

Waist-to-height ratio as an alternative measure to body mass index reduces the diagnosis of obesity in the lipoedema cohort

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Key words

Lipoedema, BMI, waist-to-height ratio, overweight, obesity, metabolically obese phenotype

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Conflict of interest statement

The authors declare that there is no conflict of interest.

Lipoedema (LI) is a chronic disease affecting loose connective tissue (and hypothesised by Torre et al as a connective tissue disease), most notably affecting the fatty tissue, occurring predominantly in women (Torre et al, 2018). This disease appears to have a genetic origin (Grigoriadis et al, 2022). Although the aetiology and pathogenesis of LI remain to be fully elucidated, “dilated blood vessels and lymphatics, and inflammation” are clinically observed (Ishaq et al, 2022). This has been linked with increased interstitial fluid and connective-tissue remodelling (Herbst et al, 2021a). At the molecular

Abstract

Background: It is widely reported and accepted that obesity commonly coexists with lipoedema (LI). In this study, we examined a set of retrospective data to determine if the waist-to-height ratio (WHtR) was a more accurate biometric than BMI in quantifying the level of overweight and obesity in the LI cohort. This paper demonstrates that obesity is over-reported in the LI population when using the BMI measurement.

Methods: The data were extracted from the standard initial assessments of 151 consecutive adult females diagnosed with LI in the lead author's clinic who satisfied the inclusion criteria. WHtR and BMI measurements were calculated for each participant. Self-reported metabolic markers were recorded for each patient.

Results: BMI results in our LI cohort showed 63.6% of participants were obese, similar to four comparable population studies, which found 50–86.7% of individuals with LI were in the obese category. When categorised using WHtR instead of BMI, 31.7% of the LI cohort were in the obese category, 50% lower than when using BMI. Patient-reported metabolic clinical markers concurred with the WHtR categorisation of “less at risk” in relation to general health in the LI population; however, this warrants further investigation.

Conclusion: Our study shows that the WHtR biometric diagnoses 50% fewer individuals with LI as obese than the BMI biometric, as it considers the distinct gynoid body fat distribution of LI and the central adiposity of obesity. Research indicates that WHtR is a more accurate tool for diagnosing life-shortening overweight or obesity in the general population, and we contend that it is a more sensitive tool than BMI for identifying the presence of overweight or obesity in the LI cohort.

level, there are robust scientific studies to elucidate the unique properties of LI tissue (Ishaq et al, 2022; Ma et al, 2020), although the exact nature of the excess fluid in LI remains unclear (Herbst et al, 2022; Keith et al, 2024).

LI causes a symmetrical overgrowth of usually painful-upon-pressure subcutaneous adipose tissue (SAT) distributed disproportionately and bilaterally below the waist, on the legs and buttocks. However, it can also occur in other areas, such as the arms and abdomen, sparing the hands and feet (Buck & Herbst, 2016; Drozd et al, 2021). LI adipose tissue

(AT) is typically resistant to weight loss relative to the rest of the body (Herbst, 2012). It is widely accepted (Buck & Herbst, 2016; Torre et al, 2018; Vyas & Adnan, 2023) that the waist area is less affected by LI unless adiposity is increased by obesity and other metabolic dysfunction.

It is reported and generally agreed upon that obesity is a common comorbidity of LI. The rate of obesity in the LI cohort is reported to be as high as 86.7% (Czerwińska et al, 2021). Several studies have assessed overweight and obesity prevalence in women with LI utilising the BMI measure (Table 1). The data reported in these studies

Table 1. Bodyweight in people with lipoedema

Reference	Subjects (n)	Data not Available (n)	Normal Body Weight (BMI = 18.5–24.9 kg/m ²), n (%)	Overweight (BMI = 25–29.9 kg/m ²), n (%)	Obesity (BMI ≥30 kg/m ²), n (%)
Dudek et al (2018)	329	8	14 (4.3%)	40 (14.4%)	267 (81.3%)
Dudek et al (2021)	98	3	20 (20.4%)	26 (26.5%)	49 (50%)
Erbacher & Bertsch (2020)	150	0	5 (3.3%)	15 (10%)	130 (86.7%)
Romeijn et al (2018)	163	0	21 (12.9%)	41 (25.2%)	101 (61.9%)
Total	729	11	60 (8.23%)	122 (16.73%)	547 (75.04%)

Source: Czerwinska et al, 2021. Reproduced with permission under a Creative Commons (CC BY-NC-ND 4.0) licence.

Table 2. Signs and symptoms of lipoedema and obesity

Signs and Symptoms	Lipoedema	Obesity
Bruise easily	Usually	No
Tender to touch	Usually	No
Valgus knees	Often	Not usually
Flat feet	Often	Not usually
Joint problems	Often	Sometimes
Excess abdominal fat	Sometimes	Yes
Disproportionate weight loss	Yes	No
Larger clothing size lower vs upper body	Yes	No
Quadriceps weakness	Often	Sometimes
Fat feels granular to palpation	Usually	No
Legs feel swollen or heavier at the end of the day	Often	No
Predominantly women	Yes	No
Retromaleolar fat pad	Usually	No
Infra patella fat pad		
Orthostatic oedema	Usually	Not usually
Pain in the arm when having blood pressure taken	Often	No

Adapted from Buck & Herbst, 2016; Ishaq et al, 2022; Van Esch-Smeenge et al, 2017.

with lipoedema, such as joint hypermobility or Ehlers-Danlos syndrome, resulting in excessive wear and tear on joints and joint pain (Ma et al, 2020). Other associated health risks have a higher association with LI, such as postural orthostatic tachycardia syndrome (Herbst et al, 2019), and other body system disorders that are not common to obesity.

The recently published 'Learning by Listening' registry by the Lipoedema Foundation (2022) notes that 'obesity represents the most common self-reported condition to exist alongside LI', present in 73% of respondents. *Table 3* demonstrates that the incidence of obesity is similar across three studies of BMI: Czerwinska's study, the lead author's clinic, and the Lipoedema Foundation's self-reported survey group. When comparing Czerwinska's data and the lead author's clinic data for overweight and obesity, the results are very similar. We suspect that the lower level of obesity in this author's data is due to a tendency for early patient referral and diagnosis of LI in this clinic.

How fatty distribution and type affect health outcomes

LI produces a hyperplasia and/or disproportionate hypertrophy in the subcutaneous adipose tissue located beneath the skin (Vyas A & Adnan G, 2023). Adiposity in obesity also includes excess SAT; however, it invariably includes intra-abdominal visceral AT located deeper inside the abdomen and ectopic AT that infiltrates internal organs, such as the heart, liver, pancreas and skeletal muscles (Lukacs et al, 2019). SAT produces a higher proportion of beneficial, anti-inflammatory and insulin-sensitising molecules such as adiponectin (Reneau et al, 2018). In contrast, visceral and ectopic AT produce more pro-inflammatory and antagonistic molecules, such as cytokines, and lower

repeatedly inform clinicians that LI and obesity are intrinsically linked, potentially creating an illusion of truth (Hasher et al, 1977) that needs to be challenged by using a more sensitive biometric.

The relationship between chronic health conditions with pain, and immobility as key symptoms, and obesity, must also be considered when implying a pathophysiological relationship between LI and obesity. Adults with a disability are more likely to be obese. The highest risk occurs among adults with some mobility difficulties in the lower extremities (Weil et al, 2002). It must be considered that conditions directly affecting physical mobility, such as knee osteoarthritis or back pain, have a closer or similar coexistence with overweight and obesity, as the mobility-affecting condition LI, and

that any pathophysiological relationship between obesity and LI needs to be examined, along with the prevalence of coexistence compared to these conditions.

It can be difficult for healthcare professionals to differentiate LI from overweight or obesity, as these conditions can all result in increased body weight, and education on LI is largely unavailable through conventional health training services. It is, therefore, common for LI to be misdiagnosed as lymphoedema or obesity, which can be comorbidities of LI (Bilancini et al, 1995; Buck & Herbst, 2016; Herbst, 2012, 2016, 2020; Lohrmann et al, 2009).

Identifying lipoedema

The signs and symptoms of lipoedema and obesity differ and are outlined in *Table 2*. Specific comorbidities commonly coexist

Table 3. Body weight comparison of data demonstrating similar patient profiles.		
Czerwińska et al, 2021	Lead author's clinic	Lipoedema Foundation, 2022
• 727 patients • 75.0% obese (BMI ≥30 kg/m²) • 16.7% overweight obese (BMI 25–29.9 kg/m²) • 91.8% total overweight or obese • 8.3% total in healthy range	• 151 patients • 63.6% obese (BMI ≥30 kg/m²) • 29.8% overweight obese (BMI 25–29.9 kg/m²) • 93.4 total overweight or obese • 6.6% total in healthy range	• 521 survey participants • 73% obese (BMI ≥30 kg/m²). Self-reported

volumes of adiponectin, thereby increasing the risk of numerous chronic diseases (Harvard Health Publishing, 2021; Reneau et al, 2018). The location and type of AT dictate the type and severity of associated metabolic risk factors (Chait & Hartigh, 2020; Lukacs et al, 2019) and are, therefore, more risk-predictive than measuring the amount of adiposity (Moini et al, 2020; Salmón-Gómez et al, 2023) when coupled with one or more metabolic risk factors (Sperling et al, 2015).

The combination of BMI and waist circumference has previously been shown to distinguish between non-abdominal, abdominal subcutaneous, and visceral adiposity (Janssen et al, 2004; Obesity Prevention Source, 2024). Waist circumference alone has been established as a stronger predictor of cardiovascular disease than BMI (Powell-Wiley et al, 2021). BMI, however, cannot distinguish between the disproportionate hypertrophied adiposity that occurs in LI from visceral adiposity and the adiposopathy of obesity. For this reason, waist circumference is shown to be a better predictor of health risk than BMI (Cancer Council Victoria, n.d., Powell-Wiley et al, 2021), and waist-to-height ratio (WHtR) individualises this further, which enhances risk prediction (Ashwell et al, 2014; Ashwell & Gibson, 2016; Powell-Wiley et al, 2021). Additionally, dual-energy X-ray absorptiometry and computed tomography scanning are essential for a comprehensive assessment of body fat distribution (Chait & Hartigh, 2020).

History of BMI and looking beyond the scales

A Belgian mathematician, Lambert Adolphe Quetelet, first introduced BMI in the early 19th century. This biometric tool was used as a general population assessment to define the 'average man' for governments to allocate resources. On a radio appearance in 2009 (Weekend Edition Saturday), mathematician and

Table 4. Adult BMI defined.	
BMI	Weight status
<18.5 kg/m ²	Underweight
18.5–24.9 kg/m ²	Healthy weight
25–29.9 kg/m ²	Overweight
≥30 kg/m ²	163

science writer Keith Delvin opined, "Continued reliance on the BMI means doctors don't feel the need to use one of the more scientifically sound methods that are available to measure obesity levels." Using the most accurate biometric is especially relevant when considering that the stress of an inaccurate obesity diagnosis can cause or exacerbate mental health issues (Dudek et al, 2021) and disordered eating (Clarke et al, 2022; Czerwińska et al, 2021) in the LI cohort.

Historically, health professionals have used the BMI to measure for overweight or obesity, and it is still widely utilised and referenced (Ashwell & Gibson, 2016; Brenner et al, 2023). BMI is calculated by dividing an individual's weight (kg) by their height (m²) to provide an inexpensive and simple approximation of total body fat. See Table 4 for BMI classification thresholds.

BMI = Weight (kg)/Height (m²)

It is well established that BMI does not account for numerous factors related to body composition, such as age, gender, body mass distribution, and exceptional height (Roth, 2018), and can misclassify lean body mass as fat mass (Gonzalez et al, 2017).

It should be noted that in the LI cohort, weight loss surgery is performed on women who have significantly less life-shortening body mass than the non-LI cohort of the same BMI; therefore, the risks versus benefits of a negative outcome are higher (Cornely et al, 2022; Pouwels et al, 2018). Significant adverse outcomes such as

Table 5. Adult waist-to-height ratio categorisation.	
Waist-to-height ratio	Central adiposity status
0.4–0.49	Healthy
0.5–0.59	Take care (overweight)
≥0.6	Overweight

anorexia nervosa have been reported when using this type of surgery for LI management (Melander et al, 2021).

Conversely, the BMI measure can result in obesity being underdiagnosed in the general population (Salmón-Gómez et al, 2023; Swainson et al, 2017).

Loss of weight on the scales can be attributed to fat loss, fluid loss, or muscle loss, also known as sarcopenia (Cava et al, 2017). Neither the BMI biometric nor body weight alone can differentiate between these changes. Body tissue analysis with bioimpedance spectroscopy, such as the SOZO Digital Health Platform, can more clearly elucidate the various components of a body's mass (Fosbol & Zerahn, 2015). An increase in muscle mass will likely lead to an increase in weight; however, it will also improve insulin sensitivity and metabolic health (Nishikawa et al, 2021). To improve metabolic and cardiovascular health and reduce the risk of premature morbidity and mortality, using BMI or body weight is misleading in guiding progress for women with LI in the pursuit of improving health outcomes.

Most clinical data on BMI references men (Muscogiuri et al, 2023). It should be argued that due to body shape differences and the varying metabolic health impacts of gynoid fat, female data, in particular, require separate referencing using WHtR (Australian Institute of Health, 2024).

Waist-to-height ratio

WHtR is measured by dividing the patient's waist measurement in centimetres, taken at a point halfway between the last palpable

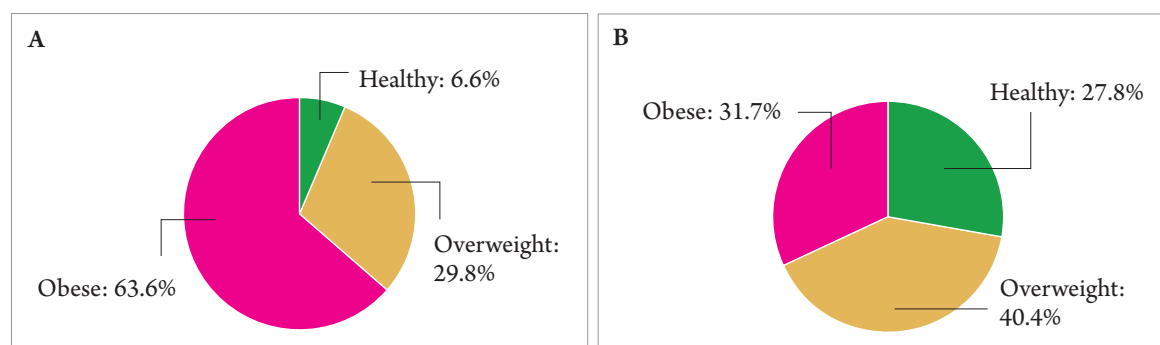


Figure 1. Lipoedema patient cohort from lymphoedema private clinic. A: Lipoedema BMI lipoedema cohort. It illustrates the percentage of individuals categorised as overweight, obese and of a healthy weight, as determined by BMI calculations. B: Lipoedema waist-to-height ratio lipoedema cohort. It illustrates the same categories established by calculating waist-to-height ratio.

rib and the top of the iliac crest (Table 5), by the height in centimetres.

$WHtR = \text{Waist circumference (cm)} / \text{Height (cm)}$

WHtR was introduced by Japanese researchers Hsieh and Yoshinaga in 1995, and further extensive population studies were conducted by Ashwell et al. (2014), Ashwell et al. (2016), and Schneider et al (2010).

The ranges for WHtR suggested by the Ashwell et al (2014) study are shown in Table 5.

This landmark study showed that WHtR was a more accurate predictor of years of life lost in the general population than BMI. The study analysed extensive health data from the National Health Service in the UK and found that our current perception of obesity is too low, and that WHtR can diagnose a higher rate of obesity in the general population. WHtR is a better proxy for centralised fat quantification.

Conversely, clinical data from our lead author demonstrate that the utilisation of the BMI measurement in diagnosing significantly more women with LI as overweight or obese than the WHtR biometric, initiating standard of care treatment for obesity in instances where it is not warranted. In the lead author's LI cohort, fewer patients will be diagnosed as overweight or obese using WHtR (72.2%) compared to using BMI (93.4%), due to a lower proportion of their fatty tissue being stored as abdominal adipose tissue. The percentage of women in the 'healthy' range using BMI was 6.6%, but when using WHtR, it was 27.8%. The WHtR tool will enable clinicians to differentiate more

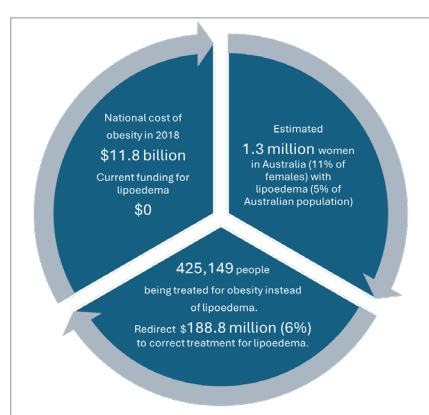


Figure 2. Reallocation potential of national obesity expenditure towards lipoedema management.

easily between overweight and obesity and LI, and therefore provide more accurate guidance, management and treatment.

WHtR provides the patient with a realistic goal of modifying their waist circumference, rather than losing weight measured by scales. When body fat mass is composed mainly of lipoedema fat, reduction is extremely difficult due to the LI fatty tissue being resistant to conventional weight loss strategies (Herbst, 2019; based on patient-reported clinical evidence). The inflamed fibrotic tissue within the LI fat makes it less accessible for lipolysis (Herbst, 2019). A more accurate and relevant biometric modification goal reduces unnecessary psychological distress and allows for more targeted and accurate management of symptoms.

National health burden of overdiagnosis of obesity

Australia's National Obesity Strategy 2022–2032 was written to "guide all governments... and partners...to prevent, reduce and treat overweight and obesity

in Australian society" (Commonwealth of Australia, 2022). This report states that "in 2018, obesity cost the Australian community \$11.8 billion". Based on the data from the lead author's clinic, we can see that of the women with LI diagnosed as obese using BMI (63.6%), half of those were not obese when using the more accurate WHtR measure (Figure 1). Using current estimates of levels of LI in the community, which are around 11% of women (Buck & Herbst, 2016), it is likely that at least 1,288,330 women have LI in Australia (5% of the Australian population). Potentially 425,149 people are being treated/managed for obesity when this management could be more appropriately directed at their LI management. With a more accurate diagnosis, this could free up 1.6% of the \$11.8 billion for LI management, equaling approximately \$188,800,000. Accurate diagnosis could repurpose this money to fund the appropriate LI health burden (Figure 2). This could potentially reduce the mental healthcare cost in the process, with fewer patients feeling confused and misunderstood by an incorrect diagnosis of obesity.

It is worth noting that in Figure 3, the percentage of the general population in the healthy range for WHtR is 30%. In Figure 1, the percentage of the LI representative cohort in the healthy range, as determined by WHtR, is 27.8%. There is therefore a 2.2% difference in the healthy range when comparing the general population cohort and the LI cohort using WHtR. The general population obesity rate in Australia is currently rising, and was estimated by the Obesity Evidence Hub, in collaboration with the Australian Bureau of Statistics, at 31.3% in 2017–2018, based on BMI (Obesity Evidence Hub, 2024). It could

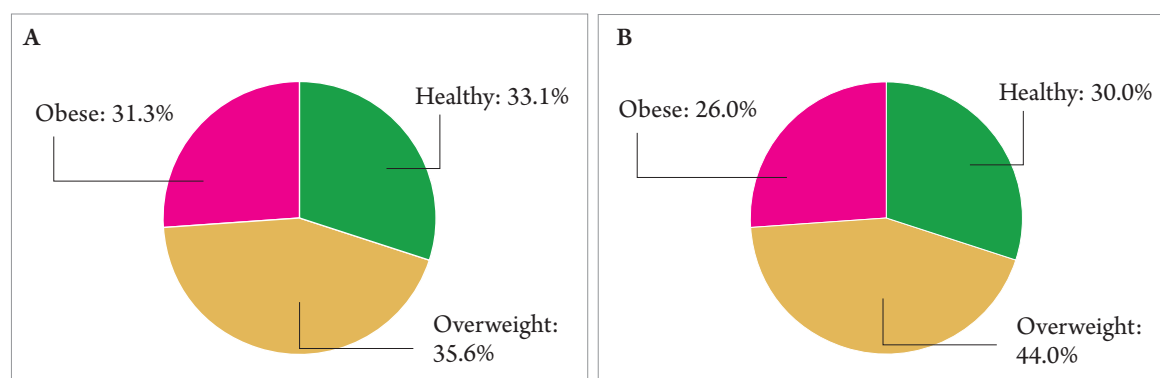


Figure 3. A: BMI in the general adult population data (Australian Bureau of Statistics, 2017; Obesity Evidence Hub, 2024). B: General adult population data using waist-to-height ratio as established by Ashwell et al (2014).

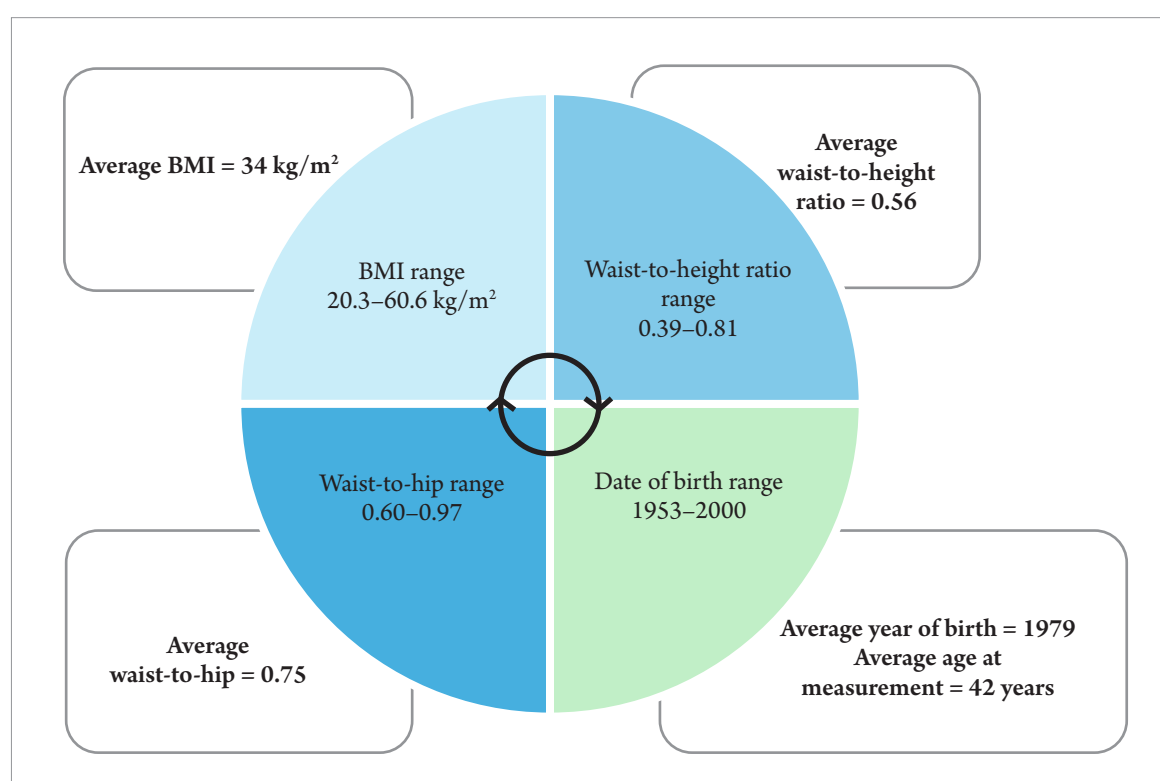


Figure 4. Summary of the features of this study's patient cohort.

therefore be expected to have increased further over the 5 years since these data were taken in line with the previous trend, bringing the general population obesity level, when using WHtR, even closer to the projected level in the LI cohort (Australian Bureau of Statistics, 2017).

Psychological impact of misdiagnosis

Women with LI are often disbelieved by healthcare professionals when reporting on food and beverage intake and level of exercise (Clarke et al, 2023). This disbelief can lead to feelings of distrust, low self-worth, and a sense of not being heard

(Melander et al, 2022). Accurate and informed assessment of this patient cohort is vital, as misdiagnosis can lead to delays or the absence of appropriate and targeted treatment and ongoing management (Clarke et al, 2023). Differentiating between obesity and LI will reduce the confusion and mental health impacts for the LI patient cohort by clarifying management strategies.

Standard practice by healthcare professionals for women with LI is to weigh them, diagnose them as overweight or obese, and prescribe weight loss, irrespective of the presenting complaint. This focus on a patient's weight can obscure the correct diagnosis of other

health conditions (Phelan et al, 2015). Being weighed and advised to lose weight (if BMI is elevated) as the solution for any complaint is a common story.

Our data show that three women, who were measured in the healthy range for WHtR (<0.5), were classified as obese when using BMI (>29.9 kg/m²). The self-reported metabolic markers of these three women concurred with the 'healthy' classification of WHtR. In our clinical experience, the implications of the incorrect diagnosis of obesity in a healthy individual put them at risk of significant emotional distress, body dysmorphia, and disordered eating.

Box 1. Clinical lipoedema assessment.

- Patient's main reported symptoms
- History of onset and progression
- Comorbidities
- History of dieting/weight loss (and gain) and relationship with food
- Stemmer's sign
- History of compression garment wearing and its effects
- Assessment of hypermobility and other joint issues, current or historical
- Extensive tissue palpation
- Suspected familial involvement
- Examination of posture
- Examination of body disproportion
- Effect of significant hormonal change events on body shape and weight
- Detailed measurements using a tape measure (waist, hip circumference, height in cm, circumferential leg measurements at 10 cm intervals and other significant individual landmarks)
- Scales and SOZO/lymph scanner as indicated
- Tracking of response to interventions



Figure 5. Clinical measurement of the waist. Waist measurement in centimetres, taken at a point halfway between the last palpable rib and the top of the iliac crest.

Women with LI were found to be depressed at a rate of 39.8% (Clarke et al, 2023). It has been speculated that this may be part of the condition inherently, a precursor to the onset of the disease (Bertsch et al, 2020) or as a result of being misunderstood by health professionals, family and friends (Hansen et al, 2014; Jusso et al, 2011; Olsen et al, 2008). The authors have found over many years of assessing women with LI that no matter what the cause, mental health disorders and disordered eating are significantly exacerbated by repeated misunderstanding and disbelief from primary healthcare

professionals (Buck & Herbst, 2016; Bilancini et al, 1995).

Taking weight out of the picture

In clinic settings, when a healthcare professional weighs a patient with LI, they are measuring their muscle mass in addition to healthy AT, any excessive (often metabolically unhealthy) AT, in addition to their diseased LI AT. This is akin to weighing a lipoedema patient with a large fatty tumour/lipoma and including this weight as obesity, to be managed the same way as obesity. As highlighted by Ishaq et al (2022), LI AT is not the same as non-lipoedema AT as it does not act or respond in the same physiological manner, and therefore should not be measured or treated in the same way.

Clinics, such as the Földi Clinic, acknowledge the WHtR as a more accurate measure of body fat distribution, if only for the "rare group of patients" with a slim upper body (Bertsch et al, 2020). The 2020 *Journal of Wound Care* international lipoedema consensus document, authored by Bertsch et al (2020), reports that 97% of patients with lipoedema at the Földi Clinic are overweight or obese, based on the BMI biometric tool, and that patients of normal weight are rare. Research indicates this is due in part to the late diagnosis of LI in most instances (Fetzer & Fetzer, 2016) and, therefore, is not likely an accurate representation of the overall LI population.

It is evident that clinics recognising the significance of WHtR for measuring body fat distribution continue to rely heavily on BMI for assessing and reporting

overweight and obesity; however, the relevance of BMI and weight on the scales needs to be questioned in the LI cohort. When using WHtR, the categorisation of the LI population as overweight or obese changes significantly (Figure 1). Similar to the reported Földi Clinic population data of 97% overweight or obese (Bertsch et al, 2020), this lead author's data show that 93.4% of all participants have a BMI indicating overweight or obesity. The lead author's LI population has 72% in the overweight or obese category when using the WHtR biometric, a statistic comparable to the 70% seen in the general population (Ashwell & Gibson, 2016).

The article by Czerwińska et al (2021) references four studies using BMI to assess overweight or obesity in LI. Table 1 summarises the authors' findings.

It is important to note that, out of a total of 727 patients in the four studies combined in this Table 1, 75.04% were found to be obese (BMI over 30 kg/m²) and 16.73% were overweight (BMI 25–29.9 kg/m²). Therefore, a total of 91.77% were overweight or obese, and only 8.27% were in the healthy range. This author's data concurs with the range of these results when using the BMI filter, with 6.6% having a healthy BMI, 29.8% being overweight, and 63.6% obese, indicating that 93.4% of the patients are overweight or obese. This demonstrates that the patient cohort in this study has a similar BMI profile to those in other studies.

Method and Materials

This was a retrospective analysis of medical records from a single physiotherapy clinic. It included data from the last 4 consecutive years of initial assessments of female patients at birth who received a LI diagnosis, where all measurements were recorded (waist, hips, height, weight, and self-reported blood test results within the past 12 months). A patient's data were included if they were diagnosed with LI by a plastic and reconstructive surgeon, endocrinologist, or general practitioner, and/or by the lead author. They had a full set of recorded data. A patient's data was excluded if they had previously had liposuction or bulk-removing surgery or bariatric surgery, or if information was missing.

Data were collected in a standardised way by the same assessing physiotherapist,



Figure 6. Lipodema patients from the lead author's clinic.



Figure 6. Lipodema patients from the lead author's clinic (continued).

with a view to using it for phenotypic LI investigation in the future. Data collected included waist and hip circumferential measures in centimetres and height in centimetres. The weight of each participant was measured in kilograms. From these data, the WHtR and BMI relationships were calculated. Each participant was asked if blood tests had been drawn in the last 12 months to assess blood sugar levels, lipid profile, liver function, and also if their doctor had checked their blood pressure. If not, they were asked to arrange testing with their doctor. When this information

was verbally provided, a box was ticked for 'yes' or 'no', and any red flags (outside the recommended range for that biometric) were noted. It was also noted if they were taking prescribed medication. This data was recorded on an Excel spreadsheet. Waist-to-height ratio data were categorised into <0.5 as healthy, $0.5\text{--}0.59$ as overweight, and ≥ 0.6 as obese. These are the values suggested by Ashwell et al (2014).

Participants

Data from this study were extracted from 151 consecutive initial assessments

conducted in the lead author's clinic between 2018 and 2022, which met the inclusion criteria.

Demographic

The age range was 18–69 years, with an average age of 42 years. The waist-to-hip ratio (WHR) in this cohort ranges from 0.60 to 0.97 with an average WHR of 0.75. This indicates a body fat distribution that is not consistent with obesity (Australian Institute of Health and Welfare, 2005). A summary of the features of this study's patient cohort can be seen in [Figure 4](#).

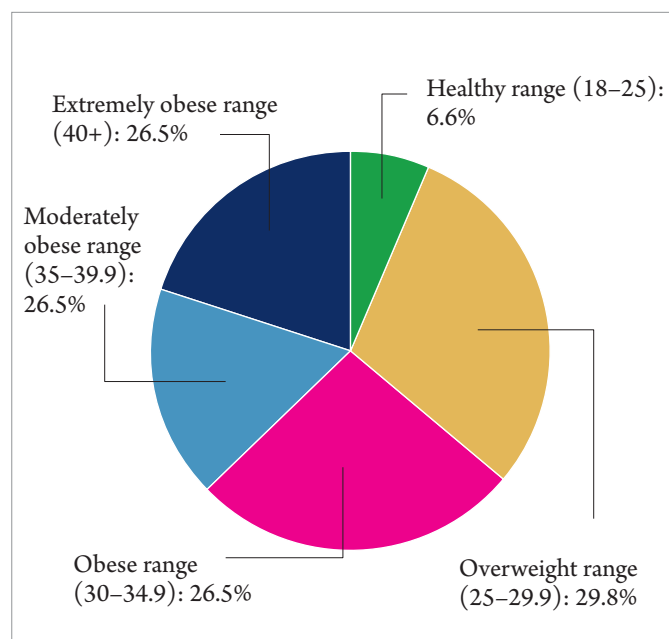


Figure 7. BMI-indexed results for lipoedema cohort.

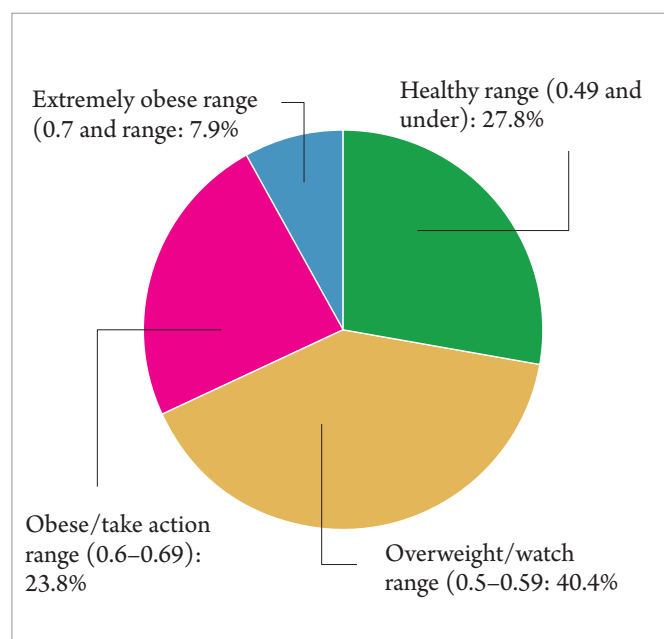


Figure 8. Waist-to-height ratio-indexed results for lipoedema cohort.

Diagnosis

The lead author has been diagnosing LI for 10 years and diagnoses approximately 50 patients per year. Diagnosis is based on a detailed assessment comprising elements guided by criteria as suggested by Kruppa et al (2020). The clinical assessment of patients in this study was based on the commonly used criteria outlined in *Box 1*.

Measurements

Waist measurement

Taken halfway between the distal ribs and the anterior superior iliac spine of the pelvis, approximately 1 cm above the navel in most participants. This was not always the narrowest point of the waist. A Jobst tape measure was used for circumferential measurements (*Figure 5*).

Height

Measured using a metric stadiometer. The back of the head, shoulder blades, buttocks, and heels should touch the wall, if possible.

Weight

Measured on Vanity Planet Digital Scales and body analyser (checked against two other clinic scales for regular calibration).

Metabolic markers

Patients were asked if blood test results within the past 12 months of blood pressure, blood sugar levels, cholesterol

profile, and liver function test were flagged as 'to watch' or were on active treatment to modify. It was marked as 'yes' or 'no' (further investigation into these results is needed to elucidate any relationship between suboptimal results that do not trigger modification strategies).

Results

The study cohort comprised 151 consecutive new patient assessments that resulted in a diagnosis of LI and met the inclusion criteria.

In this study cohort, self-reported metabolic health statistics, such as blood pressure, BMI, cholesterol profile, and liver function tests, all concur with the less at-risk category when using the WHtR biometric (*Figure 6* and *Figure 1*). Further analysis of metabolic risk factors and borderline values is warranted.

Results across 151 participants

The overall characteristics of the 151 women included in this study are outlined below:

BMI range 20.3–60.6 kg/m², average BMI across 151 participants = 34
 WHtR range 0.39–0.81, average WHtR across 151 participants = 0.56
 WHR range 0.60–0.97, average WHR across 151 participants = 0.75
 Range of DOB 1953–2000, average year of birth = 1979 (average age at measurement = 42 years)

BMI-indexed results

When categorised according to BMI ranges, the following distribution was observed among women with lipoedema (*Figure 7*):
 Number of women with LI in healthy BMI range (18–25 kg/m²) = 10 (6.6%)
 Number of women with LI in overweight BMI range (25–29.9 kg/m²) = 45 (29.8%)
 Number of women with LI in obese BMI range (30–34.9 kg/m²) = 40 (26.5%)
 Number of women with LI in moderately obese range (35–39.9 kg/m²) = 26 (17.2%)
 Number of women with LI in extremely obese range (40+ kg/m²) = 30 (19.8%)

WHtR-indexed results

Based on WHtR categories, the participants were distributed as follows (*Figure 8*):
 Number of women with LI in healthy WHtR range (<0.49) = 42 (27.8%)
 Number of women with LI in overweight/watch range (0.5–0.59) = 61 (40.4%)
 Number of women in obese/take action range (0.6–0.69) = 36 (23.8%)
 Number of women in extremely obese range (≥0.7) = 12 (7.9%)

Discussion

Prescribing weight loss as a treatment for overweight or obesity based on BMI or in the absence of the metabolically obese phenotype (bodyweight variability, multiple cardiometabolic abnormalities

and an excess of central relative to peripheral fat, as defined by Peppia et al, 2013) risks psychological harm and malnutrition (Buso et al, 2019; Wright & Herbst, 2021) in the LI patient cohort. The aim of weight loss in individuals with LI with a high BMI but relatively low WHtR could be unsafe. It may not result in significant change to their body mass (particularly in the gynoid region) aside from loss of muscle mass. This LI phenomenon is likely to apply to weight loss via caloric restriction and/or bariatric surgery.

Accurately diagnosing the relative impact of LI and that of other AT on a patient's weight is crucial for providing the patient with appropriate advice and well-directed, cost-efficient management. It also allows for more accurate risk assessment when considering a patient for surgery.

The increasing body of robust scientific evidence supports the biophysiological, genealogical and pathophysiological differences between LI AT and healthy SAT (Ishaq et al, 2022; Ma et al, 2020). This reinforces the need for clinicians to utilise the most accurate biometric to elucidate a differential diagnosis between overweight and obesity, and LI, to provide appropriate treatment advice and management. Correct and early diagnosis of LI can help to preserve mobility, reduce the risk of advanced fibrosis and secondary mental health impacts, and lower the risk of developing obesity and secondary lymphoedema (Forner-Cordero et al, 2012). Clinicians require the correct biometric tool to achieve this.

Though an increased waist circumference highlights the possibility of increased visceral fat, it does not differentiate between SAT and visceral AT, which is located in and around the body's organs and is essential to determine before prescribing any lifestyle or medical interventions. The implications of the biophysiological effects of different types of AT must be fully understood before a treatment plan is made for each patient.

WHtR in combination with metabolic health markers is a more accurate and superior tool than BMI in measuring overweight or obesity in LI patients and for planning management. The authors believe that moving the focus will make a significant contribution to the overall health and wellbeing of the LI community

and the allocation of funds within the Australian health system.

The discrepancy between recognising the effectiveness of WHtR yet relying on BMI for reporting might stem from historical precedence, as BMI is deeply entrenched in healthcare systems and practices. Shifting to a new measure requires significant re-education and restructuring. As many medical databases and research studies have historically collected BMI data, it has been easier to use for direct comparisons, even though WHtR offers more accurate insights. Education, research, and gradual integration of WHtR into clinical practices may eventually lead to a more comprehensive approach to evaluating obesity and associated health risks.

Assessing obesity and LI more accurately could redirect an estimated \$189 million annually in Australia from obesity management to LI management.

Conclusion

The authors of this article contend that WHtR is a more accurate tool than BMI for assessing overweight or obesity in the LI cohort. In this analysis of 151 women with LI, using the WHtR reduced the diagnosis of overweight or obesity from 93.4% to 72.2%, compared to 70% who are overweight or obese using this same metric in the general population. The incidence of obesity in the LI cohort, as determined by the WHtR tool, is similar to that in the general population, suggesting that obesity and LI may not have a higher incidence of coexistence than other health conditions affecting the lower limbs, which can cause pain and reduced mobility. Any pathophysiological and morphological relationship between obesity and LI, therefore, should not be assumed but rather questioned and further investigated.

LI and obesity are distinctly separate conditions that can coexist. Accurate anthropometric indices must be used to diagnose the presence or extent of obesity in the LI cohort. The differentiation of diseases will optimise the specificity of treatment advice given to each patient. This approach will likely reduce the risk of secondary obesity, mobility decline or lymphoedema, and psychosocial adversity for individuals with LI.

The WHtR may reduce the association between LI and obesity and should be the preferred biometric tool for measuring body

mass, evaluating health implications, and guiding management in individuals with LI.

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