Austin Journal of Public Health and Epidemiology

Austin Publishing Group

Open Access Full Text Article

Research Article

Evaluating the Effects of the Components of Metabolic Syndrome on Chronic Kidney Disease: Data Analysis of Adult Physical Examinations

Joseph Kwong-Leung Yu[1], Pei Fang Chia[2], Choo Aun Neoh[3], Yu Kuei Liao[4], Chun Chieh Chao[5], Chia Hsin Lai[6], Chao Sien Lee[7] and Tsan Yang[7]*

[1]Pingtung Christian Hospital Superintendent, Taiwan
[2]Department of Nursing, Pingtung Christian Hospital Management Centre, Taiwan
[3]Pingtung Christian Hospital Pain Clinic, Taiwan
[4]Pingtung Christian Hospital Nursing Department, Taiwan
[5]Department of Senior Citizen Service Management, Yuh-Ing Junior College of Health Care and Management, Taiwan
[6]Department of Physical Therapy, Tzu Hui Institute of Technology, Taiwan
[7]Department of Health Business Administration, Meiho University, Taiwan

***Corresponding author:** Tsan Yang, Department of Health Business Administration, Meiho University, Ping Kuang Road, Neipu, Pingtung, 91202, Taiwan

Received: August 15, 2014; **Accepted:** September 12, 2014; **Published:** September 15, 2014

Abstract

Background: Taiwan has the highest incidence and prevalence of End-Stage Renal Disease (ESRD) worldwide. By contrast, Chronic Kidney Disease (CKD) is a condition that occurs earlier than ESRD and has a higher prevalence rate. CKD and metabolic syndrome (MetS) increase the cardiovascular disease mortality rate, thereby increasing health care expenditures and burdens and resulting in considerable mental and financial hardships for individuals, families, and society; therefore, efforts to prevent CKD have been made worldwide.

Aim: This study aimed to identify the components of MetS that are associated with CKD in Southern Taiwan.

Methods: A cross-sectional study design was used, in which 19 142 adults from Pingtung County participated in a health examination during 2006–2011. The basic information questionnaires and physical and blood examination results of all participants were obtained. CKD was defined as an estimated glomerular filtration rate (eGFR) of < 60mL/min/1.73m2. The chi-squared test and logistic regression were applied.

Results: The prevalence of CKD (eGFR < 60) was 12.8%. Sex, age, smoking, alcohol consumption, and betel nut chewing reached statistical significance for CKD prevalence. Patients with abnormal components of MetS, such as obesity, hypertension, hyperglycemia, and hypertriglyceridemia, exhibited a higher prevalence of CKD.

Conclusion: The aforementioned components of MetS are critical factors influencing CKD prevalence. Therefore, effective control of the increases in body mass index, blood pressure, and triglyceride and glucose levels are beneficial in decreasing the incidence of CKD.

Keywords: Chronic kidney disease; Metabolic syndrome; Glomerular filtration rate

Abbreviations

ESRD: End-Stage Renal Disease; CKD: Chronic Kidney Disease; MetS: Metabolic Syndrome; eGFR: estimated Glomerular Filtration Rate; BMI: Body Mass Index; Cr: creatinine; K/DOQI: Kidney Disease Outcomes Quality Initiative; FPG: Fasting Plasma Glucose; BP: Blood Pressure; NKF: National Kidney Foundation; WC: Waist Circumference; HDL-C: High Density Lipoprotein Cholesterol; OR: Odds Ratio

Introduction

The global prevalence of chronic kidney disease (CKD), which is a major public health problem [1], is approximately 10%–14%. According to the U.S. National Health and Nutrition Examination Survey, the prevalence of CKD in 1999–2004 was 13.07% [2]. A physical examination data analysis in Taiwan (1999–2006) revealed a CKD prevalence of 11.93% (approximately two million people) in the population of Taiwan; however, the recognition rate was only 3.5% [3]. The U.S. Renal Data System 2010 annual data report revealed that the incidence of end-stage renal disease (ESRD) in Taiwan in 2008 was approximately 384 per one million people, which was higher than that in Japan (288 per one million) and Hong Kong (152 per one million people). In addition, Taiwan exhibited the highest incidence and prevalence rates of ESRD in the world for 8 consecutive years from 2001 to 2008.

Although the high incidence and prevalence of ESRD in Taiwan is a concern, the prevalence of CKD, which occurs earlier than ESRD does, is higher than that of ESRD. The progression of CKD to ESRD not only increases the mortality from cardiovascular disease but also increases psychological and financial burdens on individuals, families, and society. Therefore, CKD is a crucial disease that should be prevented and treated worldwide.

Metabolic syndrome (MetS) has become a global epidemic and is related to clustering of the risk factors for diabetes and cardiovascular disease. MetS refers to a comprehensive clinical manifestation of a group of risk factors including hypertension, diabetes, hyperlipidemia, and central obesity [4,5]. The clustering of these

Citation: Kwong-Leung Yu J, Chia PF, Neoh CA, Liao YK, Chao CC, Lai CH, et al. Evaluating the Effects of the Components of Metabolic Syndrome on Chronic Kidney Disease: Data Analysis of Adult Physical Examinations. Austin J Public Health Epidemiol. 2014;1(2): 1010.

risk factors deteriorates the diabetes and increases the incidence and mortality rates of cardiovascular disease [6,7]. The principal measures of preventing CKD include early detection, early treatment, and preventing the deterioration of kidney function. The incidence and progression of CKD can be controlled through regular examinations and treatment, thereby reducing the risk of complications and cardiovascular disease and enhancing the survival rate and quality of life [8]. CKD can be diagnosed early by replacing creatinine (Cr) with the estimated glomerular filtration rate (eGFR). Currently, this is the most critical change that leads to early discovery of CKD. The new Kidney Disease Outcomes Quality Initiative (K/DOQI) clinical diagnosis and treatment guidelines have been widely adopted in the field of nephrology [9].

Previous epidemiology surveys have focused minimally on the effects of the MetS components on kidney function in middle-aged and elderly people. Therefore, this study investigated the effects of various MetS components on CKD in the middle-aged and elderly population of Southern Taiwan.

Methods

The present study used a cross-sectional design and collected data from middle-aged and elderly people aged ≥ 40 years who participated in a free adult health examination from 2006 to 2011 in the Kaohsiung-Pingtung area. The total sample size was 21,442, with a valid sample size of 19,142 after the exclusion of participants who did not undergo complete physical and biochemical blood examination or who underwent repeated screening.

The research instruments used were an adult health examination database. The physical examination included blood pressure (BP) and anthropometric measurements (height, weight, and Body Mass Index [BMI]). Height was measured using a stadiometer to the nearest 0.1 cm, without shoes. Weight was measured using a beam balance scale to the nearest 0.1 kg, in light clothing and without shoes. BMI was calculated as weight (kg) divided by height squared (m^2). Well-trained nurses measured the systolic blood pressure and diastolic blood pressure twice in the left arm in the seated position according to a standard protocol. A third BP measurement was recorded if the difference between initial 2 BP readings was >10 mm Hg. The average of the 2 closest readings was calculated to determine the reported BP for each participant.

The biochemical blood examination included total cholesterol, triglyceride, fasting plasma glucose (FPG), and Cr levels. The sample was venous blood drawn after 8 hours of fasting, which was delivered to the laboratory within an hour and analyzed using a Hitachi-7070 biochemical analyzer and XT-1800i globulimeter.

Definition of terms:

(i) (1) CKD: According to the K/DOQI guidelines established by the National Kidney Foundation (NKF) regarding the prevention of CKD [10], and the following stages of CKD were included in this study.Stage 3: Moderately reduced GFR ranging 30–59mL/min/1.73m^2;

(ii) Stage 4: Severely reduced GFR ranging 15–29mL/min/1.73m^2;

(iii) Stage 5: ESRD with GFR < 15mL/min/1.73m^2 or currently undergoing dialysis [10].

This study adopted the NKF definition of CKD, using GFR < 60mL/min/1.73m^2 to diagnose a person with CKD [11,12].

(2) GFR: The GFR index is commonly used for early detection of CKD.

This study adopted K/DOQI [10] and used the simplified Modification of Diet in Renal Disease (MDRD) equation to calculate eGFR and evaluate kidney function. GFR (mL/min per 1.73m^2) $186 \times \text{Cr (mg/dL)}^{-1.154} \times (\text{age})^{-0.203} \times (\text{female} \times 0.742) \times 1.210$ [13].

(3) The MetS was defined according to the criteria set by the Bureau of Health Promotion, Department of Health in 2007. Since waist circumference (WC) and high density lipoprotein cholesterol (HDL-C) were not routine inspection items in the previous health examination, the present study referred to other research methods and took BMI as a replacement for WC and total cholesterol as a replacement for HDL-C [14]. The remaining components of MetS included, (i) elevated blood pressure, defined as blood pressure of at least 130/85 mm Hg or use of antihypertensive medication; (ii) elevated triglycerides, defined as serum triglycerides of at least 150 mg/dL; and (iii) elevated FPG, defined as FPG of 100 mg/dL or more or use of drug treatment for elevated glucose.

The study protocol was approved by the institutional review board before data collection.

The study data were analyzed using Statistical Package for Social Sciences for Windows (Version 17.0), with a significance level of $\alpha = .05$. The chi-squared test and multiple logistic regression model were applied for inferential statistical analysis.

Results and Discussion

International studies have indicated numerous factors associated with the incidence of CKD, including aging, sex, race, family medical history, obesity, smoking, high-protein diets, anemia, proteinuria, and several chronic diseases such as diabetes, hypertension, hyperlipidemia, MetS, cardiovascular disease, and gout [11,15-29]. In this study (Table 1), the participants with eGFR < 60 exhibited a CKD prevalence of 12.8% (14.2% for men and 11.5% for women). Sex, age, smoking, alcohol consumption, betel nut chewing, and MetS components reached statistical significance for the prevalence of CKD. Participants with abnormal MetS components (obesity, hypertension, hyperglycemia, and hypertriglyceridemia) exhibited a higher prevalence of eGFR < 60. Similar studies have also reported a higher prevalence of CKD in men [3,30]. Regarding age, people aged > 65 years exhibited a 26.8% risk of being diagnosed with CKD, which was significantly higher than that of participants aged 40–64 years (4.5%). Aging causes CKD likely because of a decrease in nephrons [31]. Previous studies have also reported that older patients exhibit a higher prevalence of CKD and poorer kidney function [30,32]. Because aging is a risk factor for CKD, CKD testing should be emphasized, particularly for patients aged > 60 years.

In addition, the findings of this study indicate a negative correlation between individual health behavior and smoking, alcohol consumption, betel nut chewing and CKD. Previous research has proven an association between smoking and CKD; however, no large-scale prospective random studies have proven that smoking

Table 1: Correlation analysis of the demographic characteristics, physical examination, blood biochemical test, and CKD from 2006 to 2011 (n=19,142).

Variables	eGFR≧60 (n=16,701, 87.2%)		eGFR<60 (n=2,441, 12.8%)		*P* value
	Number	Percentage	Number	Percentage	
Gender					<.001
Male	7519	85.8	1244	14.2	
Female	9182	88.5	1197	11.5	
Age					<.001
40-64 years old	11521	95.5	547	4.5	
65 years old and above	5180	73.2	1894	26.8	
Obesity					<.001
Normal	12995	87.8	1803	12.2	
Abnormal (BMI≧27)	3706	85.3	638	14.7	
Smoking					0.028
No	14361	87.0	2139	13.0	
Yes	2340	88.6	302	11.4	
Drinking					<.001
No	13298	86.2	2131	13.8	
Yes	3403	91.7	310	8.3	
Betel nut					0.015
No	15939	87.1	2356	13.9	
Yes	762	90.0	85	10.0	
Blood pressure[a]					<.001
Normal	7160	92.9	545	7.1	
Abnormal (≧130/85mmHg)	9541	83.4	1896	16.6	
FPG[b]					<.001
Normal	9721	90.6	1011	9.4	
Abnormal (≧100mg/dL)	6980	83.0	1430	17.0	
Triglyceride					<.001
Normal	12504	88.1	1686	11.9	
Abnormal (≧150mg/dL)	4197	84.8	755	15.2	
Cholesterol					<.001
Normal	7945	85.9	1302	14.1	
Abnormal (≧200mg/dL)	8756	88.5	1139	11.5	

Note: Using chi-squared statistical analysis and two-tailed test; significant level of α=.05.

[a] Participants with a blood pressure of ≧130/85mmHg or are currently taking antihypertensive drugs.

[b] Participants with a fasting plasma sugar of ≧100mg/dl or are currently taking anti-diabetic medications.

deteriorates kidney function. The cumulative effect of nicotine is higher than normal in patients with CKD, which is more likely to accelerate the deterioration of kidney function; this is particularly evident in CKD patients with diabetes [33]. For alcohol consumption and betel nut chewing, this study did not classify the participants based on the types and contents of the alcohol consumed, and only 4.4% of the participants reported betel nut chewing habits. Therefore, determining the direct negative effects of alcohol and betel nut chewing on kidney function was challenging; ascertaining these effects on healthy workers who experience no symptoms and are healthy but continue to engage in unhealthy behavior would likewise be difficult.

Regarding the components of MetS, participants with BMI ≥ 27 kg/m2 exhibited a higher prevalence of CKD. This finding is consistent with those of a previous study: as BMI increases, the risk of suffering from CKD and ESRD increases [34,35]. In addition, other studies have verified that obesity increases eGFR and that adipocytes produce a pro-inflammatory response. Moreover, severe obesity increases renal blood flow, thereby resulting in higher eGFR [36]. Hypertension is a crucial factor that causes kidney failure. Several kidney diseases are accompanied by high blood pressure, which accelerates the deterioration of kidney function and increases the risk of cardiovascular diseases caused by chronic kidney failure. The findings of the present study indicate a correlation between higher blood pressures and a higher risk of being diagnosed with CKD (eGFR < 60); these findings are consistent with those reported by previous studies [21,26]. The possible mechanism by which hypertension causes CKD is that the increased blood pressure causes glomerular hypertension, thereby accelerating glomerular injury, which stimulates an inflammatory response and consequently reduces the number of glomeruli [26]. The patients with CKD exhibited a higher prevalence of abnormal triglyceride levels, with no significant difference in the cholesterol levels. This finding is consistent with those of other studies, which have reported that the primary dyslipidemia in patients with CKD is characterized by increased triglyceride and low-density lipoprotein cholesterol levels, as well as decreased high-density lipoprotein cholesterol levels; these studies have not indicated a direct correlation with cholesterol levels [3,37]. In the current study, the patients with CKD exhibited increased FPG levels (17.0% vs. 9.4%). Diabetic nephropathy has become the primary causative factor for ESRD. A previous study based on the data on stage 5 CKD caused by diabetes reported that patients with diabetes required dialysis earlier than those without diabetes [38]. The pathological factors of diabetes that induce CKD are complicated and involve multiple mechanisms, including glomerular dynamics [39] and production of reactive oxygen species [40]. Logistic regression was used to determine the effects of the MetS components on CKD, after adjust the other influencing factors, which indicated BMI, blood pressure, and triglyceride and FPG levels as risk factors for predicting CKD by using odds ratios (ORs) of 1.14, 1.43, 1.38, and 1.48, respectively (Table 2). These findings are consistent with other studies [30,41].

Limitations

Although the research results regarding prevalence were not randomly sampled, the large-scale screening implemented in this study still indicated a certain degree of representativeness. Analyzing the adult physical examination data indicated a higher average age of patients; nevertheless, the inferences from these research results must be more conservative. In addition, because of the lack of the proteinuria data, the detection of the eGFR values was incomplete. Therefore, these results may be inconsistent with those presented by other studies. This study was designed as a cross-sectional study; thus, only a "snapshot" of the association between components of metabolic syndrome and CKD could be evaluated. Data took the form of prevalence rates only. The analysis was purely correlational, so causal inferences cannot be made.

Table 2: Logistic regression analysis of risk factors of CKD from 2006 to 2011 (n=19142).

Variables	β	wald	OR (95%CI)	*P* value
BMI	0.13	5.75	1.14(1.02-1.27)	0.017
Blood pressure	0.36	40.97	1.43(1.28-1.59)	<.001
Cholesterol	-0.22	21.59	0.80(0.73-0.88)	<.001
Triglycerides	0.32	37.32	1.38(1.25-1.53)	<.001
FPG	0.39	68.63	1.48(1.35-1.63)	<.001

Note: Logistic regression model correction variables such as gender, age, smoking, alcohol consumption, and betel nut chewing.

Conclusion

The components of MetS, including BMI, blood pressure, and triglyceride and FPG levels, are the risk factors for CKD. Because ESRD treatment exhausts a large amount of health care resources, understanding the associated factors and early implementation of necessary management therapies can decrease the risk of being diagnosed with CKD. Accordingly, eGFR should be calculated for all adults participating in physical examinations, and participants with stage 3 CKD or above should be followed-up regularly at the hospital for early diagnosis and management.

References

1. Levey AS, Atkins R, Coresh J, Cohen EP, Collins AJ, Eckardt KU, et al. Chronic kidney disease as a global public health problem: approaches and initiatives - a position statement from Kidney Disease Improving Global Outcomes. Kidney Int. 2007; 72: 247-259.
2. Coresh J, Selvin E, Stevens LA, Manzi J, Kusek JW, Eggers P, et al. Prevalence of chronic kidney disease in the United States. JAMA. 2007; 298: 2038-2047.
3. Wen CP, Cheng TY, Tsai MK, Chang YC, Chan HT, Tsai SP, et al. All-cause mortality attributable to chronic kidney disease: a prospective cohort study based on 462 293 adults in Taiwan. Lancet. 2008; 371: 2173-2182.
4. Eckel RH, Grundy SM, Zimmet PZ. The metabolic syndrome. Lancet. 2005; 365: 1415-1428.
5. Eckel RH, Alberti KG, Grundy SM, Zimmet PZ. The metabolic syndrome. Lancet. 2010; 375: 181-183.
6. Huang SY, Tsai CH, Lin PF. Metabolic Syndrome in Non-Obese Individuals Seeking Health Examinations. Taiwan J Fam Med. 2007; 17: 99-108.
7. Abolfotouh MA, Daffallah AA, Khan MY, Khattab MS, Abdulmoneim I. Central obesity in elderly individuals in south-western Saudi Arabia: prevalence and associated morbidity. East Mediterr Health J. 2001; 7: 716-724.
8. Levey AS, Coresh J. Chronic kidney disease. Lancet. 2012; 379: 165-180.
9. Wu MJ, Shu KH, Liu PH, Chiang PH, Cheng CH, Chen CH, et al. High risk of renal failure in stage 3B chronic kidney disease is under-recognized in standard medical screening. J Chin Med Assoc. 2010; 73: 515-522.
10. Coresh J, Astor BC, Greene T, Eknoyan G, Levey AS. Prevalence of chronic kidney disease and decreased kidney function in the adult US population: Third National Health and Nutrition Examination Survey. Am J Kidney Dis. 2003; 41: 1-12.
11. National Kidney Foundation. K/DOQI clinical practice guidelines for chronic kidney disease: evaluation, classification, and stratification. Am J Kidney Dis. 2002; 39: S1-266.
12. Levey AS, Coresh J, Balk E, Kausz AT, Levin A, Steffes MW, et al. National Kidney Foundation practice guidelines for chronic kidney disease: evaluation, classification, and stratification. Ann Intern Med. 2003; 139: 137-147.
13. Ma YC, Zuo L, Chen JH, Luo Q, Yu XQ, Li Y, et al. Modified glomerular filtration rate estimating equation for Chinese patients with chronic kidney disease. J Am Soc Nephrol. 2006; 17: 2937-2944.
14. Kuo HW, Tsai SS, Tiao MM, Yang CY. Epidemiological features of CKD in Taiwan. Am J Kidney Dis. 2007; 49: 46-55.
15. Hsu CC, Hwang SJ, Wen CP, Chang HY, Chen T, Shiu RS, et al. High prevalence and low awareness of CKD in Taiwan: a study on the relationship between serum creatinine and awareness from a nationally representative survey. Am J Kidney Dis. 2006; 48: 727-738.
16. Becker MA, Jolly M. Hyperuricemia and associated diseases. Rheum Dis Clin North Am. 2006; 32: 275-293.
17. Chagnac A, Weinstein T, Herman M, Hirsh J, Gafter U, Ori Y. The effects of weight loss on renal function in patients with severe obesity. J Am Soc Nephrol. 2003; 14: 1480-1486.
18. Eriksen BO, Ingebretsen OC. The progression of chronic kidney disease: a 10-year population-based study of the effects of gender and age. Kidney Int. 2006; 69: 375-382.
19. Fox CS, Larson MG, Leip EP, Culleton B, Wilson PW, Levy D. Predictors of new-onset kidney disease in a community-based population. JAMA. 2004; 291: 844-850.
20. Freedman BI, Volkova NV, Satko SG, Krisher J, Jurkovitz C, Soucie JM, et al. Population-based screening for family history of end-stage renal disease among incident dialysis patients. Am J Nephrol. 2005; 25: 529-535.
21. Haroun MK, Jaar BG, Hoffman SC, Comstock GW, Klag MJ, Coresh J. Risk factors for chronic kidney disease: a prospective study of 23,534 men and women in Washington County, Maryland. J Am Soc Nephrol. 2003; 14: 2934-2941.
22. Keane WF, Zhang Z, Lyle PA, Cooper ME, de Zeeuw D, Grunfeld JP, et al. Risk scores for predicting outcomes in patients with type 2 diabetes and nephropathy: the RENAAL study. Clin J Am Soc Nephrol. 2006; 1: 761-767.
23. McClellan WM, Langston RD, Presley R. Medicare patients with cardiovascular disease have a high prevalence of chronic kidney disease and a high rate of progression to end-stage renal disease. J Am Soc Nephrol. 2004; 15: 1912-1919.
24. Satko SG, Freedman BI. The importance of family history on the development of renal disease. Curr Opin Nephrol Hypertens. 2004; 13: 337-341.
25. Schaeffner ES, Kurth T, Curhan GC, Glynn RJ, Rexrode KM, Baigent C, et al. Cholesterol and the risk of renal dysfunction in apparently healthy men. J Am Soc Nephrol. 2003; 14: 2084-2091.
26. Taal MW, Brenner BM. Predicting initiation and progression of chronic kidney disease: Developing renal risk scores. Kidney Int. 2006; 70: 1694-1705.
27. Tarver-Carr ME, Powe NR, Eberhardt MS, LaVeist TA, Kington RS, Coresh J, et al. Excess risk of chronic kidney disease among African- American versus white subjects in the United States: a population-based study of potential explanatory factors. J Am Soc Nephrol. 2002; 13: 2363-2370.
28. Wrone EM, Carnethon MR, Palaniappan L, Fortmann SP; Third National Health and Nutrition Examination Survey. Association of dietary protein intake and microalbuminuria in healthy adults: Third National Health and Nutrition Examination Survey. Am J Kidney Dis. 2003; 41: 580-587.
29. Huang MC, Chen ME, Hung HC, Chen HC, Chang WT, Lee CH, et al. Inadequate energy and excess protein intakes may be associated with worsening renal function in chronic kidney disease. J Ren Nutr. 2008; 18: 187-194.
30. Wu HW, See LC, Chang RE, Chen WJ, Yang MC. Factors associated with chronic kidney disease: analysis of outreach community adult health examination data. Taiwan J Public Health. 2009; 28: 374-384.
31. Lindeman RD, Tobin J, Shock NW. Longitudinal studies on the rate of decline in renal function with age. J Am Geriatr Soc. 1985; 33: 278-285.
32. Hemmelgarn BR, Zhang J, Manns BJ, Tonelli M, Larsen E, Ghali WA, et al. Progression of kidney dysfunction in the community-dwelling elderly. Kidney Int. 2006; 69: 2155-2161.
33. Lysaght MJ. Maintenance dialysis population dynamics: current trends and long-term implications. J Am Soc Nephrol. 2002; 13: S37-40.

34. Shankar A, Leng C, Chia KS, Koh D, Tai ES, Saw SM, et al. Association between body mass index and chronic kidney disease in men and women: population-based study of Malay adults in Singapore. Nephrol Dial Transplant. 2008; 23: 1910-1918.

35. Hsu CY, McCulloch CE, Iribarren C, Darbinian J, Go AS. Body mass index and risk for end-stage renal disease. Ann Intern Med. 2006; 144: 21-28.

36. Park SK, Kang SK. Renal function and hemodynamic study in obese Zucker rats. Korean J Intern Med. 1995; 10: 48-53.

37. Mao HC, Kuo HT. Chronic Kidney Disease and dyslipidemia. Kidney and Dialysis. 2007; 19: 29-35.

38. Lin PC, Tsai SL, Hsh PH. Effectiveness of the health education of diabetes complicated by Stage V chronic kidney disease patients diet. Taiwan Journal of Dietetics. 2010; 2: 63-68.

39. Amin R, Turner C, van Aken S, Bahu TK, Watts A, Lindsell DR, et al. The relationship between micro albuminuria and glomerular filtration rate in young type 1 diabetic subjects: The Oxford Regional Prospective Study. Kidney Int. 2005; 68: 1740-1749.

40. Sakharova OV, Taal MW, Brenner BM. Pathogenesis of diabetic nephropathy: focus on transforming growth factor-beta and connective tissue growth factor. Curr Opin Nephrol Hypertens. 2001; 10: 727-738.

41. Wu HC, Lee SC, Chao TH, Wu WC, Yeh CH, Yeh SC. Prevalence and Risk Factors of Metabolic Syndrome among Adults Attending Health Examination in Southern Taiwan. Chinese J Oecup Med. 2009; 16: 127-139.

Austin J Public Health Epidemiol - Volume 1 Issue 2 - 2014
ISSN : 2381-9014 | www.austinpublishinggroup.com

Citation: Kwong-Leung Yu J, Chia PF, Neoh CA, Liao YK, Chao CC, Lai CH, et al. Evaluating the Effects of the Components of Metabolic Syndrome on Chronic Kidney Disease: Data Analysis of Adult Physical Examinations. Austin J Public Health Epidemiol. 2014;1(2): 1010.