Age- and Sex-Specific Cutoffs for Obesity-Related Indices to Improve Early Detection of Metabolic Syndrome Risk in Taiwanese Adults

Chien-Yeh Hsu[1, 2], PhD & **Jia-Wen Guo**[3], PhD, RN

[1]Department of Information Management, National Taipei University of Nursing and Health Sciences, Taipei, Taiwan
[2]Master Program in Global Health and Health Security, College of Public Health, Taipei Medical University, Taipei, Taiwan
[3]College of Nursing, University of Utah, Salt Lake City, Utah, USA

Key Finding:

- **CVAI showed highest predictive accuracy for metabolic syndrome (MetS) risk in Taiwanese adults, outperforming BMI and TyG Index.**
- **The optimal age- and sex-specific cut-off values for BMI, TyG index, and CVAI in predicting MetS among Taiwanese adults fall below the currently used clinical thresholds for identifying individuals at risk of metabolic syndrome.**

Introduction

- Metabolic syndrome (MetS) is a significant global health concern in Taiwan.
- Obesity is a major driver of MetS.
- Considering both age and sex is crucial because optimal cut-off values for BMI, TyG Index, and CVAI vary across populations and affect accurate assessment of metabolic syndrome (MetS) risk
- **Purpose of the study:** To determine age- and sex-specific optimal cutoff values for BMI, TyG index, and CVAI to predict metabolic syndrome (MetS) across five age groups (≤29, 30–39, 40–49, 50–59, and ≥60) in both females and males.

Methods

- Study design:
  - Retrospective, cross-sectional study.
- Data/Cohort:
  - Data from Mei Jau (MJ) Health Centers in Taiwan (2008 baseline, 2009–2013 follow-up) were used to identify the onset of MetS.
  - Eligibility criteria:
    - Adults aged 18 and above
    - No MetS at baseline
    - Attended health assessments between 2008 and 2013
    - Complete data on: Age and sex, lifestyle factors (exercise, drinking, smoking), metabolic measures: fasting glucose, SBP, DBP, triglycerides, HDL-C, waist circumference, BMI
    - Final sample size: 30,382 participants
- The area under the receiver operating characteristic curve (AUC) and the cutpointr R package were used to evaluate how well these cutoffs distinguish individuals who develop MetS from those who do not.

Results

- Of 30,382 participants, 76% were female (n = 23,057), with an average age of 40.9 and mean BMI of 22 at baseline.
- Females had significantly lower BMI, TyG Index, and CVAI than males ($p < .001$).
- Over 5 years, 8.5% (n = 2,584) developed MetS:
  - 8% of females, mostly between ages 40–50
  - 12% of males, mostly between ages 30–40
- BMI cutoffs:
  - Females: 22.3–24.1 (Table 1)
  - Males: 23.5–25.1 (Table 2)
- TyG Index cutoffs:
  - Females: 4.5–4.7 (Table 1)
  - Males: 4.6–4.8 (Table 2)
- CVAI cutoffs:
  - Females: 10.7–86.5 (Table 1)
  - Males: 60.4–97.9 (Table 2)

Table 1. Optimal Cutoff Values for BMI, TyG Index, and CVAI Across Age Groups in Females (n=23,057)

	Age Group	Cutoff	Interpretation	AUC	Specificity	Sensitivity
BMI		(kg/m²)	BMI cutoff			
	≤ 29	24.1	Underweight: <18.5	0.88	0.91	0.72
	30–39	22.3	Normal: 18.5 to 22.9	0.87	0.75	0.83
	40–49	22.7	Overweight: 23.0 to 24.9	0.79	0.72	0.72
	50–59	23.2	Obese: >25.0	0.75	0.69	0.69
	≥ 60	23.2		0.72	0.64	0.67
	All	22.4		0.82	0.70	0.79
TyG index			TyG index cutoff			
	≤ 29	4.5	>4.7: ↑ Prevalence of	0.86	0.80	0.78
	30–39	4.5	metabolic syndrome,	0.82	0.70	0.81
	40–49	4.6	insulin resistance, and	0.78	0.75	0.69
	50–59	4.7	other metabolic issues	0.73	0.77	0.58
	≥ 60	4.6		0.68	0.58	0.71
	All	4.6		0.80	0.77	0.69
CVAI			CVAI cutoff			
	≤ 29	10.7	>99.15 as a general	0.94	0.85	0.94
	30–39	33.9	benchmark for	0.91	0.84	0.85
	40–49	49.3	identifying metabolic	0.86	0.78	0.79
	50–59	69.0	syndrome in Chinese	0.82	0.73	0.78
	≥ 60	86.5	adults	0.77	0.64	0.78
	All	49.4		0.88	0.76	0.85

Table 2. Optimal Cutoff Values for BMI, TyG Index, and CVAI Across Age Groups in Male(n=7,325)

	Age Group	Cutoff	Interpretation	AUC	Specificity	Sensitivity
BMI			BMI cutoff			
	≤ 29	25.1	Underweight: <18.5	0.84	0.81	0.78
	30–39	24.4	Normal: 18.5 to 22.9	0.74	0.67	0.71
	40–49	24.4	Overweight: 23.0 to 24.9	0.71	0.67	0.64
	50–59	24.4	Obese: >25.0	0.67	0.66	0.57
	≥ 60	23.5		0.64	0.61	0.67
	All	24.4		0.74	0.69	0.67
TyG index			TyG index cutoff			
	≤ 29	4.6	>4.7: ↑ Prevalence of	0.73	0.70	0.66
	30–39	4.7	metabolic syndrome,	0.73	0.66	0.71
	40–49	4.7	insulin resistance, and	0.74	0.57	0.77
	50–59	4.8	other metabolic issues	0.71	0.77	0.60
	≥ 60	4.7		0.72	0.70	0.67
	All	4.7		0.74	0.66	0.71
CVAI			CVAI cutoff			
	≤ 29	60.4	>99.15 as a general	0.86	0.78	0.78
	30–39	65.7	benchmark for identifying	0.79	0.65	0.78
	40–49	77.8	metabolic syndrome in	0.77	0.69	0.72
	50–59	84.6	Chinese adults	0.74	0.68	0.70
	≥ 60	97.9		0.71	0.76	0.67
	All	77.5		0.79	0.76	0.68

Conclusions

- Age- and sex-specific assessments are important, as females tend to have lower obesity index values than males.
- Recommended screening ages:
  - Females: 40–50 years
  - Males: 30–40 years
- Cutoff values for BMI, TyG index, and CVAI were lower than those in previous studies, likely because the study population was free of MetS at baseline.
- Findings support the importance of early detection and intervention for MetS in Taiwan.
- Future research should:
  - Validate these cutoffs in other Asian populations.
  - Apply them in preventive health strategies.

National Taipei University of Nursing and Health Sciences
國立臺北護理健康大學
Department of Information Management

HEALTH
UNIVERSITY OF UTAH
College of Nursing

Contact:
cyhsu187@gmail.com
Jia-Wen.Guo@nurs.utah.edu