al., 2011). The results were different
due to the population used in this study different
from those studies.

In this study, metabolic syndrome was asso-
ciated with kidney stones in male respondents. More studies displayed increasing odds of kidney stones
with increasing number of metabolic syndrome
traits, where patients with three or more metabolic
syndrome traits tended to have higher prevalence of
kidney stones (Wong et al., 2016). Studies in Japan
reported that metabolic syndrome was associated
with a 1.8-fold higher level of echo graphic eviden-
cence of kidney stones in 11,555 patients (Kohjimoto
et al., 2013). Jeong et al. also reported that presence
of metabolic syndrome had an OR of 1.25 (95% CI,
1.03-1.50) for kidney stone prevalence evaluated
using computed tomography or ultrasonography in
34,895 individuals who underwent general health
screening tests in Korea (Jeong et al., 2011). This
study was consistent with earlier study (Cho et al.,
2013; Jeong et al., 2011; Jung et al., 2011; Kim et al.,
2013). In a separate study of UA stone formation in
metabolic syndrome, Cho et al. showed that meta-
bolic syndrome was an independent risk factor for
UA stone (Cho et al, 2013). Insulin resistance has
been known as a common pathogenic mechanism in
both kidney stones and metabolic syndrome (Kim et
al., 2013). Patients with insulin resistance have high
levels of plasma free fatty acids, which can enter the
proximal tubule cells and interfere with the utiliza-
tion of glutamine; since free fatty acids constitute an
alternative metabolic substrate for the proximal tubule cells, it results in a reduction in glutamine usage and ammonia genesis (Li et al., 2014). In addition, insulin resistance may directly impair ammonia genesis as demonstrated by in vitro studies which showed that insulin is able to stimulate renal ammonium production from L-glutamine (Krivosikova et al., 1998). Insulin receptors are expressed in the renal tubular epithelium, and insulin stimulates the renal tubular sodium-hydrogen exchanger (Na+/H+ exchanger) to increase reabsorption of hydrogen. The activation and up-regulation of the Na+/H+ exchanger by insulin promotes ionic trapping of ammonia in the renal tubule; hydrogen ions become bound to ammonia, which is converted to ammonium and is unable to exit the lumen of the renal tubule. Resistance to insulin thereby results in decreased buffering capacity for urinary acidification due to decreased ammonia secretion (Li et al., 2014).

The study also was limited because did not have data about the type of kidney stone. Kidney stone classification based on the question, “Have you ever diagnosed kidney stones by a doctor?” This responsible for the relatively lower prevalence of the actual amount. Variable that was very important and associated with the risk of kidney stones such as plasma uric acid was not identification. In addition, there are also important variables associated with kidney stone but not identification in this study, such as family history of kidney stones, fluid intake, consumption of calcium supplements, and alcohol consumption. Furthermore, another limitation in our study was the methodology used in the analysis of kidney stones. Then, because our study was not a longitudinal study but a cross-sectional study, we could not determine the certainly causal relationship between kidney stones and metabolic syndrome parameters. Despite these limitations, our study is strengthened by the large sample size and community-based studies.

CONCLUSIONS

Metabolic syndrome is associated with kidney stones. Central obesity was dominant factor which associated with the risk of kidney stones in male respondents (OR 1.9; 95% CI 1.3–2.9; p=0.003). Metabolic syndrome was dominant factor which associated with the risk of kidney stones in female respondent (OR 6.1; 95% CI 3.4–11.3; p<0.001). In next studies, the diagnosis of kidney stone disease is necessary to use ultrasound or computed tomography (CT) and needs to be done with a cohort study to determine the causality association between metabolic syndrome parameters and risk of kidney stones.

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