

## ORIGINAL ARTICLE

# Association of Platelet-to-HDL Cholesterol Ratio with Metabolic Syndrome in a Japanese Health Check-up Population

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### SUMMARY

**Background:** The platelet-to-high-density lipoprotein cholesterol (HDL-C) ratio (PHR) has been proposed as a composite biomarker reflecting both thrombogenic and lipid-related mechanisms. However, its relationship with metabolic syndrome (MetS) has not been extensively evaluated in the general Japanese population.

**Methods:** We conducted a cross-sectional analysis of 17,581 adults (7,400 women) who underwent health check-ups between 2007 and 2024. PHR was calculated as the platelet count divided by HDL-C. MetS was defined according to the Japanese criteria. The association between PHR and MetS and its components was assessed using multivariable linear and logistic regression. Receiver operating characteristic (ROC) analysis was used to evaluate the discriminatory ability of PHR compared to other simple markers.

**Results:** PHR was significantly higher in participants with MetS ( $p < 0.001$ ) and correlated with key components, including waist circumference, triglycerides (TG), and fasting plasma glucose. In multivariable logistic regression, PHR was independently associated with MetS in both sexes. The area under the curve (AUC) for PHR was 0.687 (95% confidence interval [CI]: 0.674 - 0.700) in men and 0.724 (95% CI: 0.700 - 0.748) in women. These values were modestly lower than those for TG and TG/HDL-C, but PHR showed utility as a non-redundant marker.

**Conclusions:** PHR is independently associated with MetS and its components in the Japanese population. Although its discriminatory performance is modest, PHR may serve as a supplementary marker in health check-up settings for identifying individuals at risk of metabolic disorders.

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## Supplementary Data

Table S1. Age-adjusted means and 95% confidence intervals of clinical parameters by MetS status and gender, with p-values from ANCOVA.

Variable	Men			Women		
	MetS (-)	MetS (+)	p	MetS (-)	MetS (+)	p
BMI (kg/m <sup>2</sup> )	22.5 [22.4 - 22.5]	27.6 [27.4 - 27.7]	< 0.0001	21.6 [21.6 - 21.7]	29.1 [28.7 - 29.5]	< 0.0001
Waist circumference (cm)	79.9 [79.8 - 80.1]	94.6 [94.3 - 94.9]	< 0.0001	77.3 [77.1 - 77.5]	98.1 [97.4 - 98.8]	< 0.0001
Systolic BP (mmHg)	119.0 [118.8 - 119.3]	132.9 [132.2 - 133.6]	< 0.0001	116.4 [116.0 - 116.8]	136.6 [134.9 - 138.3]	< 0.0001
Diastolic BP (mmHg)	75.0 [74.8 - 75.2]	84.8 [84.3 - 85.3]	< 0.0001	71.7 [71.4 - 72.0]	82.7 [81.5 - 83.8]	< 0.0001
FPG (mmol/L)	5.35 [5.34 - 5.36]	6.19 [6.14 - 6.25]	< 0.0001	5.19 [5.17 - 5.20]	6.26 [6.12 - 6.39]	< 0.0001
FIRI (μIU/mL)	5.61 [5.52 - 5.69]	11.60 [10.97 - 12.23]	< 0.0001	5.46 [5.34 - 5.57]	12.00 [11.06 - 12.94]	< 0.0001
HOMA-IR	1.38 [1.35 - 1.41]	3.35 [3.11 - 3.60]	< 0.0001	1.31 [1.27 - 1.35]	3.46 [3.08 - 3.84]	< 0.0001
HbA1c (mmol/mol)	36.83 [36.72 - 37.05]	41.75 [41.31 - 42.07]	< 0.0001	36.83 [36.72 - 37.05]	42.62 [42.19 - 43.17]	< 0.0001
TG (mmol/L)	1.17 [1.15 - 1.19]	2.24 [2.18 - 2.30]	< 0.0001	0.91 [0.90 - 0.93]	1.51 [1.46 - 1.56]	< 0.0001
HDL-C (mmol/L)	1.59 [1.58 - 1.60]	1.28 [1.27 - 1.30]	< 0.0001	1.93 [1.91 - 1.94]	1.54 [1.50 - 1.58]	< 0.0001
LDL-C (mmol/L)	3.20 [3.18 - 3.22]	3.26 [3.23 - 3.30]	0.0012	3.16 [3.13 - 3.18]	3.33 [3.25 - 3.40]	< 0.0001
non-HDL-C (mmol/L)	3.60 [3.58 - 3.62]	3.99 [3.95 - 4.04]	< 0.0001	3.47 [3.45 - 3.50]	3.87 [3.79 - 3.95]	< 0.0001
AST (U/L)	23.08 [22.86 - 23.29]	28.07 [27.43 - 28.71]	< 0.0001	20.38 [20.21 - 20.55]	24.77 [24.12 - 25.42]	< 0.0001
ALT (U/L)	24.90 [24.55 - 25.26]	37.27 [36.06 - 38.48]	< 0.0001	17.20 [16.93 - 17.47]	29.83 [28.78 - 30.89]	< 0.0001
GGT (U/L)	38.92 [38.09 - 39.75]	61.70 [58.77 - 64.62]	< 0.0001	22.04 [21.54 - 22.54]	37.81 [35.88 - 39.75]	< 0.0001
UA (μmol/L)	358.1 [356.3 - 359.3]	381.9 [378.9 - 385.4]	< 0.0001	266.5 [264.7 - 268.3]	315.2 [309.9 - 320.6]	< 0.0001
RBC (10 <sup>6</sup> /mL)	4.84 [4.83 - 4.85]	4.95 [4.93 - 4.96]	< 0.0001	4.41 [4.41 - 4.42]	4.63 [4.60 - 4.67]	< 0.0001
Hb (g/L)	148.5 [148.3 - 148.8]	151.2 [150.7 - 151.7]	< 0.0001	130.6 [130.3 - 130.9]	136.8 [135.8 - 137.9]	< 0.0001
Ht (L/L)	0.442 [0.442 - 0.443]	0.449 [0.448 - 0.450]	< 0.0001	0.398 [0.397 - 0.399]	0.413 [0.411 - 0.416]	< 0.0001
WBC (10 <sup>3</sup> /mL)	5.34 [5.31 - 5.37]	6.07 [6.00 - 6.14]	< 0.0001	5.05 [5.01 - 5.08]	6.08 [5.93 - 6.23]	< 0.0001
PLT (10 <sup>4</sup> /mL)	23.20 [23.08 - 23.31]	23.61 [23.37 - 23.86]	< 0.0001	24.73 [24.60 - 24.87]	26.53 [26.00 - 27.07]	< 0.0001
PHR	155.31 [154.15 - 156.48]	194.77 [191.71 - 197.83]	< 0.0001	136.27 [135.07 - 137.46]	180.54 [175.91 - 185.17]	< 0.0001
hsCRP (mg/L)	1.08 [0.99 - 1.17]	1.52 [1.35 - 1.69]	0.0001	0.86 [0.78 - 0.95]	2.36 [2.03 - 2.69]	< 0.0001
No. of MetS	1.04 [1.02 - 1.06]	3.87 [3.84 - 3.90]	< 0.0001	0.73 [0.71 - 0.75]	3.67 [3.59 - 3.74]	< 0.0001

Variables are expressed as means and 95% confidence intervals. MetS metabolic syndrome, BMI body mass index, BP blood pressure, FPG fasting plasma glucose, FIRI fasting immunoreactive insulin, HOMA-IR homeostasis model assessment of insulin resistance, TG triglyceride, HDL-C high-density lipoprotein cholesterol, LDL-C low-density lipoprotein cholesterol, non-HDL-C non high-density lipoprotein cholesterol, AST aspartate transaminase, ALT alanine aminotransferase, GGT  $\gamma$ -glutamyl transpeptidase, UA uric acid, RBC red blood cell, Hb hemoglobin, Ht hematocrit, WBC white blood cell, PLT platelet, PHR platelet to HDL-C ratio, hsCRP high-sensitivity C-reactive protein.

**Table S2. ROC analysis comparing PHR with other commonly used MetS-related markers.**

	Men				Women			
	AUC (95% CI)	Cutoff	Sensitivity (%)	Specificity (%)	AUC (95% CI)	Cutoff	Sensitivity (%)	Specificity (%)
PHR	0.687 (0.675 - 0.700)	155.4	71.7	56.1	0.724 (0.700 - 0.748)	153.0	63.7	70.3
WC	0.876 (0.870 - 0.882)	85.0	100.0	68.8	0.975 (0.972 - 0.978)	90.0	100.0	93.9
TG	0.831 (0.820 - 0.841)	148.0	63.9	86.9	0.803 (0.783 - 0.824)	95.0	70.2	74.4
TG/HDL-C	0.837 (0.827 - 0.848)	2.4	75.9	78.8	0.820 (0.799 - 0.839)	1.3	77.5	71.5

ROC receiver operating characteristic curve, PHR platelet-to-high-density lipoprotein cholesterol ratio, WC waist circumference, TG triglycerides, HDL-C high-density lipoprotein cholesterol, AUC area under the curve, CI confidence interval.