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# Cardiovascular-Kidney-Metabolic Syndrome Among Healthcare Workers in Chinese Tertiary Hospital

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**Objective:** To determine the prevalence of Cardiovascular-Kidney-Metabolic (CKM) Syndrome and identify risk factors, including occupational factors, lifestyle factors and clinical measurements, and female-specific risk enhancers among healthcare workers in China.

**Methods:** A cross-sectional study was conducted among healthcare workers at Taizhou People's Hospital between April and May 2024. We collected data through surveys and laboratory results. Univariate and multivariate logistic regression analyses were performed to identify predictors of CKM syndrome and female-specific risk enhancers.

**Results:** A total of 1110 participants were recruited (197 male; 913 female; mean age 34.8±7.9). Almost 90% of male healthcare workers and 60% of female healthcare workers met the criteria for CKM syndrome (stage 1 or higher). Additionally, most male CKM syndrome patients were in stages 2–3 (53.81%), while most female CKM syndrome patients were in stage 1 (35.82%). Multivariate logistic regression analysis revealed that, compared to those with over 20 years of work duration, a work duration of less than 10 years was a protective factor for CKM Syndrome. Additionally, more than 8 hours of sedentary time was identified as a risk factor compared to less than 2 hours (OR = 1.376, 95% CI 1.027–1.844, $P < 0.05$). Receiver operating characteristic analysis showed that body mass index (BMI) was superior to fasting plasma glucose, glycated hemoglobin, triglycerides, and the triglyceride glucose product index in predicting CKM Syndrome, with area under the curve values of 0.884 vs 0.638, 0.708, 0.745, and 0.761, respectively ($P < 0.05$ for all). BMI was identified as an independent risk factor for female-specific risk enhancers.

**Conclusion:** CKM syndrome is prevalent among healthcare workers in Chinese tertiary hospitals, with males generally presenting at more advanced stages than females. BMI is a key predictor of CKM syndrome and female-specific risk enhancers.

**Keywords:** cardiovascular-kidney-metabolic syndrome, BMI, healthcare workers, triglyceride glucose product index

## Introduction

According to survey data, the prevalence of cardiovascular diseases (CVD) in China is 330 million, with approximately 120 million patients suffering from type 2 diabetes mellitus (T2DM), and around 120 million patients affected by chronic kidney disease (CKD).[1,2] CVD patients often have concomitant T2DM and CKD;[3,4] similarly, the presence of T2DM or CKD also leads to worse cardiovascular outcomes. Previous studies have demonstrated that the pathophysiological mechanisms of T2DM, CVD, and CKD are interrelated and mutually reinforcing.[3] Compared to patients without any of these conditions, those with T2DM or CKD have higher incidences of myocardial infarction, heart failure, and mortality, with the highest incidence rates observed in patients with both T2DM and CKD.[5] In October 2023, the American Heart



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Association issued a Presidential Advisory on cardiovascular-kidney-metabolic (CKM) syndrome, defining CKM syndrome as a systemic disease resulting from the pathophysiological interactions among obesity, diabetes, CKD, and CVD, including heart failure, atrial fibrillation, coronary artery disease, stroke, and peripheral arterial disease.[6] The advisory also highlighted that other risk factors, such as chronic inflammatory diseases and sleep disorders, increased the likelihood of CKM syndrome progression and were associated with an increased risk of CVD and CKD.[7]

Healthcare workers often work long hours under high levels of stress, coupled with prolonged periods of sitting and insufficient physical exercise, all of which are associated with an increased risk of CVD.[8,9] In a study conducted in Malaysia by Hazmi et al, it was found that 42% of the 330 selected healthcare workers had at least one medical condition, such as dyslipidemia (30.8%), hypertension (14.3%), or diabetes mellitus (10.4%).[10] In another study by Mohd Ghazali et al, it was found that the majority (68.4%) of healthcare workers had at least three CVD risk factors with hypercholesterolemia and obesity being the most common.[11] In Taiwan, a study indicated that compared to non-medical workers, medical technicians had a significantly higher prevalence of hypertension, with an odds ratio of 1.74.[12]

The prevalence of CKM in China population remained unclear. Given that healthcare workers were a high-risk group for CVD, this study aimed to determine the prevalence of CKM and identify the risk factors associated with CKM and female-specific risk enhancers among healthcare workers in tertiary hospitals in China.

# Methods

## Study Design and Population

This was a cross-sectional study involving healthcare workers in tertiary hospitals in China. Study participants were recruited at the Affiliated Taizhou People's Hospital of Nanjing Medical University between April and May 2024 and passed down to healthcare workers by the head nurses of all clinical departments. The study was approved by the Ethics Research Committee of Taizhou People's Hospital. This study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki.

## Study Questionnaires

Prior to beginning the electronic questionnaire, each participant signed an electronic informed consent form. A comprehensive study questionnaire was then administered to collect information on various aspects, including: Social and Demographic Information (Gender, education level, occupation); Lifestyle-Related Questions (Smoking status, physical activity, and alcohol consumption); Medical History Related to CKM Syndrome (Information on diabetes mellitus, hypertension, dyslipidemia, coronary artery disease, stroke, heart failure, atrial fibrillation, and CKD); Enhanced Risk Factors for CKM Syndrome (Presence of obstructive sleep apnea, chronic inflammatory conditions, mental health disorders, and female-specific risk enhancers); Work History (Duration of employment, working hours, sedentary time, and number of night shifts per month). Only participants who completed all sections of the questionnaire and provided consistent and valid responses were included in the analysis. Questionnaires with incomplete or inconsistent data were excluded. A total of 1110 valid questionnaires were received.

## Anthropometric and Biochemical Measurements

We retrieved the most recent annual health examination reports for all 1110 participants. These reports included measurements of weight, height, glycosylated hemoglobin (HbA1c), triglycerides (TG), and fasting plasma glucose (FPG). Body mass index (BMI) was calculated by dividing weight (in kilograms) by the square of height (in meters). The triglyceride glucose product (TyG) index was calculated using the formula: ln[TG (mg/dL) × FBG (mg/dL) / 2].

## Statistical Analysis

SPSS Statistics Version 25.0 (IBM SPSS Statistics, IBM Corporation, Chicago, IL, USA) and the R Programming Language (Version 4.2.0) were used to run the statistical analysis. Continuous variables were expressed as mean ± standard deviation and analyzed using *t*-tests. Categorical data were presented as frequency and percentage (%) and analyzed using chi-square tests. Based on the definition of the American Heart Association, the stages of CKM Syndrome were defined as follows: Stage 0 (No CKM risk factors); Stage 1 (Excess or dysfunctional adiposity); Stage 2 (hypertriglyceridemia, hypertension, diabetes, or metabolic syndrome, or CKD); Stage 3 (Subclinical CVD); Stage 4 (Clinical CVD). Potential predictors of CKM syndrome and female-specific risk enhancers were initially investigated using univariate logistic regression analysis, followed by multivariate analysis to identify independent predictors and their power. The predictive ability of BMI, TG, FPG, HbA1c, and TyG index for CKM syndrome were evaluated using receiver operating characteristic (ROC) curve analysis and area under the curve (AUC) values. Statistical significance was defined as a *P*-value less than 0.05.

# Results

## Characteristics of Study Population

A total of 1,110 participants were recruited, including 197 males (mean age 37.4 ± 9.3 years) and 913 females (mean age 34.3 ± 7.4 years). Most of the participants belonged to the nursing staff (N = 798, 71.89%), as shown in Table 1. These were 227 participants with a postgraduate or higher degree, and the rest have an associate or bachelor degree. Most participants worked 40–60 hours per week (N = 943, 84.95%). More than half of the participants had less than 10 years of work experience (N = 570, 51.26%), followed by those with 10–20 years (N = 355, 31.92%). Most participants did not smoke (N = 1053, 94.87%) or drink alcohol (N = 941, 84.78%), with only 1.89% smoking regularly and 2.79% drinking excessively. Most participants also did not exercise (N = 900, 81.08%). More than half of the participants had sedentary periods of less than 5 hours, while 7.48% had sedentary periods of more than 8 hours. 63.87% of the participants had less than 7 hours of sleep.

## Stages of CKM Syndrome and Risk Enhancement Factors by Gender

The CKM syndrome stages for males and females were shown in Figure 1.

Due to the limitations of our data, it was not possible to distinguish between Stage 2 and Stage 3. Therefore, these two groups were combined for analysis. There was a significant statistical difference in the distribution of CKM stages between male and female healthcare workers ($P < 0.001$). 87.82% of male and 57.39% of female healthcare workers met the criteria for CKM syndrome (stage 1 or higher). Additionally, most male CKM syndrome patients were in stages 2–3 (53.81%), while most female CKM syndrome patients were in stage 1 (35.82%).

The distribution of CKM syndrome risk enhancement factors for males and females was shown in Figure 2. The proportion of obstructive sleep apnea was significantly higher in males compared to females (5.08% vs 0.55%, $P < 0.001$), while there was no difference between the groups regarding chronic inflammatory condition (1.52% vs 1.31%, $P = 0.818$) and mental health disorders (2.03% vs 0.88%, $P = 0.155$). And 6.46% of females had female-specific enhancement factors such as premature ovarian insufficiency and polycystic ovary syndrome.

## Clinical and Biochemical Characteristics by CKM Syndrome

Participants with CKM syndrome, compared to those without CKM syndrome, were older, had a higher proportion of postgraduate degrees, a higher proportion of physicians, a greater proportion of those with more than 20 years of work experience, a higher proportion of sedentary behavior, fewer night shifts, a higher proportion of smokers, a higher proportion of drinkers, and higher levels of BMI, FPG, TG, HbA1c, and TyG index ($P < 0.05$ for all, Table 1).

## Univariate and Multivariate Analyses of Factors Associated with CKM Syndrome

The univariate logistic regression analysis of CKM Syndrome showed that male gender, being a physician, having a postgraduate or higher degree, sedentary behavior, smoking, drinking, age, BMI, TG, HbA1c, FPG and TyG index were risk factors. Shorter work duration (less than 10 years) and night shifts were protective factors ($P < 0.05$ for all, Table 2).

The multivariate logistic regression analysis of CKM Syndrome, after adjusting for age and sex, revealed several significant findings. Using work duration of more than 20 years as the control group, it was found that a work duration of less than 10 years was a protective factor (OR = 0.676, 95% CI 0.459–0.995, $P < 0.05$). When using less than 2 hours of sedentary time as the control, more than 8 hours of sedentary time was identified as a risk factor (OR = 1.376, 95% CI

**Table 1** Demographic and Clinical Characteristics of Participants

| Characteristic | All Participants (N=1110) | CKM Syndrome | | P value |
|---|---|---|---|---|
| | | With (N=697) | Without (N=413) | |
| Age, years | 34.83±7.90 | 35.97±8.50 | 32.90±6.31 | <0.001 |
| Education, % | | | | 0.004 |
| Associate or bachelor | 883 (79.55%) | 536 (76.90%) | 347 (84.02%) | |
| Postgraduate or above | 227 (20.45%) | 161 (23.10%) | 66 (15.98%) | |
| Profession, % | | | | <0.001 |
| Nursing staff | 798 (71.89%) | 464 (66.57%) | 334 (80.87%) | |
| Physicians | 312 (28.11%) | 233 (33.43%) | 49 (19.13%) | |
| Years of work experience, % | | | | <0.001 |
| <10 | 570 (51.26%) | 337 (48.35%) | 233 (56.42%) | |
| 10–20 | 355 (31.92%) | 219 (31.42%) | 136 (32.93%) | |
| >20 | 187 (16.82%) | 141 (20.23%) | 44 (10.65%) | |
| Work hours (hours/week), % | | | | 0.445 |
| <40 | 83 (7.48%) | 53 (7.60%) | 30 (7.26%) | |
| 40–60 | 943 (84.95%) | 586 (84.07%) | 357 (86.44%) | |
| >60 | 84 (7.57%) | 58 (8.32%) | 26 (6.30%) | |
| Sedentary time (hours/day), % | | | | <0.001 |
| <2 | 430 (38.74%) | 235 (33.72%) | 195 (47.22%) | |
| 2–5 | 399 (35.94%) | 267 (38.31%) | 132 (31.96%) | |
| 5–8 | 198 (17.84%) | 138 (19.80%) | 60 (14.53%) | |
| >8 | 83 (7.48%) | 57 (8.18%) | 26 (6.30%) | |
| Night shifts per month | 6.15±3.74 | 4.70±3.51 | 6.46±3.72 | <0.001 |
| Smoking, % | | | | <0.001 |
| No | 1053 (94.87%) | 646 (92.68%) | 407 (98.55%) | |
| Occasional | 36 (3.24%) | 31 (4.45%) | 5 (1.21%) | |
| Regular | 21 (1.89%) | 20 (2.87%) | 1 (0.00%) | |
| Current alcohol consumption, % | | | | <0.001 |
| No | 941 (84.78%) | 565 (81.06%) | 376 (91.04%) | |
| Moderate | 138 (12.43%) | 105 (15.06%) | 33 (7.99%) | |
| Excessive | 31 (2.79%) | 27 (3.87%) | 4 (0.97%) | |
| Physical exercise, % | | | | 0.093 |
| No | 900 (81.08%) | 553 (79.34%) | 347 (84.02%) | |
| Low intensity | 91 (8.20%) | 58 (8.32%) | 33 (7.99%) | |
| Moderate intensity | 101 (9.10%) | 71 (10.19%) | 30 (7.26%) | |
| High intensity | 18 (1.62%) | 15 (2.15%) | 3 (0.73%) | |
| Sleep duration (hours/day), % | | | | 0.215 |
| <7 | 709 (63.87%) | 458 (69.54%) | 251 (62.65%) | |
| 7–8 | 384 (35.60%) | 230 (28.94%) | 154 (35.82%) | |
| >8 | 17 (1.53%) | 9 (15.2%) | 8 (1.53%) | |
| BMI (kg/m$^2$) | 23.06±3.25 | 24.54±3.10 | 20.56±1.49 | <0.001 |
| FPG (mg/dL) | 85.51±10.84 | 87.22±12.43 | 82.53±6.26 | <0.001 |
| HbA1c (%) | 5.46±0.43 | 5.55±0.48 | 5.29±0.22 | <0.001 |
| TG (mg/dL) | 109.76±90.83 | 130.18±107.37 | 74.05±22.92 | <0.001 |
| TyG index | 8.28±0.55 | 8.46±0.57 | 7.97±0.33 | <0.001 |

**Abbreviations**: CKM, cardiovascular-kidney-metabolic; BMI, body mass index; TG, triglycerides; FPG, fasting plasma glucose; TyG, triglyceride glucose product Index.

1.027–1.844, $P < 0.05$). Smoking and drinking were also determined to be risk factors, with the risks increasing for regular smoking and excessive drinking. Additionally, BMI, TG, HbA1c, and TyG index were identified as risk factors ($P < 0.05$ for all, Table 2).

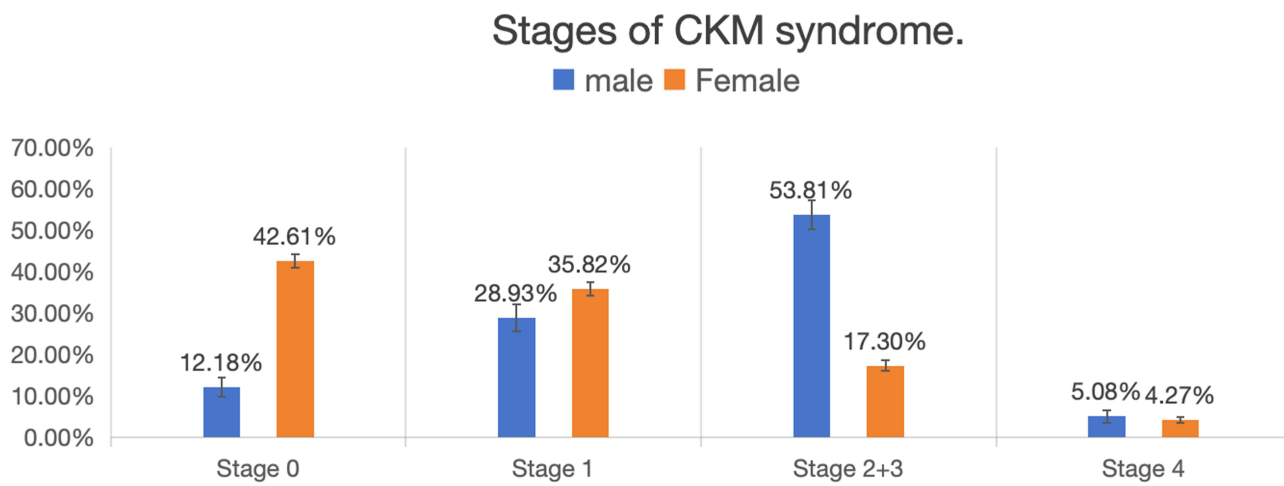


**Figure 1** Distribution of CKM Syndrome Stages by Gender Among Healthcare Workers.

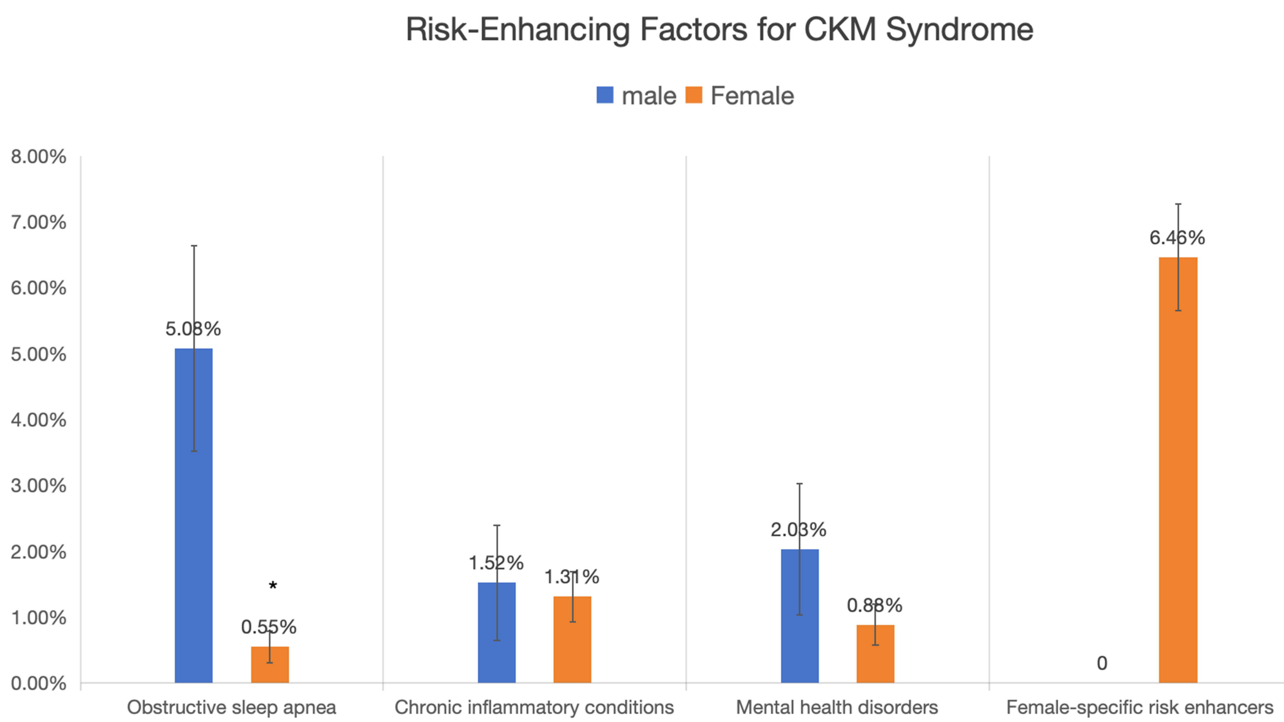


**Figure 2** Risk-Enhancing Factors for CKM Syndrome by Gender.
**Note:** *$P$<0.001.

## ROC Analyses of BMI, TG, HbA1c, FPG, and TyG Index

The results of the ROC analysis of BMI, TG, HbA1c, FPG, and TyG index were summarized in Table 3 and Figure 3. According to the results, the BMI outperformed the FPG, HbA1c, TG, and the TyG index in predicting CKM Syndrome [0.884 (0.864, 0.904) vs 0.638 (0.604,0.672) vs 0.708 (0.677, 0.739) vs 0.745 (0.715, 0.774) vs.0.761 (0.733, 0.790); $P < 0.05$ for all DeLong's test]. The cutoff values for BMI for predicting CKM Syndrome were 22.88 kg/m$^2$.

**Table 2** Univariate and Multivariate Analyses of Factors Associated with CKM Syndrome

| Parameters | OR (95% CI) | |
|---|---|---|
| | Univariate Analysis | Multivariate Analysis |
| Gender | 4.305 (2.714, 6.830)* | — |
| Age | 1.071 (1.047, 1.095)* | — |
| Years of work experience | | |
| >20 | ref | ref |
| 10–20 | 0.406 (0.243, 0.679)* | 0.498 (0.232, 1.067) |
| <10 | 0.310 (0.190, 0.505)* | 0.676 (0.459, 0.995)# |
| Education | 1.693 (1.124, 2.550)# | 1.180 (0.820, 1.698) |
| Profession | 2.523 (1.704, 3.736)* | 1.171 (0.817, 1.679) |
| Sedentary time (hours/day) | | |
| <2 | ref | ref |
| 2–5 | 1.655 (1.102, 2.486)# | 1.108 (0.751, 1.635) |
| 5–8 | 2.040 (1.040, 4.002)* | 1.237 (0.728, 2.100) |
| >8 | 2.349 (1.418, 3.889)* | 1.376 (1.027, 1.844)# |
| Night shifts per month | 0.908 (0.865, 0.952)* | 0.990 (0.952, 1.030) |
| Smoking | | |
| No | ref | ref |
| Occasional | 4.320 (1.649, 11.317)* | 1.446 (1.016, 3.678)# |
| Regular | 5.330 (1.810, 15.696)* | 2.382 (1.300, 10.933)# |
| Current alcohol consumption | | |
| No | ref | |
| Moderate | 2.658 (1.590, 4.442)* | 1.222 (1.013,1.916)# |
| Excessive | 5.422 (1.988, 14.787)* | 1.603 (1.154,4.995)# |
| BMI (kg/m2) | 1.399 (1.312, 1.491)* | 2.336 (2.097, 2.602)* |
| FPG (mg/dl) | 1.040 (1.022, 1.058)* | 1.055 (1.035, 1.074)* |
| HbA1c (%) | 5.811 (3.453, 9.779)* | 10.290 (6.098, 17.363)* |
| TG (mg/dl) | 1.017 (1.013, 1.020)* | 1.025 (1.020, 1.030)# |
| TyG index | 10.349 (7.172, 14.934)* | 8.585 (5.883, 12.527)* |

**Note**: *<0.01, #<0.05.
**Abbreviations**: CKM, cardiovascular-kidney-metabolic; BMI, body mass index; TG, triglycerides; FPG, fasting plasma glucose; TyG, triglyceride glucose product Index.

**Table 3** ROC Curve Analyses of Risk Factors for CKM Syndrome

| Parameters | AUC (95% CI) | *P* value | Optimal Cutoff | Sensitivity | Specificity | Youden's Index |
|---|---|---|---|---|---|---|
| BMI (kg/m2) | 0.884 (0.864, 0.904) | <0.001 | 22.88 | 0.723 | 0.992 | 0.715 |
| FPG (mg/dl) | 0.638 (0.604,0.672) | <0.001 | 83.79 | 0.627 | 0.592 | 0.219 |
| HbA1c (%) | 0.708 (0.677, 0.739) | <0.001 | 5.65 | 0.367 | 1.000 | 0.367 |
| TG (mg/dl) | 0.745 (0.715, 0.774) | <0.001 | 105.85 | 0.487 | 0.905 | 0.392 |
| TyG index | 0.761 (0.733, 0.790) | <0.001 | 8.42 | 0.495 | 0.913 | 0.408 |

**Abbreviations**: CKM, cardiovascular-kidney-metabolic; BMI, body mass index; TG, triglycerides; FPG, fasting plasma glucose; TyG, triglyceride glucose product Index.

## Clinical and Biochemical Characteristics by Female-Specific Risk Enhancers

Participants with female-specific risk enhancers, compared to those without female-specific risk enhancers were found to have a lack of physical exercise, and higher levels of BMI, TG, and TyG index ($P < 0.05$ for all, Table 4).

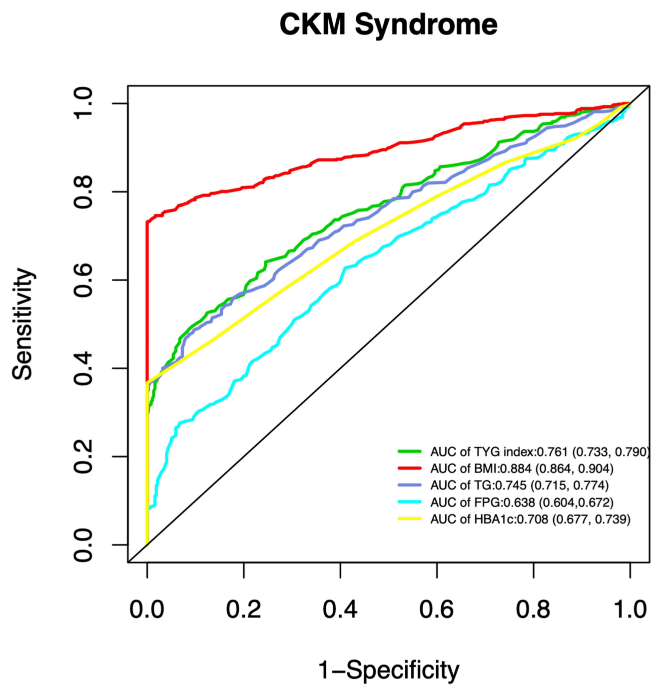


**Figure 3** ROC Curve Analysis of BMI, FPG, HbA1c, TG, and TyG Index for CKM Syndrome Prediction.
**Abbreviations**: CKM, cardiovascular-kidney-metabolic; BMI, body mass index; TG, triglycerides; FPG, fasting plasma glucose; TyG, triglyceride glucose product Index.

## Univariate and Multivariate Analyses of Factors Associated with Female-Specific Risk Enhancers

The univariate logistic regression analysis of female-specific risk enhancers showed that BMI, TG, and TyG index were risk factors ($P < 0.05$ for all, Table 5). Employing the statistical method of multivariate logistic regression analysis,

**Table 4** Demographic and Clinical Characteristics of Participants According to Female-Specific Risk Enhancers

| Characteristic | All Participants (N=913) | Female-Specific Risk Enhancers | | P value |
|---|---|---|---|---|
| | | With (N=59) | Without (N=854) | |
| Age, years | 34.27±7.43 | 34.95±6.82 | 34.22±7.47 | 0.466 |
| Education, % | | | | 0.687 |
| Associate or Undergraduate | 798 (87.4%) | 53 (89.83%) | 745 (87.24%) | |
| Postgraduate or above | 115 (12.6%) | 6(10.17%) | 109 (12.76%) | |
| Profession, % | | | | 0.539 |
| Nursing staff | 770 (84.34%) | 52 (88.14%) | 718 (84.08%) | |
| Physicians | 143 (15.66%) | 7 (11.86%) | 136 (15.92%) | |
| Years of work experience, % | | | | 0.729 |
| <10 | 465 (50.93%) | 27 (45.76%) | 438 (51.29%) | |
| 10–20 | 309 (33.84%) | 22 (37.29%) | 287 (33.61%) | |
| >20 | 139 (15.23%) | 10 (16.95%) | 129 (15.10%) | |
| Work hours (hours/week), % | | | | 0.704 |
| <40 | 75 (8.22%) | 5 (8.47%) | 70 (8.20%) | |
| 40–60 | 798 (87.40%) | 50 (84.75%) | 748 (87.59%) | |
| >60 | 40 (4.38%) | 4 (6.78%) | 36 (4.21%) | |

(*Continued*)

**Table 4** (Continued).

| Characteristic | All Participants (N=913) | Female-Specific Risk Enhancers | | P value |
|---|---|---|---|---|
| | | With (N=59) | Without (N=854) | |
| Sedentary time (hours/day), % | | | | 0.034 |
| <2 | 404 (44.25%) | 24 (40.68%) | 380 (44.50%) | |
| 2–5 | 322 (35.27%) | 27 (45.76%) | 295 (34.54%) | |
| 5–8 | 129 (14.13%) | 2 (3.39%) | 127 (14.87%) | |
| >8 | 58 (6.35%) | 6 (10.17%) | 52 (6.09%) | |
| Night shifts per month | 6.46±3.72 | 6.99±3.41 | 6.43±3.74 | 0.259 |
| Smoking, % | | | | 0.556 |
| No | 908 (99.45%) | 59 (100%) | 849 (99.41%) | |
| Occasional | 5 (0.55%) | 0 (0.00%) | 5 (0.59%) | |
| Regular | 0 (0.00%) | 0 (0.00%) | 0 (0.00%) | |
| Current alcohol consumption, % | | | | 0.770 |
| No | 833 (91.24%) | 780 (91.33%) | 53 (89.83%) | |
| Moderate | 72 (7.88%) | 67 (7.85%) | 5 (8.48%) | |
| Excessive | 8 (0.88%) | 7 (0.82%) | 1 (1.69%) | |
| Physical exercise, % | | | | 0.006 |
| No | 764 (83.68%) | 59 (100%) | 705 (82.55%) | |
| Low intensity | 69 (7.56%) | 0 (0.00%) | 69 (8.08%) | |
| Moderate intensity | 71 (7.78%) | 0 (0.00%) | 71 (8.32%) | |
| High intensity | 9 (0.98%) | 0 (0.00%) | 9 (1.05%) | |
| Sleep duration (hours/ady), % | | | | 0.356 |
| <7 | 572 (62.65%) | 41 (69.49%) | 531 (62.18%) | |
| 7–8 | 327 (35.82%) | 18 (30.51%) | 309 (36.18%) | |
| >8 | 14 (1.53%) | 0 (0.00%) | 14 (1.64%) | |
| BMI (kg/m2) | 22.59±3.05 | 23.86±3.46 | 22.50±3.00 | 0.001 |
| FPG (mg/dl) | 84.99±10.80 | 85.74±8.82 | 84.93±10.93 | 0.505 |
| HbA1c (%) | 5.43±0.43 | 5.49±0.29 | 5.43±0.43 | 0.143 |
| TG (mg/dl) | 97.99±67.43 | 119.67±86.55 | 96.47±65.69 | 0.010 |
| TyG index | 8.20±0.50 | 8.36±0.58 | 8.19±0.49 | 0.011 |

**Abbreviations**: CKM, cardiovascular-kidney-metabolic; BMI, body mass index; TG, triglycerides; FPG, fasting plasma glucose; TyG, triglyceride glucose product Index.

**Table 5** Univariate and Multivariate Analyses of Factors Associated with Female-Specific Risk Enhancers

| Parameters | OR (95% CI) | |
|---|---|---|
| | Univariate Analysis | Multivariate Analysis |
| BMI ($kg/m^2$) | 1.131 (1.050, 1.217)* | 1.112 (1.025, 1.207)# |
| TG (mg/dl) | 1.003 (1.000, 1.006)# | 1.001 (0.996, 1.006) |
| TyG index | 1.879 (1.150, 3.071)# | 1.321 (0.527, 3.313) |

**Note**: *<0.01, #<0.05.
**Abbreviations**: BMI, body mass index; TG, triglycerides; TyG, triglyceride glucose product Index.

which included TG, and TyG index, the result revealed that BMI (OR = 1.112, 95% CI 1.025–1.207), $P < 0.05$) was identified as risk factors for female-specific risk enhancers.

## Discussion

Cardiovascular, kidney, and metabolic diseases are interconnected in their pathophysiology.[6] Between 2015 and 2020, over 25% of adults in the US were affected by these conditions,[13] which were the leading causes of death in 2021.[14] In 2023, the American Heart Association introduced a new staging framework called CKM syndrome. This framework aims to improve multidisciplinary approaches to the prevention, risk stratification, and management of CKM diseases. Few studies have evaluated CKM syndrome stages. We found that almost 90% of male healthcare workers and 60% of female healthcare workers met the criteria for CKM syndrome (stage 1 or higher) in Chinese Tertiary Hospital. Additionally, most male CKM syndrome patients were in stages 2–3 (53.81%), while most female CKM syndrome patients were in stage 1 (35.82%).

In a recent study, it was reported that 92.1% of male adults in the United States met the criteria for CKM syndrome (stage 1 or higher), with 56.8% in stages 2–3,[15] which was consistent with our findings. However, considering that the obesity rate in the US was significantly higher than that in China,[16] it suggested that the prevalence of CKM syndrome might also be higher in the US compared to China. This highlights the need for increased attention to CKM syndrome among male healthcare workers in China. This study showed that the prevalence of CKM syndrome among women (57.39%) was significantly lower than the data reported by Aggarwal R et al (86.9%). A possible explanation for this discrepancy is that our population consisted of women of reproductive age (mean age 34.3 years), whereas the study by Aggarwal R et al involved perimenopausal women (mean age 47.3 years). Previous research has clearly established that estrogen has protective effects against cardiovascular,[17] kidney,[18] and metabolic-related diseases.[19] Aggarwal R et al also reported that, compared with women, men were more likely to have advanced stages of CKM syndrome.[15] This study indicated that the prevalence of CKM syndrome was lower in women than in men, and that CKM stages in women were primarily concentrated in stage 1. In addition, the higher risk of CKM syndrome among males in our study might also be partially explained by the fact that the mean age of males (37.4 years) was slightly higher than that of females (34.3 years).

This study analyzed the risk factors for CKM syndrome. In addition to gender, age, smoking, and alcohol consumption, prolonged sitting for more than 8 hours was identified as a risk factor. Previous studies have confirmed that long-term sedentary behavior increases the risk of CVD,[20,21] diabetes,[21] and obesity.[22] This study also found that a shorter work duration (less than 10 years) among healthcare workers was a protective factor against CKM syndrome. A shorter career means less exposure to occupational risk factors such as job strain,[20] and long-term night shift work,[23] resulting in a lower risk of developing CKM syndrome. This study revealed that nearly 90% of healthcare workers worked 40–60 hours per week. Previous research has shown that compared with standard hours (35–40 hours per week), working long hours was associated with an increased risk of incident coronary heart disease and incident stroke.[24] This study indicated that night shift work was a protective factor for CKM syndrome; however, after adjusting for age and gender, this effect was not significant. This could be because this study only investigated the number of night shifts in the past month and did not account for long-term night shift work. This study also compared the predictive value of various indicators for CKM syndrome and found that BMI was the most effective predictor.

This study also analyzed the prevalence of risk-enhancing factors for CKM syndrome among healthcare workers. It was found that the prevalence of obstructive sleep apnea was significantly higher in men compared to women, with male prevalence exceeding the general population rate by 1%-4%. Further investigation into female-specific risk enhancers revealed that all 59 female healthcare workers with these risk factors reported never engaging in physical exercise. The study identified BMI, TG, and TyG index as risk factors for female-specific risk enhancers, with BMI being an independent predictor. Previous studies have also reported that high BMI has a significant impact on premature ovarian insufficiency[25] and polycystic ovary syndrome,[26] while exercise or weight loss have been shown to have significant positive effects on both premature ovarian insufficiency and polycystic ovary syndrome.[27]

This study has several limitations. Firstly, the assessments of established CVD, risk-enhancing factors for CKM syndrome were based on self-report, which may introduce potential for misdiagnosis or incomplete diagnosis. Secondly, some data essential for defining advanced stages of CKM syndrome—such as cardiac biomarkers, echocardiography, coronary angiography, cardiac computed tomography, atrial fibrillation, and peripheral artery disease—were unavailable.


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This lack of data may lead to an underestimation of stages 3 and 4. Lastly, this study's cross-sectional design limited the ability to predict CKM and female-specific risk enhancers, as it provides only a snapshot of data at a single point in time.

## Conclusion

Poor CKM health is widespread among healthcare workers in Chinese tertiary hospitals, particularly among male healthcare workers. There is an urgent need for equitable healthcare approaches that prioritize CKM health.

## Data Sharing Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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The authors declare that there is no conflict of interests regarding the publication of this paper.

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