Cylinder to Weight Ratio: New Anthropometric Index for Cardiovascular Risk Factors

정성진, 고은실, 김성준, 윤혜은, 박철휘, 장윤식, 신석준

가톨릭대학교 의과대학 내과학교실 신장내과

Introduction

Anthropometric indices for obesity

- Various anthropometric indices are associated with cardiovascular risk factors, such as type 2 diabetes, hypertension, dyslipidemia, and cardiovascular diseases.
  - Body mass index (BMI)
  - Waist to hip ratio (WHR)
  - Waist circumference (WC)
  - Waist to height ratio (WHtR)
- Reasons for choosing anthropometric indices
  - Easily obtained without expensive or complex instruments
  - Conveniently self-measurable
  - Frequently used in many previous epidemiological studies

Public Health Nutr 2009;12:1061-1071

Circ J 2009;73:1643-1650

Body Mass Index (BMI)

- The most commonly applied clinical measure to characterize obesity in individuals
  - Adolphe Quetelet first proposed the index in 1871
  - Keys et al. selected the BMI as the best measure of body fatness
  - Highly correlated with overall obesity
- Limitation
  - Relatively poorly with visceral obesity (central obesity, android-type obesity or abdominal adiposity)
  - At the same BMI, the relative composition of fat mass vs lean body mass depends on age, sex and ethnicity

Public Health Nutr 2009;12:1061-1071

Waist to Height Ratio (WHtR)

- Indices of abdominal obesity (WHtR and WC) have increasingly been associated with higher cardiometabolic risk
- WHtR
  - It was first proposed in the mid-1990
  - In recent reports, WHtR to be significantly better than WC for diabetes, hypertension, CVD and all outcomes in men and women

Obes Rev 2012;13:275-86

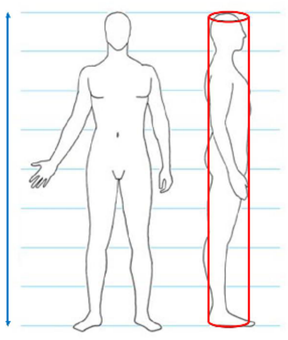
Which anthropometric index is the best?

- BMI is often used to reflect total body fat, whereas WC, WHR, or WHtR may be used as surrogate markers of body fat centralization.
- Controversy still remains regarding the most sensitive and specific anthropometric indices for obesity associated with cardiovascular risk factors.

Obesity 2008;16, 834-840

Circ J 2009;73:1643-1650

New Index Formula



$$V_{cyl} = \pi r^2 \times h \qquad c = \pi \times 2r$$

$$Cylinder\ \ Vol \div Weight = V_{cyl} \div Weight = \pi r^2 \times h \div Weight$$

$$= \pi \left(\frac{c}{2\pi}\right)^2 \times h \div Weight$$

$$Cylinder\ \ to\ \ Weight\ \ Ratio = Waist^2 \times Height \div Weight$$

Purpose

- To validate CWR as the predictor for cardiometabolic risk factors through comparison with other anthropometric parameters

Methods

- **Study population**
  - Data obtained from the KNHANES 2009
- **Anthropometry**
  - BMI
  - WHtR
  - CWR
- **Background characteristics**
  - Smoking, alcohol use, education level, occupation
  - Past/current medical history of cardiovascular disease (cerebrovascular disease or ischemic heart disease), hypertension, dyslipidemia, renal insufficiency and diabetes mellitus
- **Statistical analysis**
  - Descriptive statistics for obesity indices
  - Student's t test
  - Logistic regression
  - Receiver-operating characteristic curve analysis
  - Area under the curve

Results

Characteristics in subjects

Age (mean±SE)	38.45±0.39	Drinking	
≥ 65 yr (%)	15.40	≥ 30 g/day (%)	10.09
< 65 yr (%)	84.60	< 30 g/day (%)	89.91
Sex		Blood pressure (mmHg)	
Male (%)	46.18	Systolic (mean±SE)	114.62±0.32
Female (%)	53.82	Diastolic (mean±SE)	74.12±0.23
Residence		Mean arterial (mean±SE)	87.62±0.22
Urban (%)	83.75	Hypertension (%)	13.00±0.49
Rural (%)	19.25	Diabetes (%)	4.86±0.27
Education		Cerebrovascular dis (%)	1.09±0.10
≥ College (%)	23.00	Renal insufficiency (%)	0.21±0.06
< High school (%)	77.00	Angina (%)	0.72±0.08
Occupation		Myocardial infarction (%)	0.41±0.06
Service (%)	61.07	Ischemic heart dis (%)	1.10±0.10
Agriculture and fishery (%)	8.33	Dyslipidemia (%)	5.57±0.27
Industry (%)	30.60	Hypercholesterolemia (%)	10.00±0.43
Smoking		BMI (mean±SE)	22.61±0.06
Current smoking (%)	21.00	WHtR (mean±SE)	0.48±0.00
No smoking (%)	79.00	CWR (mean±SE)	16429±70

Adjusted odds ratio for hypertension, diabetes, ischemic heart disease and cerebrovascular disease, renal insufficiency and dyslipidemia comparing quartiles of indices

		Hypertension			Diabetes		
	Quartile	OR	95% CI	*P*-value	OR	95% CI	*P*-value
BMI	Q1 vs. Q2	3.128	2.462,3.974	< 0.0001	2.914	1.834,4.629	< 0.0051
	Q1 vs. Q3	6.305	4.885,8.139	< 0.0001	5.319	3.473,8.148	< 0.0001
	Q1 vs. Q4	13.296	10.220,17.297	< 0.0001	8.533	5.803,12.546	< 0.0001
	Q123 vs. Q4	3.897	3.330,4.562	< 0.0001	2.691	2.191,3.305	< 0.0001
WHtR	Q1 vs. Q2	5.392	3.722,7.812	< 0.0001	3.031	1.724,5.330	< 0.0001
	Q1 vs. Q3	10.387	7.094,15.209	< 0.0001	5.820	3.240,10.454	< 0.0001
	Q1 vs. Q4	27.088	18.0008,40.748	< 0.0001	15.601	9.251,26.310	< 0.0001
	Q123 vs. Q4	4.719	4.002,5.564	< 0.0001	4.495	3.595,5.619	< 0.0001
CWR	Q1 vs. Q2	4.505	2.766,7.338	< 0.0001	2.607	1.294,5.252	< 0.0001
	Q1 vs. Q3	10.160	6.395,16.142	< 0.0001	6.331	3.334,12.019	< 0.0001
	Q1 vs. Q4	23.428	14.771,37.159	< 0.0001	20.841	11.261,38.569	< 0.0001
	Q123 vs. Q4	4.258	3.655,4.960	< 0.0001	5.922	4.656,7.533	< 0.0001

		Ischemic Heart Disease			Cerebrovascular Disease		
	Quartile	OR	95% CI	*P*-value	OR	95% CI	*P*-value
BMI	Q1 vs. Q2	2.237	1.105,4.530	< 0.0001	2.237	1.105,4.530	< 0.0051
	Q1 vs. Q3	4.834	2.392,9.797	< 0.0001	4.834	2.392,9.767	< 0.0001
	Q1 vs. Q4	5.602	2.842,11.042	< 0.0001	5.602	2.842,11.042	< 0.0001
	Q123 vs. Q4	1.966	1.305,2.962	0.0012	1.944	1.305,2.896	0.0011
WHtR	Q1 vs. Q2	2.665	1.005,7.064	< 0.0001	2.665	1.005,7.064	< 0.0001
	Q1 vs. Q3	4.862	1.939,12.191	< 0.0001	4.862	1.939,12.191	< 0.0001
	Q1 vs. Q4	7.642	3.230,18.007	< 0.0001	7.642	3.230,18.077	< 0.0001
	Q123 vs. Q4	2.444	1.540,3.879	< 0.0001	3.610	2.354,5.537	< 0.0001
CWR	Q1 vs. Q2	1.130	0.337,3.789	< 0.0001	1.781	0.590,5.374	< 0.0001
	Q1 vs. Q3	3.789	1.421,10.108	< 0.0001	3.545	1.282,9.806	< 0.0001
	Q1 vs. Q4	6.229	2.445,15.864	< 0.0001	10.081	3.803,26.721	< 0.0001
	Q123 vs. Q4	2.444	1.540,3.879	< 0.0001	4.284	2.580,7.115	< 0.0001

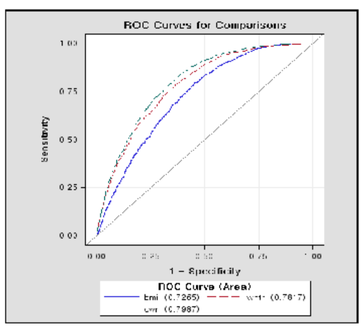
		Renal Insufficiency			Dyslipidemia		
	Quartile	OR	95% CI	*P*-value	OR	95% CI	*P*-value
BMI	Q1 vs. Q2	7.272	1.241,42.598	0.0629	3.719	2.253,6.138	< 0.0051
	Q1 vs. Q3	2.175	0.345,13.695	0.0629	8.440	5.316,13.400	< 0.0001
	Q1 vs. Q4	8.259	1.419,48.058	0.0629	11.900	7.586,18.668	< 0.0001
	Q123 vs. Q4	2.362	0.987,5.654	0.0537	2.718	2.235,3.305	< 0.0001
WHtR	Q1 vs. Q2	1.222	0.180,8.321	0.3415	2.872	1.655,4.983	< 0.0001
	Q1 vs. Q3	0.753	0.111,5.109	0.3415	7.037	4.167,11.885	< 0.0001
	Q1 vs. Q4	3.300	0.640,17.013	0.3415	11.439	6.810,19.215	< 0.0001
	Q123 vs. Q4	3.342	1.288,8.670	0.0131	3.121	2.526,3.856	< 0.0001
CWR	Q1 vs. Q2	0.702	0.083,5.969	0.3415	3.909	2.398,6.374	< 0.0001
	Q1 vs. Q3	3.064	0.396,23.724	0.3415	7.669	4.688,12.546	< 0.0001
	Q1 vs. Q4	3.221	0.444,23.379	0.3415	12.811	7.831,20.959	< 0.0001
	Q123 vs. Q4	1.939	0.750,5.011	0.1716	3.012	2.373,3.823	< 0.0001

The relationship between indices and diseases

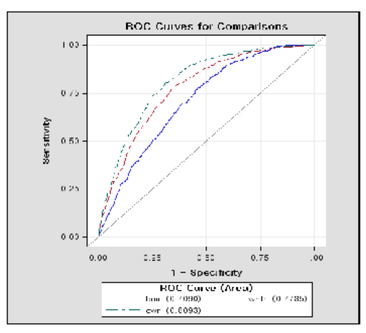
	Hypertension			Diabetes		
	No	Yes	*P*-value	No	Yes	*P*-value
BMI	22.21±0.06	25.25±0.11	< 0.001	22.47±0.06	25.25±0.17	< 0.001
WHtR	0.47±0.00	0.54±0.00	< 0.001	0.48±0.00	0.55±0.00	< 0.001
CWR	16063±68	18663±100	< 0.001	16266±69	19082±136	< 0.001
	Cerebrovascular Disease			Renal Insufficiency		
	No	Yes	*P*-value	No	Yes	*P*-value
BMI	22.58±0.06	24.54±0.25	< 0.0001	22.60±0.06	24.51±1.05	0.0704
WHtR	0.48±0.00	0.54±0.01	< 0.0001	0.48±0.00	0.52±0.02	0.0393
CWR	16373±72	19079±209.16	< 0.0001	16399±72	17874±607	0.0180
	Ischemic Heart Disease			Dyslipidemia		
	No	Yes	*P*-value	No	Yes	*P*-value
BMI	22.58±0.06	24.70±0.29	< 0.0001	22.45±0.06	25.13±0.16	< 0.001
WHtR	0.48±0.00	0.53±0.01	< 0.0001	0.48±0.00	0.53±0.00	< 0.001
CWR	16377±72	18545±196	< 0.0001	16298±72	18151±121	< 0.001

Receiver-operating characteristic curves of indices

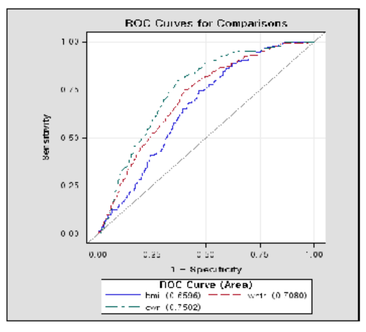
Hypertension



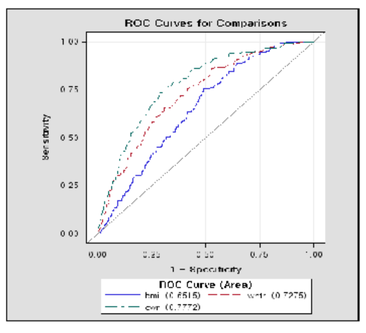
Diabetes



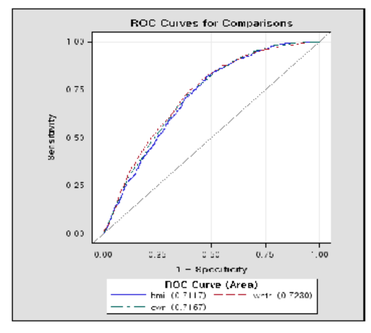
Ischemic Heart Disease



Cerebrovascular Disease



Dyslipidemia



Difference in the area under the receiver-operating characteristics curve between WHtR and CWR

		Improvement in AUC (CWR > WHtR)			
Sex	Disease	Mean	Lower 95%	Upper 95%	*P*-value
All	Hypertension	0.017	0.00982	0.0242	<.0001
	Diabetes	0.0358	0.0252	0.0464	<.0001
	Ischemic Heart Disease	0.0422	0.0214	0.0631	<.0001
	Cerebrovascular Disease	0.0497	0.0283	0.0711	<.0001
	Dyslipidemia	-0.00629	-0.0176	0.00503	0.2764
Male	Hypertension	0.0389	0.0273	0.0505	<.0001
	Diabetes	0.0581	0.0412	0.0751	<.0001
	Ischemic Heart Disease	0.057	0.026	0.0881	0.0003
	Cerebrovascular Disease	0.0747	0.0435	0.1059	<.0001
	Dyslipidemia	0.0214	0.0026	0.0402	0.0257
Female	Hypertension	0.00036	-0.0079	0.00862	0.932
	Diabetes	0.0145	0.00252	0.0266	0.0178
	Ischemic Heart Disease	0.0235	-0.00152	0.0486	0.0656
	Cerebrovascular Disease	0.0158	-0.00963	0.0412	0.2239
	Dyslipidemia	-0.0125	-0.0252	0.000242	0.0545

Comparison of the area under the receiver-operating characteristics curve for indices

Disease	Sex	Index	Mean AUC	Lower 95%	Upper 95%	*P*-value when compare with BMI
Hypertension	All	BMI	0.7265	0.7143	0.7387	
		WHtR	0.7817	0.7703	0.7930	< 0.0001
		CWR	0.7987	0.7879	0.8094	< 0.0001
	Male	BMI	0.6948	0.6762	0.7133	
		WHtR	0.7354	0.7169	0.7540	< 0.0001
		CWR	0.7743	0.7574	0.7913	< 0.0001
	Female	BMI	0.7518	0.7358	0.7678	
		WHtR	0.8174	0.8037	0.8311	< 0.0001
		CWR	0.8178	0.8040	0.8315	< 0.0001
Diabetes	All	BMI	0.7090	0.6901	0.7278	
		WHtR	0.7735	0.7557	0.7913	< 0.0001
		CWR	0.8093	0.7933	0.8253	< 0.0001
	Male	BMI	0.6748	0.6464	0.7033	
		WHtR	0.7376	0.7089	0.7663	< 0.0001
		CWR	0.7957	0.7711	0.8204	< 0.0001
	Female	BMI	0.7376	0.7129	0.7624	
		WHtR	0.8054	0.7838	0.8271	< 0.0001
		CWR	0.8200	0.7987	0.8412	< 0.0001
Ischemic Heart Disease	All	BMI	0.7265	0.7143	0.7387	
		WHtR	0.7817	0.7703	0.7930	< 0.0001
		CWR	0.7987	0.7879	0.8094	< 0.0001
	Male	BMI	0.6948	0.6762	0.7133	
		WHtR	0.7354	0.7169	0.7540	< 0.0001
		CWR	0.7743	0.7574	0.7913	< 0.0001
	Female	BMI	0.7518	0.7358	0.7678	
		WHtR	0.8174	0.8037	0.8311	< 0.0001
		CWR	0.8178	0.8040	0.8315	< 0.0001
Cerebrovascular Disease	All	BMI	0.7090	0.6901	0.7278	
		WHtR	0.7735	0.7557	0.7913	< 0.0001
		CWR	0.8093	0.7933	0.8253	< 0.0001
	Male	BMI	0.6748	0.6464	0.7033	
		WHtR	0.7376	0.7089	0.7663	< 0.0001
		CWR	0.7957	0.7711	0.8204	< 0.0001
	Female	BMI	0.7376	0.7129	0.7624	
		WHtR	0.8054	0.7838	0.8271	< 0.0001
		CWR	0.8200	0.7987	0.8412	< 0.0001
Dyslipidemia	All	BMI	0.7117	0.6936	0.7297	
		WHtR	0.723	0.7045	0.7414	0.0517
		CWR	0.7167	0.6985	0.7349	0.6053
	Male	BMI	0.7084	0.6798	0.7369	
		WHtR	0.7063	0.6763	0.7362	0.0498
		CWR	0.7277	0.7002	0.7551	0.2303
	Female	BMI	0.7169	0.6936	0.7403	
		WHtR	0.728	0.7048	0.7513	0.1074
		CWR	0.7156	0.6923	0.7389	0.9124

Summary

- Like BMI and WHtR, CWR is consistently associated with hypertension, diabetes, ischemic heart disease, cerebrovascular disease and dyslipidemia regardless of the subjects' gender.
- Both CWR and WHtR have a greater correlation with cardiometabolic risk factors than BMI in both men and women.
- CWR has a stronger association with hypertension, ischemic heart disease and cerebrovascular disease than WHtR in men.
- The best indicator for diabetes in both men and women is CWR.

Conclusion

CWR, newly designed indicator for obesity, is the best anthropometric index of cardiometabolic risk factors.

52 ERA

364--SP

J3) Chronic Kidney Disease. Clinical Epidemiology.

Sungjin Chung

DOI: 10.3252/pso.eu.52era.2015

ePosters supported by F. Hoffmann- La Roche Ltd.

52nd ERA-EDTA CONGRESS LONDON 2015 UNITED KINGDOM MAY 28 - 31

PosterSessionOnline.com