台灣青年與青壯年世代成人健檢結果分析：慢性腎臟病之相關因子

Risk factors for chronic kidney disease using health checkup data from youth and adulthood in Taiwan

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Introduction & Background

In recent years, Chronic Kidney Disease (CKD) has emerged as a major public health concern in Taiwan due to its high prevalence and impact on health care burden.According to the 2021 statistics from the National Health Insurance Administration, the prevalence of CKD in Taiwan is approximately 11.9%.Numerous studies have identified hypertension, hyperglycemia, dyslipidemia (the so-called “three highs”), obesity, smoking, and age as important risk factors for CKD. However, the degree of risk may vary by region, population group, and healthcare utilization. Thus, applying multivariable analytic methods with actual medical data can provide more precise insights into CKD risk factors and guide effective prevention strategies.

In 2025, Taiwan’s free adult health checkup program was extended to individuals aged 30 years to 39 years. This study utilizes these health checkup data to investigate risk factors of CKD, focusing on hypertension, hyperglycemia, hyperlipidemia, obesity, smoking, and age.

Statistics

This study analyzed data from the Taipei City Hospital ZhongXing Branch adult health checkup database, collected between January 1 to June 30, 2025, comprising a total of 2,454 records. CKD was defined based on eGFR and proteinuria. Participants with eGFR ≥ 90 mL/min/1.73m² and no proteinuria were classified as non-CKD, whereas those with eGFR < 90 mL/min/1.73m² or with proteinuria were classified as CKD, whereas individuals with eGFR ≥ 90 but with proteinuria were classified as CKD stage 1. CKD stages were further defined as follows: stage 2 (60 ≤ eGFR < 90), stage 3 (30 ≤ eGFR < 60), stage 4 (15 ≤ eGFR < 30), and stage 5 (eGFR < 15).

Participants were categorized into three age groups: 30–39 years (N = 252, 10.3%), 40–64 years (N = 1,865, 76.0%), and ≥65 years (N = 337, 13.7%). Waist circumference was defined as abnormal if ≥90 cm for men or ≥80 cm for women. BMI was classified as underweight (<18.5), normal (18.5–24), overweight (24–27), mild obesity (27–30), or obesity (>30). Blood pressure was categorized as SBP ≥ 130 mmHg or DBP ≥ 80 mmHg. Other cutoffs included cholesterol ≥ 200 mg/dL, triglycerides ≥ 150 mg/dL, HDL < 50 mg/dL, LDL ≥ 130 mg/dL, glucose ≥ 100 mg/dL, AST 10–39 U/L, ALT 7–42 U/L, UA ≥ 7 mg/dL (men), and UA ≥ 6 mg/dL (women). Metabolic syndrome was defined as at least three abnormal criteria among waist circumference, HDL, blood pressure, lipids, and glucose. Lifestyle factors (smoking, alcohol, betel nut, physical activity) were coded as binary variables (yes vs. no).

Table of some parts of variables

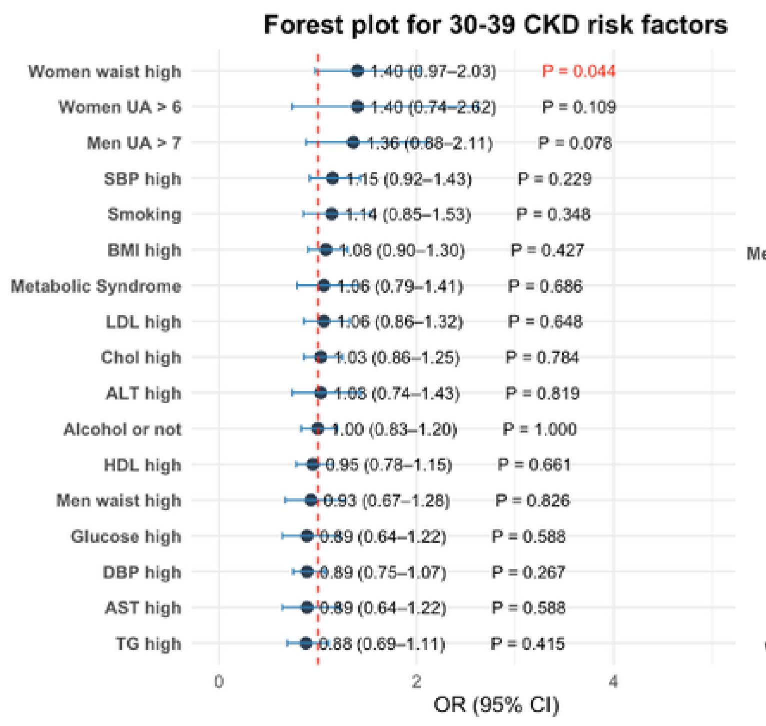
Other models and full table of variables here

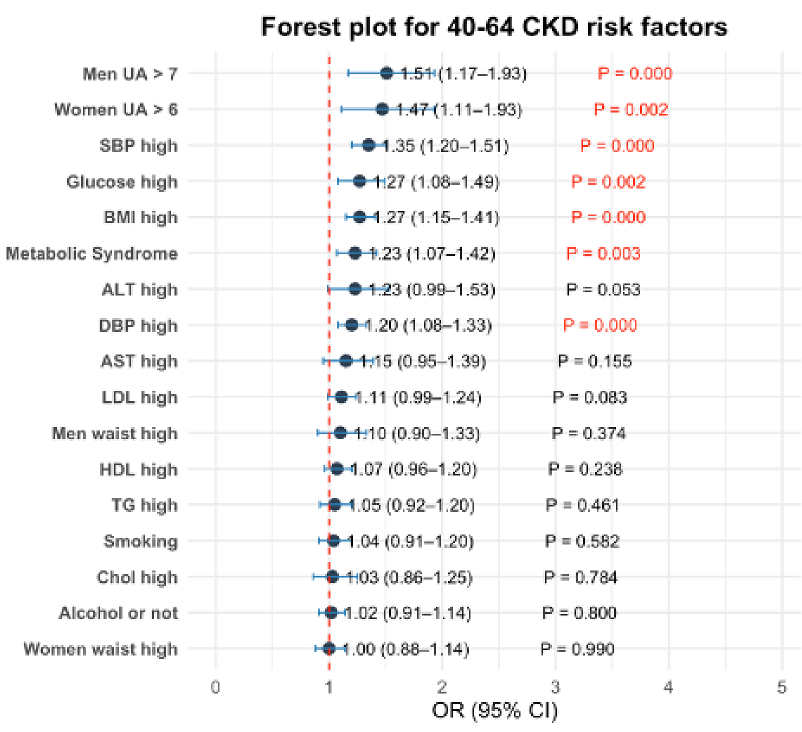
Characteristics	30-39 (N=252) N(%)	40-64 (N=1865) N(%)	65+ (N=337) N(%)	Overall (N=2454) N(%)	p-value
Glucose (100mg/dL≤)					<0.001
	15 (6.0%)	309 (16.7%)	126 (37.6%)	450 (18.1%)	
Waist of men (90cms≤)					0.3
	30 (29.0%)	292 (34.0%)	51 (39.0%)	373 (34.0%)	
Waist of women (80cms≤)					<0.001
	27 (18.0%)	260 (26.0%)	85 (41.0%)	372 (27.0%)	
Chol (Cholesterol)(≥200mg/dL)					0.01
	92 (37.0%)	868 (47.0%)	148 (44.0%)	1108 (45.0%)	
TG (Triglyceride)(≥150mg/dL)					<0.001
	30 (12.0%)	404 (22.0%)	87 (26.0%)	521 (21.0%)	
AST (>39U/L or <10U/L)					0.4
	7 (2.8%)	75 (4.0%)	10 (3.0%)	92 (3.7%)	
ALT (>42U/L or <7U/L)					<0.001
	26 (10.0%)	164 (8.8%)	10 (3.0%)	200 (8.1%)	

Method & Result

We applied logistic regression models to identify significant predictors of CKD, construct a risk prediction model, and evaluate predictive performance using odds ratios, AUC, Youden Index, sensitivity, specificity, and ROC curves.

This study first conducted stratified analyses by age and sex to calculate the crude odds ratios of each variable in relation to CKD, and the results were presented using forest plots. Furthermore, multiple logistic regression models were applied to different age groups to adjust for different confounders, and ROC curves were generated to evaluate the predictive performance of the models.





The logistic regression model was specified as follows:

$$\mathrm{logit}(P(Y=1)) = \beta_0 + \beta_1 \cdot \mathrm{AGE} + \beta_2 \cdot \mathrm{SBP} + \beta_3 \cdot \mathrm{LDL} + \beta_4 \cdot \mathrm{CHOL} + \beta_5 \cdot \mathrm{ALT}$$
$$+\beta_6 \cdot \mathrm{WAIST} + \beta_7 \cdot \mathrm{BMI} + \beta_8 \cdot \mathrm{GLUCOSE} + \beta_9 \cdot \mathrm{DBP} + \beta_{10} \cdot \mathrm{AST} + \beta_{11} \cdot \mathrm{TG}$$
$$+\beta_{12} \cdot \mathrm{ALCOHOL} + \beta_{13} \cdot \mathrm{SMOKE} + \beta_{14} \cdot \mathrm{MS\_binary}$$

Interpretation

1.Variables were selected based on established risk factors for CKD reported in prior studies and forest plots, and their availability in the health checkup database.

2.β0: Intercept, representing the baseline log-odds when all predictors are equal to 0.

3.β1 to β11: Effects of continuous variables (e.g., AGE, SBP, LDL, etc.) on the log-odds of CKD for each one-unit increase.

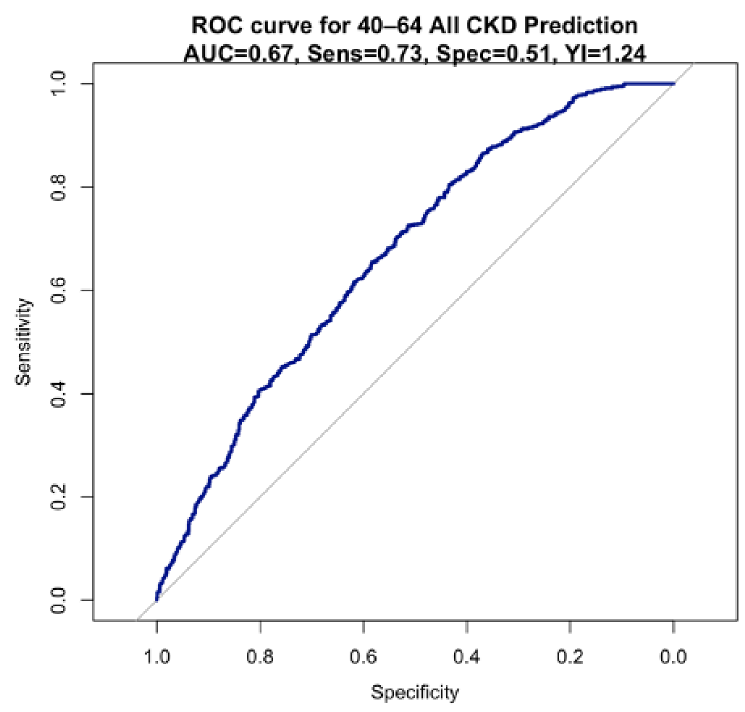
4.β12,β13,β14:Effect so binary predictors(ALCOHOL,SMOKE,MS_binary) representing the change in log-odds when the variable changes from 0 to 1. The exponentiated coefficients exp(β) correspond to odds ratios.

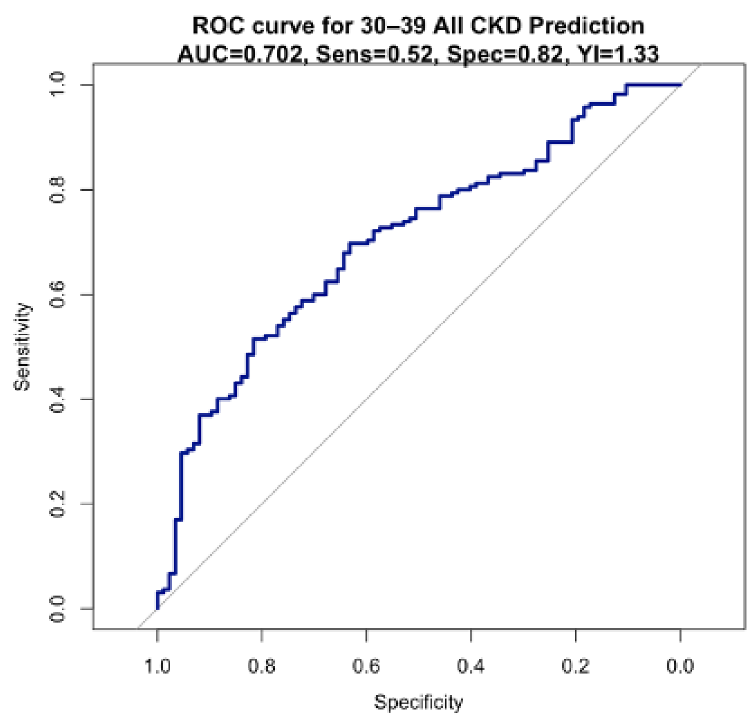
Univariate analysis:

- In the 30–39 age group (N = 252), female waist circumference ≥ 80 cm was significantly associated with CKD (OR = 1.40, 95% CI = 0.97–2.03, p = 0.044). Other factors such as men/women high uric acid, elevated SBP/DBP, obesity, smoking, metabolic syndrome, high LDL, high cholesterol, and high ALT had OR > 1 but were not statistically significant.
- In the 40–64 age group (N = 1,865), significant associations with CKD were observed for men high uric acid (OR = 1.51, 95% CI = 1.17–1.93, p < 0.001), women high uric acid (OR = 1.47, 95% CI = 1.11–1.93, p = 0.002), elevated SBP (OR = 1.35, 95% CI = 1.25–1.51, p < 0.001), elevated DBP (OR = 1.20, 95% CI = 1.08–1.33, p < 0.001), high BMI (OR = 1.27, 95% CI = 1.15–1.41, p < 0.001), metabolic syndrome (OR = 1.23, 95% CI = 1.07–1.42, p = 0.003), and high glucose (OR = 1.27, 95% CI = 1.08–1.49, p = 0.002).

Multivariate logistic regression & ROC analysis:

- In the 30–39 age group, AUC were 0.683 for men (sensitivity 55.6%, specificity 75.0%, Youden index = 1.31), 0.744 for women (sensitivity 67.6%, specificity 72.3%, Youden index = 1.40), and 0.702 overall (sensitivity 51.5%, specificity 81.6%, Youden index = 1.33), indicating moderate predictive ability. DBP was significant for females (p = 0.02) and for the overall group (p = 0.017), while SBP was borderline significant (p = 0.09).
- In the 40–64 age group, AUC were 0.691 for men (sensitivity 89.3%, specificity 39.4%), 0.682 for women (sensitivity 61.2%, specificity 64.9%), and 0.670 overall (sensitivity 72.5%, specificity 51.4%). Significant predictors included age, glucose, DBP, and TG in men; age, cholesterol, BMI, DBP, and AST in women; and age, BMI, and glucose in the overall model.





Discussion & Conclusion

1. Age, metabolic, and blood pressure factors drive CKD risk in middle-aged adults (40–64 years): Age, BMI, glucose, DBP, and TG (plus AST in women) remained significant in multivariate models, underscoring the importance of weight management, glycemic control, lipid regulation, and blood pressure management in CKD prevention.
2. Early blood pressure effects are evident in younger adults (30–39 years): DBP was significant, and SBP showed borderline significance, suggesting early vascular burden even in young adulthood. Female waist circumference was also significant.
3. Sex-specific differences: Women (40–64 years) were more sensitive to cholesterol (Chol, LDL) and DBP, and also showed AST association; men were more influenced by TG, total cholesterol, and glucose. These patterns reflect sex-specific metabolic risks.
4. Predictive ability of models: AUC for younger groups (particularly women) were higher (AUC for overall model is 0.702, for women is 0.744) compared to middle-aged adults (AUC for overall model is 0.67, for women is 0.682), though overall predictive power was moderate.
5. Public health implications: Age and sex specific strategies are needed. For middle-aged adults, metabolic management should be prioritized; for younger adults, early intervention on blood pressure and waist circumference (especially in women) may delay CKD onset.