The Increasing Importance of Waist-to-Height Ratio to Assess Cardiometabolic Risk: A Plea for Consistent Terminology

Margaret Ashwell[*1,2] and Lucy M. Browning[1]

[1]*Ashwell Associates (Europe) Ltd, Ashwell Street, Ashwell, Herts, SG7 5PZ, UK*

[2]*Oxford Brookes University, Oxford OX3 0BP, UK*

Abstract: We have recently performed a systematic review which collated seventy eight cross-sectional and prospective studies exploring waist-to-height ratio and waist circumference or body mass index as predictors of diabetes and cardiovascular disease published in English between 1950 and 2008. This review, which also employed specificity and sensitivity comparisons, indicated that waist-to-height ratio could be a useful global clinical screening tool, with a weighted mean boundary value of 0.5, supporting the simple public health message "keep your waist circumference to less than half your height". During the collation of evidence, we noticed inconsistency in the site of measurement of waist circumference and also the terminology and abbreviations used to describe 'waist-to-height ratio'. We encourage others to routinely use the waist circumference measurement used most often (that recommended by World Health Organization – mid way between the lower rib and the iliac crest) and the terminology 'waist-to-height ratio' abbreviated to WHtR to avoid confusion about this anthropometric index which is growing in popularity for screening for cardiometabolic risk.

Keywords: Waist-to-height ratio, waist circumference, abdominal obesity, terminology, body weights and measures.

INTRODUCTION

The use of waist-to-height ratio (WHtR) for detecting central obesity and its associated health risks was first proposed in the mid 1990s [1-4]. Interest in the practicality and effectiveness of this measure is rising in both adults and children [5-11]. A previous paper [12] systematically reviewed the evidence supporting the use of WHtR, a proxy for abdominal fatness, as a predictor of cardiovascular disease (CVD) and diabetes, and their risk factors. In order to put the relationships into context, the review drew on evidence from prospective and cross-sectional studies, in adults and in children, which reported relationships between WHtR and either body mass index (BMI) or waist circumference (WC), or both. The analyses showed that WHtR and WC were significant predictors of these cardiometabolic outcomes more often than BMI, with similar odds ratios; sometimes being significant predictors after adjustment for BMI. Receiver operating characteristic curve (ROC) analyses were also summarised to indicate sensitivity and specificity of the potential predictors and to confirm the suitability of WHtR 0.5 as a possible boundary value for WHtR.

During the collation of evidence, we noticed inconsistency in the terminology used to describe 'waist-to-height ratio' and its abbreviated form; also in the site of measurement of waist circumference. This study further investigates those papers cited in the systematic review to collate evidence relating to these two issues.

*Address correspondence to this author at the Ashwell Associates (Europe) Ltd, Ashwell Street, Ashwell, Herts, SG7 5PZ, UK; Tel: +44(0)1462742166; E-mail: margaret@ashwell.uk.com

METHODS

Search Methods

The methodology for the systematic review has already been described [12]. We restricted our analysis for this paper to the 78 papers retrieved in the systematic review and those extra 6 papers used in the ROC analysis alone. Full references are given elsewhere [12].

Collation of Terminology Used for Waist-to-Height Ratio

The title and abstract of each paper was searched by hand to identify the terminology used when waist circumference was divided by height to obtain the anthropometric index of interest and also the abbreviation used throughout the text for that index.

Collation of Site Measurement Methods for Waist Circumference

The Methods section of each paper was searched by hand to identify the anatomical site used for measuring waist circumference.

RESULTS

Table **1** shows the overall summary of our analysis.

Collation of Terminology Used for Waist-to-Height Ratio

The papers retrieved in the systematic review probably represented a conservative range of terminologies for this anthropometric index by the very nature of the search terms used to retrieve the papers in our systematic review. By far

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Table 1. Summary of Analysis

First author	Refs.	Year	What full name do they use for the ratio in text?	What abbreviation do they use?	Code*	Where do they measure waist circumference?	Code†
Hsieh	[1]	1995	Waist/height ratio	none	-	umbilicus	3
Hsieh	[19]	1995	Waist/height ratio	none	-	umbilicus	3
Cox	[20]	1997	Ratio of Waist circumference to height	WHTR	1	halfway between the lowest rib and the top of the iliac crest	1
Rissanen	[21]	1997	Waist-to-height ratio	WHTR	1	midway between the lateral lower rib margin and the iliac crest	1
Cox	[22]	1998	Waist : height ratio	WHTR	1	midway between the lowest rib and the top of the hip	1
Sattar	[23]	1998	Waist to height ratio	none	-	midway between the lowest rib margin and the iliac crest	1
Ko	[24]	1999	Waist-to-height ratio	WTH	2	minimum circumference between the umbilicus and xiphoid process	4
Patel	[25]	1999	Waist-to-height ratio	none	-	midpoint between lower costal margin and the superior iliac crest	1
Thomas	[26]	1999	Waist circumference -to-height	WHtR	1	not stated	-
Harris	[27]	2000	Waist-to-height ratio	Waist/height	2	umbilicus	3
Hsieh	[28]	2000	Waist-to-height ratio	W/Ht	2	umbilical	3
Savva	[29]	2000	Waist-to-height ratio	WHtR	1	umbilicus	3
Turcato	[30]	2000	Waist-to-height ratio	none	-	minimum abdominal circumference between the xiphoid process and the umbilicus.	4
Yasmin	[31]	2000	Waist to height ratio	WHTR	1	natural waist	3
Berber	[32]	2001	Waist-to-height ratio	WTH	2	minimum circumference between the umbilicus and xiphoid process	4
Teixeira	[33]	2001	Waist-to-height ratio	WHtR	1	narrowest part of the trunk	2
Hara	[34]	2002	Waist-to-height ratio	W/Ht ratio	2	umbilicus	3
Lin	[35]	2002	Waist-to-height ratio	WHtR	1	midway between the inferior margin of the last rib and the crest of the ileum	1
Lovegrove	[36]	2002	Waist - height ratio	W/Ht	2	midway between the lowest rib margin and the iliac crest	1
Sargeant	[37]	2002	Waist-to-height ratio	WHTR	1	between the ribs and iliac crest	1
Bertsias	[38]	2003	Waist-to-height ratio	WHtR	1	middle between 12th rib and iliac crest at the level of umbilicus	1
Ho	[39]	2003	Waist to stature ratio	WSR	3	half way between the xiphisternum and the umbilicus	4
Hsieh	[40]	2003	Waist-to-height ratio	W/Ht	2	umbilical	3
Lopatynski	[41]	2003	Waist to height	WHtR	1	navel	3
Sayeed	[42]	2003	Waist-to-height ratio	WHtR	1	midway between 12th rib and iliac crest on the mid-axillary line.	1
Tulloch-Reid	[43]	2003	Waist-to-height ratio	none	-	umbilicus	3
Azizi	[44]	2004	Waist-to-height ratio	none	-	point of noticeable waist narrowing	2
Esmaillzadeh	[45]	2004	Waist-to-height ratio	WHtR	1	narrowest level	2
Mirmiran	[46]	2004	Waist-to-height ratio	WHtR	1	narrowest level	2
Wessel	[47]	2004	Waist-height ratio	none	-	umbilicus	3
Zhang	[48]	2004	Waist-to-standing height ratio	WHtR	1	umbilicus	3
Fuchs	[49]	2005	Waist-to-height ratio	none	-	above the iliac crest and below the lowest rib margin	1

(Table 1) Contd…..

First author	Refs.	Year	What full name do they use for the ratio in text?	What abbreviation do they use?	Code*	Where do they measure waist circumference?	Code†
Hsieh	[50]	2005	Waist-to-height ratio	W/Ht	2	umbilical	3
Jeong	[51]	2005	Waist-to-height ratio	WHtR	1	midway between the lower rib margin and the iliac crest	1
Kahn	[52]	2005	Waist-to-height ratio	WHtR	1	in the horizontal plane at a point marked just above the right ileum on the mid-axillary line, at minimal respiration	1
Aekplakorn	[53]	2006	Waist-to-height ratio	WHtR	1	horizontal plane at 1 cm above the navel	3
Bosy-Westphal	[54]	2006	Waist-to-height ratio	WC/ht	2	midway between the lowest rib and the iliac crest	1
Deshmukh	[55]	2006	Waist-height ratio	WHtR	1	halfway between the iliac crest and the costal margin in the mid-axillary line	1
Esmaillzadeh	[56]	2006	Waist-to-height ratio	WHtR	1	narrowest or at end of the lowest rib	2
Hadaegh	[57]	2006	Waist-to-height ratio	WHtR	1	narrowest level and that of hip at maximal level	2
Lu	[58]	2006	Waist-to-height ratio	none	-	self reported	-
Mukuddem-Petersen	[59]	2006	Waist-to-height ratio	none	-	level midway between the lowest rib margin and the iliac crest	1
Sakurai	[60]	2006	Waist-to-height ratio	none	-	above the iliac crests and below the lowest rib margin	1
Aekplakorn	[61]	2007	Waist-to-height ratio	WHtR	1	umbilicus	3
Botton	[62]	2007	Waist-to-height ratio	none	-	between iliac crest and the lower rib	1
Chehrei	[63]	2007	Waist to height ratio	W/Ht	2	halfway between the lower border of ribs and the iliac crest in a horizontal plane	1
Diaz	[64]	2007	Waist-to-height ratio	WHR	2	not stated	-
Freedman	[7]	2007	Waist-to-height ratio	none	-	midway between the rib cage and the superior border of the iliac crest	1
Ghosh	[65]	2007	Waist stature ratio	WSR	3	not stated	-
Gracey	[66]	2007	Waist-to-height ratio	WTHR	2	level of the umbilicus	3
Mansour	[67]	2007	Waist-to-height ratio	WHtR	1	umbilical level from the horizontal plane	3
Mirzaei	[68]	2007	Waist-to-height ratio	WHR	2	navel level	3
Ruiz	[69]	2007	Waist-to-height ratio	none	-	midway between the lowest rib and the iliac crest	1
Schneider	[6]	2007	Waist to height ratio	WHtR	1	midway between the lowest rib and pelvis	1
Sung	[70]	2007	Waist/height ratio	none	-	midway between the lowest rib and the superior border of the iliac crest	1
Wang	[71]	2007	Waist-to-height ratio	WHTR	1	measured to 0.1 cm using standard techniques	-
Welborn	[72]	2007	Waist-to-stature ratio	WSR	3	at the narrowest point between ribs and hips after exhaling	2
Wu	[73]	2007	Waist to height ratio	WHtR	1	full paper not available	-
Ajay	[74]	2008	Waist-circumference-to-height ratio	WC-HR	2	standardised protocol	-
Bray	[75]	2008	Waist/height ratio	none	-	midpoint between the highest point of the iliac crest and the lowest part of the costal margin in the mid-axillary line	1
Chei	[76]	2008	Waist-to-height ratio	WHtR	1	umbilicus	3
Garnett	[77]	2008	Waist-to-height ratio	WHtR	1	narrowest point between the lower costal border and the iliac crest	2
Gelber	[78]	2008	Waist-to-height ratio	WHtR	1	at level of umbilicus	3
Kaur	[79]	2008	Waist-to-stature ratio	WSR	3	midpoint between lower end of the rib cage and iliac crest	1
Khan	[80]	2008	Waist to height ratio	WHTR	1	midway between the ribcage and the iliac crest	1

(Table 1) Contd…..

First author	Refs.	Year	What full name do they use for the ratio in text?	What abbreviation do they use?	Code*	Where do they measure waist circumference?	Code†
Kotchen	[81]	2008	Waist/height ratio	none	-	narrowest point between umbilicus and superior iliac spine	2
Lee	[82]	2008	Waist-to-height ratio	WHTR	1	midway between the lowest lateral border of the ribs and the uppermost lateral iliac crest	1
Maffeis	[83]	2008	Waist-to-height ratio	W/Hr	2	lowest portion of the rib cage and iliac crest	1
Manios	[84]	2008	Waist-to-height ratio	none	-	umbilicus	3
Nyamdorj	[85]	2008	Waist-to-stature ratio	WSR	3	at the midpoint between the lower margin of the ribs and the iliac crest	1
Paniagua	[86]	2008	Waist-height ratio	WHtR	1	midway between the inferior margin of the last rib and the iliac crest at the end of expiration	1
Pischon	[87]	2008	Waist-to-height ratio	none	-	either at the narrowest circumference of the torso or at the midpoint between the lower ribs and the iliac crest.	1
Shimajiri	[88]	2008	Waist-to-height ratio	none	-	umbilical level	3
Tseng	[89]	2008	Waist-to-height ratio	WHeiR	2	midway between the inferior margin of the last rib and the crest of the ileum in a horizontal plane	1
Can	[90]	2009	Waist : height ratio	WHtR	1	midpoint between the last rib and the superior iliac crest during mild expiration	1
Freedman	[91]	2009	Waist/height ratio	WHtR	1	midway between the rib cage and the superior border of the iliac crest	1
He	[92]	2009	Waist : height ratio	WHtR	1	halfway between the costal border and the iliac crest	1
Mackay	[93]	2009	Waist-height ratio and Waist-to-height ratio	WHtR	1	following standardized protocol	-
Maher	[94]	2009	Waist/height ratio	WHTR	1	midway between the lowest rib and the iliac crest	1
Nyamdorj	[95]	2009	Waist-to-stature ratio	WSR	3	at the midpoint between the lower margin of the ribs and the iliac crest to the nearest 0.5 cm.	1
Page	[96]	2009	Waist-height ratio	none	-	level of umbilicus	3
Panagiotakos	[97]	2009	Waist-to-height ratio	none	-	using standard procedures	
Zhang	[98]	2009	Waist-height ratio	WHtR	1	measured at 2.5 cm above the umbilicus	3

*Terminology of abbreviation was categorised into 3 groups as described in Table **2**.
†Anatomical measurement site was categorised into 4 groups as described in Table **3**.
Ref: reference.

the majority of papers (90%) used 'waist-to-height ratio' with just minor changes in the exact terminology (e.g. waist/ height ratio or waist circumference to height). Only 6 papers used waist to stature ratio. As far as abbreviations were concerned, even those authors who used the most popular terminology, waist-to-height ratio, used several different abbreviated forms. The terminology for abbreviations fell broadly into 3 groups as shown in Table **2**. The most consistently used abbreviation was WHtR.

Collation of Site Measurement Methods for Waist Circumference

The anatomical site for measuring WC was described in many ways in the papers. However, the different anatomical sites fell broadly into four groups across studies as shown in Table **3**. The most consistently used site was World Health Organization (WHO) definition [13] of halfway between the lower rib margin and the iliac crest.

DISCUSSION

This is the first paper to focus on terminology for the 'waist-to-height ratio'. It is timely because of the increasing popularity of this anthropometric index and the number of papers showing that it performs well for screening for cardiometabolic outcomes. When conducting our systematic review we realised that terminology presented a problem and this limited analysis of those papers which were retrieved, even with a conservative selection process, showed diversity among them. One problem is that scientific journals have their preferred editorial styles. We have submitted manuscripts using the terminology 'waist-to-height ratio' and discovered the proofs of the accepted papers use the terminology 'waist: height ratio'. We urge authors to ask journal editors to override their grammatical principles for the sake of scientific consistency. Nevertheless, there seems to be a growing consistency among authors and we strongly urge others to use the waist-to-height ratio and to abbreviate this term to WHtR. This will help literature searches to be

Table 2. Summary of Terminology Abbreviation for Waist-to-Height Ratio

Code for abbreviation	Terminology abbreviation group	Number of papers	% Papers where abbreviation used
1	Using the terms waist and height and using W and Ht as the abbreviations for them to produce either WHtR or WHTR	38	63
2	Using the terms waist and height but using different abbreviations for them such as WTH, WTHR, W/height, WHr, WHR, W/Ht, WHeiR, WC-HR and WC/Ht	16	27
3	Using terms such as stature instead of height	6	10
-	No abbreviation used	23	-

Abbreviations: W: waist; Ht: height; WHtR, WHTR, WTH, WTHR, W/height, WHr, WHR, W/Ht, WHeiR, WC-HR or WC/Ht: waist-to-height ratio.

Table 3. Summary of Anatomical Site Measurement of Waist Circumference

Code for measurement site	Measurement site	Number of papers	% Papers where measurement site used
1	Using the WHO definition of halfway between the lower rib margin and the iliac crest	37	50
2	The minimum WC	9	12
3	WC at or 1cm from the umbilicus	24	32
4	WC at the midpoint between the xiphoid process and the umbilicus	4	5
-	Not stated	8	-

Abbreviations: WHO: World Health Organization; WC: waist circumference.

comprehensive. It will also help with the acceptance and promotion of the ratio in public health circles.

A good example of this terminology problem has only recently come to our notice. Parikh and colleagues have advocated their 'index of central obesity' [14, 15] and they have defined this as a ratio of waist circumference and height. Unfortunately, our standard literature search did not retrieve these papers, even though they present some valuable thoughts about the global potential of waist-to-height ratio.

We are not the first to analyse the diversity of sites for measuring waist circumference. This has been done in a systematic review by others [16] who have concluded that WC measurement protocol has no substantial influence on the association between WC, all-cause and CVD mortality, CVD and diabetes. The most common WC protocol in their systematic review was the midpoint between the iliac crest and lower margin of rib cage. Our analysis reached the same conclusion. We therefore reiterate the plea by these authors and others [17] for the scientific community to adopt a consistent measurement site and that proposed by WHO seems a sensible choice for conformity [13].

All the scientific papers in our study reported values of waist-to-height ratio as a proportion of 1, e.g. 0.5. We have noticed a tendency for public health websites to promote, say, a healthy waist-to-height ratio as 50%. Maybe this is quite a good idea for health promotion and it corresponds nicely to the simple message "Keep your waist circumference to less than half your height". Together with the consumer friendly Shape chart [18] which puts WHtR 0.5 as an important boundary value for risk, it provides the basis for a simple public health campaign.

CONFLICT OF INTEREST

The author devised and copyrighted the Ashwell ® Shape Chart (based on WHtR) which is distributed to health professionals on a non profit making basis.

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