

Waist-to-Height Ratio Is the Best, Simple Indicator of Health Risk

My Personal Journey

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Margaret is currently Chair of SENSE for self-employed nutritionists in UK; she is the immediate Past President of the Association for Nutrition in UK. She has been a research scientist with the Medical Research Council, Principal of the Good Housekeeping Institute, Science Director of the British Nutrition Foundation, and, for more than 30 years, Director of Ashwell Associates, a nutrition science consultancy. Margaret has always loved instigating networks and collating stories. For example, she edited the biography of the nutrition pioneers McCance and Widdowson in 1993, and she founded the SENSE network in 1996. More recently, she has edited collations of memories for the Nutrition Society in UK in 2021 and for the International Union of Nutrition Sciences in 2022. Most of Margaret's research career has been in the effect of fat distribution on health. In 1996, she was the first to advocate the waist-to-height ratio as a warning of early health risk and promote the simple message: "Keep your waist to less than half your height." This message was eventually adopted in the 2025 guidelines from the National Institute for Health and Care Excellence. Primary screening, then, only requires a piece of string: Margaret served on the UK Government's Food Advisory Committee for 9 years and was rewarded with the OBE. Margaret has received honorary doctorates from 2 universities and 2 Lifetime Achievement Awards. Margaret lives in the lovely village of Ashwell in North Hertfordshire, UK, and her passions are playing golf and, for her sins, supporting Southampton FC.

This is my personal journey of my scientific research about waist-to-height ratio as the best and simplest proxy for central adiposity. It is full of personal anecdotes that are not found in my scientific publications but are extremely important to encourage young researchers to pursue their dreams.

I realize (with a certain amount of horror) that I have had an interest in the effect of fat distribution on health for well over 50 years. So, I'm very grateful to the Editor for allowing me to tell you about my journey. Let me start with the publication of the United Kingdom's 2025 National Institute for Health and Care Excellence (NICE) guideline because I hope it represents a full stop in my journey, and then I'll go back in time.

THE 2025 NICE GUIDELINE NG246

I have spent the last four years as a committee member for NICE. This is a UK organization that provides guidance and advice to improve health and social care. It is known for its evidence-based recommendations on treatments and interventions.

This particular committee has been working on the newly published 2025 NICE Guideline (NG246) on overweight and obesity management.¹ In fact, several sections of the 2025 NICE Guideline, including that on defining and identifying obesity using anthropometric indices, had already been published as an update to previous guidelines.²

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Nutrition Today, (2025) 00, Issue, 00–00

The author has no conflicts of interest to disclose.

<http://dx.doi.org/10.1097/NT.0000000000000778>

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The recommendations within the guideline relating to anthropometric indices and health risk are shown in Table.

The 2022 NICE Guideline² was the first official report to formally recognize what the global scientific evidence base had been suggesting since 1995:

- The confirmation that waist-to-height ratio (WHtR) is a good simple proxy for central adiposity as measured directly by dual energy X-ray absorptiometry.³
- The use of WHtR as a proxy for central adiposity (and therefore a good indicator of health risk) in adults and children of all ethnicities.^{4–10}
- The use of WHtR 0.5 as the boundary value for increased health risk in all groups lending itself to the simple, universal message of "Keep your waist to less than half your height."^{10–12}

EARLY DAYS

My own interest in fat distribution, as opposed to body weight, goes way back to 1970. Although I had qualified as a biochemist (and I had chosen to miss the nutrition modules in my university course!), my first job after my Doctorate was with the Consumers' Association in London. I was asked to be the Editorial Research Officer for the Which? Slimming Guide,¹³ and that was the beginning of my long career in obesity, energy balance, and nutrition.

TABLE

Recommendations 1.9.14 and 1.9.15 of NG246 classify the degree of central adiposity based on waist-to-height ratio

- *Healthy central adiposity: waist-to-height ratio of 0.4-0.49, indicating no increased health risks*
- *Increased central adiposity: waist-to-height ratio of 0.5-0.59, indicating increased health risks*
- *High central adiposity: waist-to-height ratio of 0.6 or more, indicating further increased health risks*

These classifications can be used for people with a body mass index under 35 kg/m² for both sexes and all ethnicities, including adults with high muscle mass. The health risks associated with higher levels of central adiposity include type 2 diabetes, hypertension, and cardiovascular disease. When talking to a person about their waist-to-height ratio, explain that they should try and keep their waist to less than half their height (so a waist-to-height ratio of under 0.5). Recommendations 1.10.10 and 1.10.11 of NG246 give the same advice for children and young people.

The Which? Slimming Guide contained a Table of Desirable Weights simplified from the American Life Insurance tables because body mass index (BMI) had not even been suggested then. But I also chose to conduct a survey to see what people considered to be the ideal shape.

One of the scientific advisors I chose for the Which? report was Professor John Garrow. Once the report was published, he asked me to work with him at the Medical Research Council's Clinical Research Centre from 1972 until 1981. Garrow was one of the first, along with George Bray and Ancel Keys, to suggest that you could use the data from the American Life Insurance companies to adapt the index first proposed in 1832 by Adolphe Quetelet into an obesity index, which came to be known as the BML.^{14,15} In fact, I can remember John Garrow showing me his first attempt at a BMI chart sketched on the back of a brown envelope.

DISCOVERING THE WORK OF JEAN VAGUE

It was during this time that I came across the works of Jean Vague¹⁶—the real granddaddy of work on fat distribution. Vague had classified people as having android and gynoid types of fat distribution. However, this involved taking many measurements of skinfold thicknesses and body circumferences. Vague was the first to show that having the android shape led to a tendency to diabetes.

Garrow and I put forward an early, but still very complicated, suggestion for assessing fat distribution based on waist and thigh diameters taken from photographs¹⁷ and, later, a suggestion of how to do this from measured waist and thigh circumferences. Maybe our most useful contribution was to show that fat distribution remained relatively constant even after weight loss.¹⁸

CAMBRIDGE DAYS—THE “APPLES AND PEARS” LADY

Once I moved to the Medical Research Council's Dunn Nutrition Unit in Cambridge in 1981, a collaboration with Dr Adrian Dixon the head of radiology at Addenbrooke's hospital was to reawaken my interest in fat distribution. Adrian had just acquired his first computed tomography (CT) scanner, and so we compared anthropometric measurements with his accurate CT assessment of intra-abdominal fat and subcutaneous fat.

We calculated the ratio of intra-abdominal fat to subcutaneous fat and looked at the correlations of this ratio with BMI (poor), with waist-to-thigh ratio (good), and also with the new kid on the block, the waist-to-hip ratio (better).¹⁹ I remember Adrian ringing me with these results and remarking that “My ‘two and sixpenny Woolworths’ tape measure was as good as his £100 k CT scanner!”

In Figure 1, the upper scan is typical of an apple-shaped person with more intra-abdominal fat compared with subcutaneous fat. The lower scan is a pear-shaped person with more subcutaneous fat compared with intra-abdominal fat and subcutaneous fat.¹⁹

I left scientific research at the Dunn in 1986 and moved on to become the Principal of the Good Housekeeping Unit. No time for research but at least a hot line to the media. By then, I was known as “the apples and pears lady” so it wasn't surprising that this was the obvious headline for the article I wrote for the Beauty Editor of the magazine.²⁰

BRITISH NUTRITION FOUNDATION DAYS

There was no time for original research in my next role as Science Director of the British Nutrition Foundation (BNF) as, by this time, I had firmly moved into the world of science communication. However, I did take the opportunity in 1994 to publish my view that it was time for some type of shape chart combining BMI and some index of shape.²¹ Luckily, the first Health Survey for England (HSE) was published soon after,²² and I realized that we could do some analysis of this cross-sectional survey to see how various anthropometric indices compared to the “coronary heart disease (CHD) risk” computed in the HSE. Professor Klim McPherson agreed to help, and the BNF got a grant from J Sainsbury (a large supermarket chain in UK) to employ Sonya Lejeune to do the important analysis. She looked at all possible anthropometric indices involving waist circumference and hip. For each person (1411 men and 1481 women aged 30-74 years), anthropometric measurements and ratios were compared with the logarithm of his or her risk of CHD, calculated from his or her sex, age, blood pressure, cholesterol concentration, and smoking and diabetic status.

THE ASHWELL® SHAPE CHART © DR MARGARET ASHWELL OBE

I can remember exactly where I was when I had my Eureka moment about the Ashwell® Shape Chart. I had left the BNF in early 1995 (becoming self-employed), and so Sonya's results arrived in the post one Saturday morning. I stuffed them in my bag because I had to take my daughter to her hockey match on a very cold, wet day.

Luckily for me, I could sit in a nice warm café perusing the results. Much to my surprise, WHtR had the best correlation with the “CHD risk,” not only better than BMI but also better than that with waist circumference or waist-to-hip ratio. My real Eureka moment came when I realized that measurements of waist circumference and height would work very well as a chart. So, the first draft of the Ashwell® Shape Chart was drawn on the back of a beer mat!

Once we had published our findings,⁵ we took every opportunity to disseminate our suggestion that WHtR was the

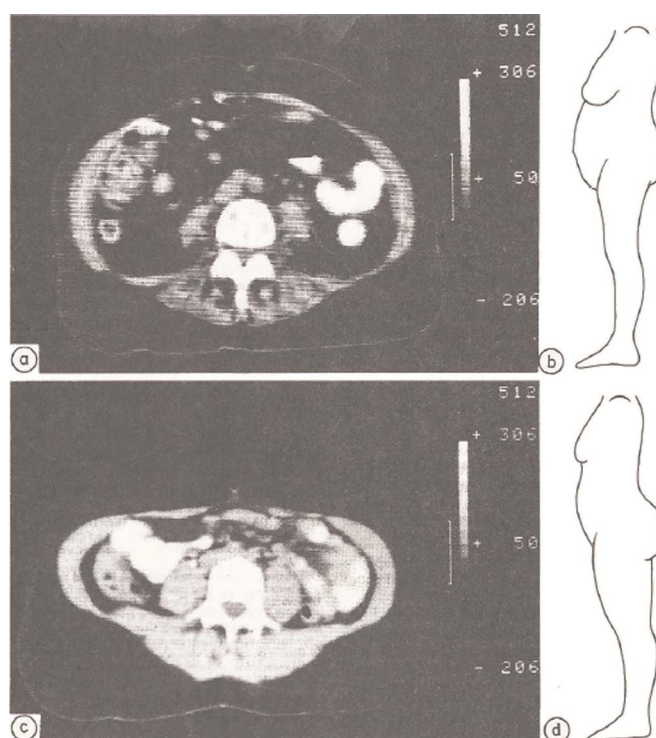


FIGURE 1. The upper scan is typical of an apple-shaped person with more intra-abdominal fat compared with subcutaneous fat. The lower scan is a pear-shaped person with more subcutaneous fat compared with intra-abdominal fat subcutaneous fat (taken from Ashwell²⁰).

best simple proxy for health risk. But there were 2 important things to do and check as soon as possible. The first was to see if any prospective survey data could corroborate our findings from the cross-sectional HSE survey. Help was closer at hand than I had imagined. Standing behind me at my poster at a conference in Aberdeen²³ were Brian Cox and Margaret Whiceloh from Cambridge. They had set up the prospective Health and Lifestyle Survey (HALS) in 1984. “Maybe we could use our HALS data to see how well WHtR performs?” Hooray. Their analysis showed that WHtR was a better predictor of mortality than BMI.²⁴

The second thing to do was to contact Adrian Dixon again and asked him to do a new analysis of his CT data to include WHtR this time around. No problems. Waist-to-height ratio turned out to be the best predictor of intra-abdominal fat.²⁵

Armed with all this evidence, I dared to produce the first Ashwell® Shape Chart in 1996 (see Figure 2 for the latest version of the chart). But where would I draw the boundary values? One other group in Japan had also suggested WHtR just before us.⁴ We knew from our HSE research that CHD risk started at a WHtR of about 0.5, and this value was supported by the Japanese work. So, that's where I put the first, and most important, boundary value between “Ok” and Consider Action. The other boundary values were determined on the basis of common sense. It was important that the upper boundary value was set so that this category contained roughly the same proportion of the population as those in the top BMI category of above 30. At that time, an upper boundary value of 0.6 would put 16% men and 11% women into the “Take Action” category, and this mirrored the proportions in the BMI obese category.

Initially, I called the different sections of the chart “Underweight” (later to become “Undesirable” and then “Take Care”), “OK,” “Take Care” (later to become “Consider Action”), and “Take Action” and published it like this.^{26–28}

A good friend gave me the invaluable advice to copyright the chart, and I also took the opportunity to acquire the registered trademark for “Ashwell.” In those days, you could only trademark a “proper” name if there was no place with more than 2000 inhabitants and as long as there were no more than 1000 people with that name in the London telephone directory. There are 2 villages called Ashwell in UK, and I happen to live in the largest, which only had 1600 inhabitants at that time. At first, I would give the Ashwell® Shape Chart away at conferences, asking attendees for feedback. For example, attendees at an eating disorders conference suggested that the category below WHtR 0.4 should become “Take Care.” More recently, I have been happy to grant copyright licences to those who ask to use or adapt the Ashwell® Shape Chart.

During the first 20 years of this century, I was kept busy with my self-employed consultancy, and so research on WHtR and the Ashwell® Shape Chart became my hobby.

MORE ANALYSIS OF UK NATIONAL SURVEYS—THE “PIECE OF STRING” LADY

A collaboration with Dr David McCarthy from London Metropolitan University gave me the chance to look at WHtR in children because David had a wonderful database of 2 UK cross-sectional surveys.¹¹

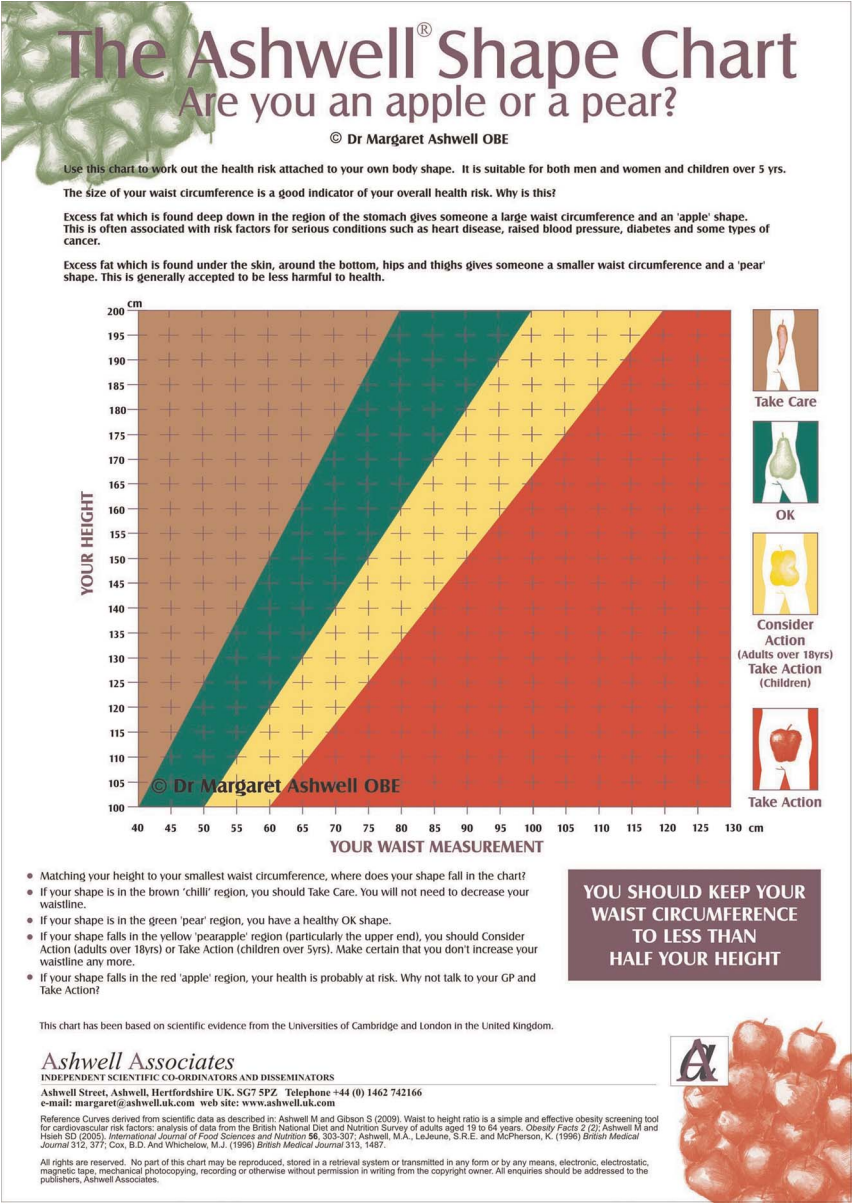


FIGURE 2. The Ashwell® Shape Chart. © Dr Margaret Ashwell OBE.

From these, we showed that values of WHtR during the past 10-20 years have increased greatly showing that central fatness in children had risen dramatically. Waist-to-height ratio is more closely linked to childhood morbidity than BMI, and we suggested it to be used as an additional or alternative measure to BMI in children as well as adults. About this time, and based on the important boundary value of WHtR 0.5, I began to promote the simple message “Keep your waist to less than half your height.”

Sigrid Gibson was also self-employed. We worked on many projects together, and if there was an opportunity to analyze surveys in the public domain, then Sigi was always happy to be my analyst and coworker on many self-funded papers. We started with analysis of the UK National Diet and Nutrition Survey,²⁹ and then we performed a systematic review and meta-analysis⁷ to follow the systematic review that I had done previously.³⁰

In about 2009, Professors Ben Rickayzen and Les Mayhew from City University approached me about some actuarial data they had produced using HSE and HALS. Their chart of waist circumference and height chart plotted different anthropometric indices against years of life lost at different adult ages. This collaboration eventually led to a joint paper³¹ that looked at WHtR from the actuarial point of view.

I should mention, of course, that we were not the only people looking at alternative anthropometric indices to BMI. Many other cross-sectional and prospective studies were done in different global populations that supported WHtR as a superior indicator of health risk compared with BMI. For example,³¹⁻³⁵ a particularly important systematic review was that of Yoo.³⁶

A presentation at a European conference first introduced the idea that if the message was “Keep your waist to less than half your height,” then you didn't even need a tape measure^{37,38},

you only needed a piece of string. The Ashwell® String Test was picked up by the journalists in the print³⁹ and visual media,⁴⁰ and I became known as “the piece of string” lady.

We kept a careful watch on the guidelines from the National Institute for Health and Care Excellence (NICE) to see if they had picked up on the growing evidence for WHtR being a good indicator of risk. However, when NICE eventually updated their guidelines,⁴¹ they suggested that waist circumference be measured alongside BMI. A “matrix” of BMI and waist circumference was then suggested to help identify risk.

In 2015, my City University colleagues suggested it was time we visited NICE to see if they would drop their BMI/waist circumference matrix in favor of WHtR. Mark Baker was the Director. He greeted us at the door with encouraging remarks about the evidence that would be needed to change the NICE guidance.

This then encouraged Sigi Gibson and me to continue analyzing new HSE data to show that nearly one-third of the “no increased risk” group in the “matrix” had WHtR greater than 0.5 and hence could be underdiagnosed for cardiometabolic risk.¹⁰

THE LATEST NICE COMMITTEE 2021–2025

This NICE committee was convened with the idea of updating and collating its many guidelines relating to obesity. I was delighted to be asked to join it, and we met for the first time in April 2021. Of course, all our meetings were virtual because of the COVID-19 pandemic, and this made it much harder to get to grips with the way in which the committee worked and to get to know my colleagues.

It was agreed at the outset that the task of covering all aspects of obesity together was too much, and so it was decided to cover some aspects first to update existing guidelines and then to produce a completely new set of amalgamated guidelines at the end. The section on identifying and using anthropometric markers for health risk was in the first tranche.

It is not that obvious from the text in the final guideline¹ the amount of work that the NICE staff do behind the scenes to help the committee reach their decisions. However, I can assure you that NICE performed an extensive statistical analysis of systematic reviews within a large global evidence base covering

many prospective as well as cross-sectional studies, in many ethnicities and in children and adults of all ages. NICE started with 14 299 studies and then decided which met their criteria for further analysis. Seventy-six of these were prospective studies in adults, and 42 were prospective studies in children. Seventy-two studies in adults and 110 in children were cross-sectional studies. Certain ethnic groups were underrepresented in adult prospective studies, and so the cross-sectional studies were also looked at in the South Asian and Black Caribbean populations. This meant that all the cross-sectional studies in White populations were not used in the NICE analysis (including all of our studies, of course, which were all of this nature).

Although the usual BMI classifications were also published in NG246, it was the first guideline to also mention WHtR. I refer the reader back to the Table to see these recommendations. NICE also took the opportunity to remind people how to measure their waist circumference:

To measure waist circumference: Find the bottom of the ribs and the top of the hips. Wrap a tape measure around the waist midway between these points (this will be just above the belly button) and breathe out naturally before taking the measurement.

Figure 3 shows some of the publicity relating to the message “Keep your waist to less than half your height.”

Now we have to wait and see how these new guidelines are implemented. It could still take a long time before taking waist circumference measurements and calculating WHtR becomes routine in practice. I strongly believe that the focus should be on the prevention of obesity in children and young people. My Ashwell® String Test could come into its own here with a simple piece of string being used to assess the problem in the first place and then used as an exercise aid to address the problem.

WHEN WILL WHtR BE RECOMMENDED IN USA?

Currently, national bodies in USA give recommended waist circumference measurements alongside their recommended BMI measures, but none has yet encompassed WHtR. The National Heart, Lung, and Blood Institute; International

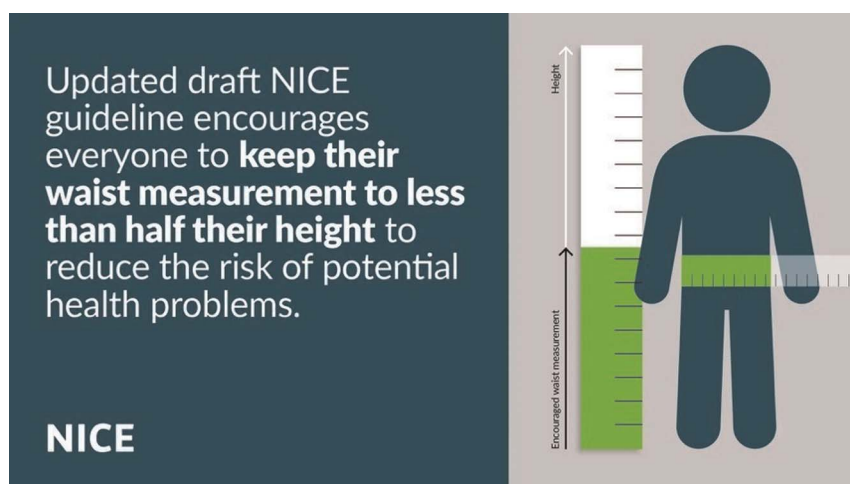


FIGURE 3. Some of the publicity relating to the message “Keep your waist to less than half your height.”

Diabetes Federation; and American Heart Institute consider only waist measurement.

The National Heart, Lung, and Blood Institute and American Heart Institute define a healthy waist size as

- 35 inches or less for women; and
- 40 inches or less for men.

The International Diabetes Federation defines a healthy waist size as

- 31.5 inches or less for women (31.4 inches for Chinese, Japanese, and South Asian women); and
- 35.5 or less for men (35.4 inches for Chinese, Japanese, and South Asian men).

OTHER PROXIES FOR CENTRAL ADIPOSITY

In telling my personal story about my quest to show that WHtR is a better indicator of central adiposity than BMI, I hope I haven't given the impression that others have not been trying to do the same thing. Many other indices have been proposed. Most popular have been the Conicity Index,⁴² the Visceral Adipose Index,⁴³ the Body Adiposity Index,⁴⁴ A Body Shape Index,⁴⁵ and the Body Roundness Index.⁴⁶ However, although all of these are better proxies for central adiposity than BMI, some involve blood measurements of triglycerides and/or cholesterol, and even those that only use waist circumference and height use a far more complicated equation than WHtR. None lends itself to the simple message about prevention: "Keep your waist to less than half your height."

CONCLUSIONS

This paper has taken the reader through my 50-year journey to show how WHtR has gradually been adopted as a good, simple proxy for central adiposity and therefore health risk in UK. We should never forget that BMI was originally suggested as a great measure to assess the obesity level of populations, but it was never designed to be used by individuals.

Just before Christmas last year, I was at a lunch where we pulled the traditional Christmas crackers. Out of mine fell a tape measure. I muttered something like "How apt," and my neighbor at the table, who had pulled the cracker with me, said, "Why, were you a dressmaker?" Maybe I should have been? I would have needed less patience!

Acknowledgments

I hope I have managed to mention everyone who has helped me on this specific journey. Many others have been important and encouraging throughout my whole career, which has covered more than the story I tell here. Thank you so much to all of you.

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How to cite this article: Ashwell M. Waist-to-height ratio is the best, simple indicator of health risk: My personal journey. *Nutr Today* 2025;00:00–00. doi: 10.1097/NT.0000000000000778