Mining workers, Obesity, Kidney Disease History, and Hypertension increased risk Impaired Kidney Function among Indonesian Workers

J.F. Liem[1], M. Mansyur[2]

[1] Prodia Occupational Health Institute International, Jakarta, Indonesia
[2] Universitas Indonesia – Faculty of Medicine, Department of Community Medicine, Jakarta, Indonesia

Abstract

Introduction Kidney Disease is a major health problem among productive age group. The purpose of this study was to explore the risk of mining worker to have Impaired Kidney Function.

Methods A comparative cross sectional study was conducted to examine the secondary data of 2016 annual medical examination results of 5634 workers from six various industries in Indonesia. The data subjects consisted of 90 of them who were considered Impaired Kidney Function (IKF) compared with 450 data subjects were randomly chosen from those who were normal serum creatinine. Those who have serum creatinine (SCr) level >1.2 mg/dL and >0.9 mg/dL for male and female respectively were categorised as IKF. Logistic regression analysis was used and the risk of mining workers to have IKF were calculated using Odds Ratios and adjusted by individual risk factors (age, hypertension, obesity, history of diabetes, history of kidney disease) as well as with occupational risk factors (type of task, chemical exposure, and heat exposure).

Result This study analysed 540 workers (32.4 years+8.5). No significant associations were observed between outcome and medical history of diabetes mellitus, alcohol consumption, smoking, physical exercise, as well as chemical exposure history. Risk factors associated with IKF were identified including work in mining sector (OR 6.4, 95% CI: 4.0 to 10.3), obesity (OR 2.5, 95% CI: 1.5 to 4.0), grade II hypertension (OR 3.8, 95% CI: 1.1 to 13.2), history of kidney disease (OR 9.7, 95% CI: 1.5 to 60.9) respectively having been adjusted by age group and working activity.

Discussion Miners appear to be more susceptible of developing IKF rather than other manufacturing workers. Further research is needed to explain the role of specific occupational exposures in kidney impairment among miners

Discussion: mining workers, obesity, kidney disease history, hypertension, kidney function

INTRODUCTION

There is no workplace that is completely safe and free from potential hazards including the mining and its related industry, known as one of the most hazardous work environment. Miners are exposed to various potentially toxic or harmful materials or agents including but not limited to fuels, reagents, solvents, metal fumes, and dust (e.g. coal, silica) and workers are vulnerable to kidney disease as well as occupational health related illness accordingly.In order to keep workers in their optimum health condition, the government requires each employer to provide comprehensive and sustainable access to occupational health services for every worker. One important way is to conduct thorough periodic medical examination at least once a year including kidney function examination for early diagnosis of kidney disease.

Kidney Disease is a major health problem among productive age group. Chronic Kidney Disease (CKD) has a high global prevalence with a consistent estimated global CKD prevalence of between 11 to 13%.[1] High blood pressure and diabetes are the most common causes of kidney diseases.[2] Obesity is a significant marker of risk for CKD, independent of hypertension and diabetes.[3,4]Prior research also suggests that silica exposure is associated with kidney damage.[5]Other studies also reported that occupational heat-stress combined with dehydration may result in increased serum creatinineand when repeated on a daily basis this may cause permanent damaged.[6,7] In this study, we aimed to explore the risk of mining worker to have Impaired Kidney Function (IKF).

METHODS

We used secondary data from 2016 annual medical examination results of 6 various industries in Indonesia; construction, automotive, pharmacy, chemical product and 2 mining companies which then categorized as mining and non-mining groups.We derived 5,634 eligible data from total data population of 6,067 subjects after exclusion of incomplete history and pregnancy subjects. One hundred and thirty five of 5,634 data who were considered IKF are included in the study together with 405 data subjects who were randomly selected from those who were normal serum creatinine (SCr). The data used in this study consisted of demographic information (age, gender, work sector, type of task), qualitative history of chemical and heat exposure, physical exercise, smoking habits, alcohol consumption,and previous medical condition (kidney disease, diabetes mellitus).

Blood pressure measurement during medical examination is performed using a manual cuff and sphygmomanometer in sitting position by trained medical personnel. On the other hand, serum creatinine was measured using an enzymatic Jaffe endpoint method at the accredited clinical laboratory.

According to the Steering Committee of the Regional Office for the Western Pacific Region of the World Health Organization (WPRO), the Asian standards for BMI (kg/m2) were as follows: underweight <18.5; normal 18.5 – 22.9; overweight 23 – 24.9; obese >= 25.
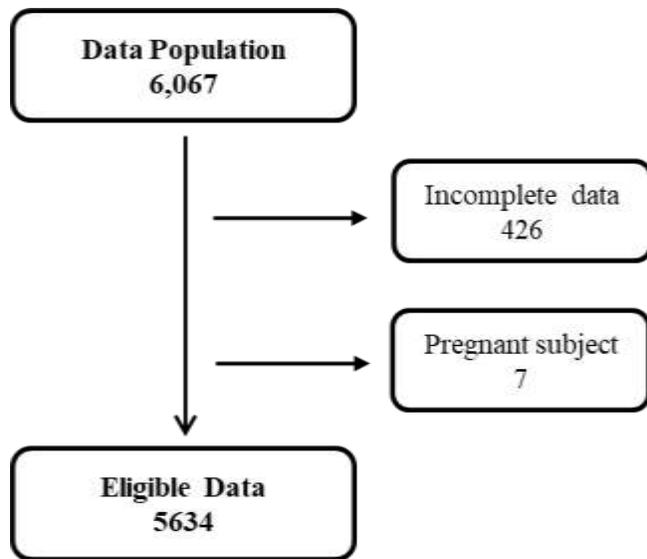
Figure 1. Derivation of study population

Hypertension was defined according to the Joint National Committee (JNC VII) Classification of Hypertension; systolic blood pressure ≥ 140 mmHg or diastolic blood pressure ≥ 90 mmHg and systolic ≥ 160 mmHg or diastolic ≥ 100 mmHg as grade 1 and grade 2 hypertension respectively. Impaired Kidney Function was defined as serum creatinine (SCr) level >1.2 mg/dL and >0.9 mg/dL for male and female respectively.

Continuous variables were presented as mean and standard deviations while dichotomous data will be presented as proportion and percentage. X^2-test analyses were used to define the variable candidates for multivariate analysis based on the p-value <0.25 and calculate the crude odds ratios (crude ORs). Multiple logistic regression were used to estimate the odds ratios (ORs) and 95% CIs for impaired kidney function after adjustment for age, BMI, blood pressure, work sector, type of task and kidney disease history. All statistical analyses were performed using STATA version 10 software and p<0.05 indicates statistical significance.

RESULTS

Baseline characteristic of study data are given in table 1 and table 2. The mean age was 32.4 years (range 19 – 62 years), 91% were male, 28% work in mining sector, and 83% were technical workers.

In bivariate logistic regression, older age group worker (≥ 35 years) had 4 times higher risk for IKF (cOR= 4.02; 95% CI: 2.67 – 6.05), while work in mining sector was significantly associated with increased risk of IKF (cOR=5.75; 95%CI: 3.77 – 8.77) as well as obese workers with a greater risk of having IKF (cOR=2.90; 95% CI: 1.94 – 4.33).

Table 1. Baseline characteristics of continuous variables

| Variables | Kidney Function | |
	Normal (n=405)	Impaired (n=135)
Age (years) [Mean ± SD]	30.61 ± 7.49	37.92 ± 8.86
Creatinine (mg/dL) [Mean ± SD]	0.88 ± 0.15	1.39 ± 0.96
BMI (kg/m^2) [Mean ± SD]	23.75 ± 4.34	26.03 ± 4.05

Table 2. Characteristics of dichotomous variables in association with kidney function

| Variables | Kidney Function | | p-value |
	Normal (n=405)	Impaired (n=135)	
Male Gender [n (%)]	361 (89.1)	129 (95.6)	0.026
Work in mining sector [n (%)]	76 (18.8)	77 (57.0)	< 0.001
Task as technical worker [n (%)]	337 (83.2)	109 (80.7)	0.512
History of heat exposure [n (%)]	192 (47.4)	65 (48.1)	0.881
History of chemical exposure [n (%)]	154 (38.0)	47 (34.8)	0.504
Not exercising [n (%)]	147 (36.3)	64 (47.4)	0.022
Smoking [n (%)]	154 (38.0)	62 (45.9)	0.105
Consuming alcohol [n (%)]	14 (3.5)	2 (1.5)	0.380*
History of kidney disorders [n (%)]	2 (0.5)	5 (3.7)	0.012*
History of Diabetes [n (%)]	7 (1.7)	4 (3.0)	0.480*
Obese [n (%)]	141 (34.8)	82 (60.7)	< 0.001
Grade II - Hypertension [n (%)]	5 (1.2)	9 (6.7)	0.002*

* Fisher's exact

Risk factors associated with IKF were identified in our logistic models after being adjusted by age group and working activity, including work in mining sector, obesity, grade II hypertension and history of kidney disease.

Table 3. Adjusted Odds Ratios and 95% Confidence Intervals for IKF

Variables	p	aOR	95% CI
Obesity	< 0.001	2.48	1.55 - 4.00
Miners	< 0.001	6.44	4.03 - 10.30
Kidney disease history	0.015	9.7	1.54 - 60.94
Grade II Hypertension	0.032	3.85	1.12 - 13.22

DISCUSSION

Serum creatinine known as most common indicator of kidney function is a waste product of the body produced by muscles activity. At present, despite of its limitation SCr is used to estimate GFR (Glomerular Filtration Rate) to measure the kidney function. Using SCr to defined IKF, our study suggest that obesity and grade II hypertension were significantly increased risk of IKF. Furthermore, we also found that work in mining sectors, and has had history of kidney disease are also associated with IKF.

Obesity is likely to play an important pathogenic role in approximately 14-34% of patients with CKD.[8]Obesity causes cardiovascular and renal diseases through several mechanism including hypertension, hyperglycemia, dyslipidemia and have often been referred to as "metabolic syndrome" especially when there is increased visceral adiposity.[9]In addition, obesity is an independent risk factor for the onset, aggravated, and poor outcomes of CKD.[10] Superimposed obesity can fuel the progression of other renal diseases, and reduced number of functioning neurons synergizes with obesity to induce end-stage renal disease.[11]

Mining remains an important industrial sector in the world with numerous occupational health hazards in it including physical, chemical, biological, ergonomic, and psychosocial hazards. Among the chemical hazards, crystalline silica has long been a serious hazard in mining and there is some evidence for renal disease following prolonged silica exposure.[5,12] Other hazard related to mining activity is heat stress exposure. Extreme occupational heat stress combined with chronic dehydration may contribute to the development of CKD and resulted to kidney failure.[6,7,13]In this study we didn't find any association of chemical or heat exposure with IKF.

We highlighted the number of reported kidney disease history, there are 5 subjects with prior history of kidney disease compared to 135 subjects defined as IKF.Most people with kidney damage or mildly reduced kidney function are not aware of having CKD.[2]A person can lose up to 90% of their kidney functions before experiencing any symptoms because CKD typically becomes symptomatic only in stages 4 and 5.[14]Targeted screening for kidney function in people with hypertension and diabetes as well as obesity may be beneficial.[15] The consequence of undetected CKD is the risk of developing progressive loss of kidney function that can lead to kidney failure or end-stage renal disease (ESRD).

Our study has several potential limitations. First,because of its cross-sectional design, we were unable to determine whether or not there was causal association, hence the result should be considered with caution. Second,with respect to the use of secondary data in this study, we couldn't account for residual confounders including dietary intake and hardness of water consumed as well as potential risk factors such as shift work, heat and chemical exposure due to insufficient of required data.However, our study has important strength due to its large sample size derived from 6 different companies which may represents workers population in Indonesia.

CONCLUSION& RECOMMENDATION

Since kidney is one of the most important organs in human body, if IKF is detected early and managed appropriately, the deterioration in kidney function can be slowed or even stopped, and the risk of associated complications can be reduced.As a part of early detection in impaired kidney function, mining health services should also provide comprehensive management for worker with known hypertension, type-2 diabetes, and obesity including early dietary intervention to reduce weight.

With regards to several limitations in this study, further research is needed to explain the role of specific occupational and environmental exposures in kidney impairment among miners such as exposure to heat stress, chemicals, and shift work.

Competing interests
The Authors have no conflict of interest to declare.

References
1. Hill NR, Fatoba ST, Oke JL, Hirst JA, O'Callaghan CA, Lasserson DS, et al. Global Prevalence of Chronic Kidney Disease – A Systematic Review and Meta-Analysis. PLoS ONE. 2016; 11 (7): e0158765
2. Centers for Disease Control and Prevention. National Chronic Kidney Disease Fact Sheet, 2017. http://www.cdc.gov/kidneydisease/pdf/kidney_factsheet.pdf
3. Herrington WG, Smith M, Bankhead C, Matsushita K, Stevens S, Holt T, et al. Body-mass index and risk of advanced chronic kidney disease: prospective analyses from a primary care cohort of 1.4 million adults in England. Plos ONE. 2017; 12(3):e0173515
4. Sarathy H, Henriquez G, Abramowitz MK, Kramer H, Rosas SE, Johns T, et al. Abdominal obesity, race and chronic kidney disease in young adults: Results from NHANES 1999-2010. Plos ONE. 2016; 11(5):e0153588
5. Vupputuri S, Parks CG, Nylander-French LA, Owen-Smith A, Hogan SL, Sandler DP. Occupational silica exposure and chronic kidney disease. Ren Fail. 2012; 34(1): 40-6
6. Wesseling C, Aragon A, Gonzales M, Weiss I, Glaser J, Bobadilla NA, et al. Kidney function in sugarcane cutters in Nicaragua – A longitudinal study of workers at risk of Mesoamerican nephropathy. Environmental Research. 2016; 147:125-32
7. Garcia-Trabanino R, Jarquin E, Wesseling C, Johnson RJ, Gonzales-Quiroz M, Weiss I, et al. Heat stress, dehydration, and kidney function in sugarcane cutters in El Salvador – A cross-shift study of workers at risk of Mesoamerican nephropathy. Environmental Research. 2015; 142:746-55
8. Wang Y, Chen X, Song Y, Caballero B, Cheskin LJ: Association between obesity and kidney disease: a systematic review and meta-analysis. Kidney int. 2008; 73:19-33
9. Hall ME, doCarmo JM, da Silva AA, Juncos LA, Wang Z, Hall JE. Obesity, hypertension, and chronic kidney disease. International Journal of Nephrology and Renovascular Disease 2014; 7:75-88
10. Eknoyan G. Obesity and chronic kidney disease. Nefrologia 2011; 31(4):397-403

11.   Praga M, Morales E. The fatty kidney: obesity and renal disease. Nephron 2017; 136:273-6

12.   Donoghue AM. Occupational health hazards in mining: an overview. Occupational Medicine 2004; 54:283-9.

13.   Nerbass FB, Pecoits-Filho R, Clark WF, Sontrop JM, McIntyre CW, Moist L. Occupational heat stress and kidney health: from farms to factories. Kidney Int Rep. 2017; 2:998-1008

14.   de Jong PE, Curhan GC. Screening, Monitoring, and Treatment of Albuminuria: Public Health Perspectives. Journal of the American Society of Nephrology. 2006; 17(8):2120–6

15.   Neuen BL, Chadban SJ, Demaio AR, Johnson DW, Perkovic V. Chronic kidney disease and the global NCDs agenda. BMJ Glob Health 2017;2:e000380