Institution: University of Glasgow

Unit of Assessment: Unit 2; Public Health, Health Services and Primary Care

Title of case study: Waist circumference defines the need to take action on disease risk

1. Summary of the impact

Obesity is a global epidemic. Currently, more than half a billion adults worldwide are estimated to be overweight or obese yet this problem is entirely preventable. Excess weight costs the NHS over £5 billion each year and is associated with an increased risk of obesity-related disease (e.g. type 2 diabetes and heart disease). University of Glasgow researchers defined two 'Action Levels' for waist circumference to indicate the point when an individual needs to initiate weight loss to reduce their risk of disease. These Action Levels have been incorporated into national and international clinical guidelines for the diagnoses and management of obesity-related disease, and have provided the foundation for public-health campaigns and policies worldwide, designed to reduce the burdens of chronic ill-health that follow obesity.

2. Underpinning research

Body mass index (BMI) has been traditionally applied to define overweight and obesity for epidemiological purposes; this measure takes both a person's weight and height into account. However, the general public cannot easily calculate BMI, and errors are often compounded by overestimating height and underestimating weight. Moreover, BMI can be misleading when applied to individuals with variable muscle mass. University of Glasgow research led by Professor Mike Lean aimed to identify a simpler and more reliable measure than BMI to classify body fat and consequent disease risk that could primarily be used in health-promotion initiatives. Although waist circumference had been measured in some previous epidemiological studies, University of Glasgow research was the first to investigate the independent relation of this parameter to total body fat, and to propose cut-off values of waist circumference for practical use.

Waist circumference established as valid indicator of total body fat (1995–1997)

A population-based study conducted by Lean's group in 1995 measured height, weight, waist-to-hip ratio and waist circumference in almost 2,000 Scottish men and women.[1] Through comparison with conventional BMI categories (BMI >25 and >30 indicating excess weight and obesity, respectively), this study demonstrated that waist circumference alone could provide comparable classification.[1] The accuracy of waist circumference for estimating body fat was further established with underwater weighing as the reference method for body composition and predictive equations for body fat content were developed, using simple body measurements.[2] Between 1996 and 1997, while working in collaboration with groups in the Netherlands (led by Jacob Seidell at the National Institute of Public Health and the Environment, Bilthoven, and Paul Deurenberg at the University of Wageningen), the University of Glasgow researchers further validated the predictive ability of waist circumference using data from two existing international survey databases. Waist circumference was shown to be a better predictor of both total body fat and its distribution than BMI,[3] even without adjusting for height.[4]

Development of 'Action Levels' for waist circumference (1995–1998)

The above work culminated in the definition of two key 'Action Levels' for waist circumference,[1] which identify the need for weight management among white populations:

- **Action Level 1**: a waist circumference over 94 cm in men or 80 cm in women signals that personal action is required.
- **Action Level 2**: a waist circumference over 102 cm in men or 88 cm in women signals that professional advice should be sought.

To address the issue of self-assessed waist circumference being under-estimated, Lean's team developed the 'Waist Watcher' – a push-button tension-controlled tape measure with three intuitively coloured bands:(i) green: waist circumference below Action Level 1; (ii) amber: waist circumference between Action Levels 1 and 2; and (iii) red: waist circumference above Action Level 2. The University of Glasgow researchers showed that individuals could self-assess waist

circumference significantly more accurately using the Waist Watcher than they could with a conventional tape measure (sensitivity and specificity for Waist Watcher both above 95%).[5]

Action Levels for waist circumference correlate with risk of chronic disease

By the late 1990s, the association between increased accumulation of body fat – particularly with an intra-abdominal or 'central' distribution – and obesity-related ill-health became widely accepted. To determine the ability of waist circumference to predict such disease risk, the University of Glasgow researchers performed statistical correlations of data on cardiovascular risk factors (type 2 diabetes, blood pressure, cholesterol levels and lifestyle factors) with waist circumference measurements from over 5,000 men and women.[2] Individuals with a waist circumference between Action Levels 1 and 2 were 1.5–2.0 times more likely to be at cardiovascular risk than were those with a waist circumference below Action Level 1. At a waist circumference above Action Level 2, individuals had a 2.5–4.0 times greater risk.[2] In addition, other obesity-related symptoms (shortness of breath, impaired physical function and lower back pain), as well as the prevalence of type 2 diabetes, were significantly greater among individuals with a waist circumference above Action Level 2, even following adjustment for age and lifestyle.[6] Higher waist circumference measurements were also associated with impaired quality of life, including reduced capacity for performing everyday activities and increased likelihood of becoming unemployed.

Key University of Glasgow researchers: Mike Lean (Professor of Human Nutrition [1990–present]); Caroline Morrison (Honorary Clinical Lecturer [2007–2010]).

3. References to the research

1. Lean ME *et al*. Waist circumference as a measure for indicating weight management. *BMJ* 1995; 311: 158–116 doi 10.1136/bmj.311.6998.158.
2. Han TS *et al*. Waist circumference action levels in the identification of cardiovascular risk factors: prevalence study in a random sample. *BMJ* 1995; 311: 1401–1405.
3. Lean ME *et al*. Predicting body composition by densitometry from simple anthropometric measurements. *Am J Clin Nutr* 1996; 63: 4–14 [doi not available]
4. Han TS *et al*. The influence of height and age on waist circumference as an index of adiposity in adults. *Int J Obes* 1997; 21: 83–89 [doi not available]
5. Han TS & Lean ME. Self-reported waist circumference compared with the 'Waist Watcher' tape-measure to identify individuals at increased health risk through intra-abdominal fat accumulation. *Br J Nutr* 1998, 80: 81–88 doi./10.1017/S0007114598001809
6. Lean ME *et al*. Impairment of health and quality of life in people with large waist circumference. *Lancet* 1998; 351: 853–856 doi: 10.1016/S0140-736(97)10004-6

4. Details of the impact

Context

By the late 1990s, concerns were growing about the global scale of the obesity epidemic and high-profile health organisations sought to develop public-health strategies to tackle the problem. The University of Glasgow waist circumference Action Levels published 1995 were rapidly adopted by the World Health Organisation (WHO) in its influential Technical Report 'Obesity: Preventing and Managing the Global Epidemic' released in 2000.[a] Although the report did not include any citations to published research, the WHO explicitly defined a waist circumference above 94 cm and 102 cm in men, and above 80 cm and 88 cm for women, as corresponding to an increased risk and a substantially increased risk, respectively, of obesity-related illness within white populations. A statement from the Chairman of the WHO committee confirms that University of Glasgow research (Lean *et al.* 1995a[1]) formed the evidence base for these cut-offs.[b] Citation by the WHO gave the Glasgow Action Levels a global profile and stimulated public-health impacts across the world. The WHO report is cited by many of the campaigns that quote the University of Glasgow waist circumference Action Levels. Indeed, since the exact values (94 cm in men or 80 cm and 102 cm in men or 88 cm in women) stated by the waist circumference Action Levels are entirely unique to the University of Glasgow human nutrition research evidence-base, any publication or guideline which cites these values can be considered an impact of this research.

Incorporation in health promotion and disease risk screening campaigns

The simplicity of measuring waist circumference and the ease of interpretation of the Action Levels by the general public confer a strategic advantage over previous BMI-focused messages and lend themselves to inclusion in public-health initiatives. Since 2008, there has been a flood of prominent public-health programmes targeting obesity and obesity-related health risks. The waist circumference Action Levels defined by the University of Glasgow have become the benchmarks in a broad range of these campaigns internationally.[c,d]

For example, the charity Diabetes UK uses the University of Glasgow Action Levels in their online materials to alert the public to the need for weight loss to limit the risk of developing diabetes. Similarly, the British Heart Foundation advocate the Glasgow Action Levels as a way to determine if weight loss is required in order to '*raise awareness of shape as well as weight being important in relation to risk of coronary heart disease*'. To complement this, as part of their Heart Matters campaign, the society offers a tape measure based on the 'Waist Watcher' in their welcome pack. The Waist Watcher tape is also available to buy from online retail giant Amazon. Further UK campaigns that cite the University of Glasgow Action Levels to promote weight loss and raise awareness of the central obesity-related disease risks include the NHS Choices '*Why is my waist size important?*' initiative, the British Dietetic Association '*Weight Wise'* campaign and the Public Health Agency, Northern Ireland information leaflet '*Is your waistline creeping up on you?*'. Internationally, the University of Glasgow Action Levels have been prolifically cited in health-promotion campaigns from 2008 onwards, including '*Healthy Weight – it's not a diet, it's a lifestyle*' (Centers for Disease Control and Prevention, USA.)*,* '*Healthy Waist*' (Heart and Stroke Foundation of Canada), '*Measure your waist'* (National Heart Foundation of Australia), *'Measure Up'* (Australian Government) and 'Health@Work' (Hong Kong Government).

Informing clinical guidelines and policies

The impact of the University of Glasgow Action Levels within clinical and public-health medicine has been substantial. They are cited in numerous national and international clinical guidelines[e] on obesity and cardiovascular risk that recommend the use of the Action Levels for waist circumference, in combination with BMI, for the diagnosis of obesity and stratification of disease risk:

- The UK *National Institute for Health and Clinical Excellence* (NICE) guideline CG43 on prevention, identification, assessment and management of overweight and obesity in adults and children (originally published in 2006, reviewed in 2011 with all recommendations upheld)
- The *Scottish Intercollegiate Guideline Network* (SIGN) guideline 115 on management of obesity (2010)
- The *Australian National Health and Medical Research Council* guideline on management of overweight and obesity in adults, adolescents and children in Australia (2013)
- The *New Zealand Ministry of Health* clinical guideline for weight management in New Zealand adults (2009) as part of the clinical weight management algorithm to raise patient awareness of obesity-related disease risk
- The joint *European Society of Cardiology/European Atherosclerosis Society* (ESC/EAS) guidelines on the management of dyslipidaemias (2011) included the Action Levels to categorise heightened obesity-related cardiovascular risk and signal the need for blood cholesterol testing
- The *International Atherosclerosis Society* position paper on global recommendations for the management of dyslipidemia (2013)
- The *World Gastroenterology Organisation* (WGO) global guideline on obesity (2011). The WGO is an umbrella organisation of over 100 national professional gastrointestinal societies. Their 2011 guideline recommends a management scheme to stratify eligibility for surgery and initial treatment options according to the Action Levels defined by the University of Glasgow, in combination with BMI. Within this scheme, individuals with a waist circumference above 94 cm (men) and 80 cm (women) (Action Level 1) are recommended to receive diet and exercise advice; above 102 cm (men) and 88 cm (women) (Action Level 2) individuals should be considered for additional behavioural support and weight-loss

drugs. Patients should only be considered for surgery once they have exceeded the upper Action Levels for waist circumference, with a BMI greater than 35 and failed diet and lifestyle interventions.

In addition, the University of Glasgow Action Levels have been highly influential in government-commissioned population-based studies and are routinely used to analyse the National Health Surveys (Scottish Health Survey and Health Survey for England; most recently published in 2011).[f]

5. Sources to corroborate the impact

a. WHO report 'Obesity: Preventing and Managing the Global Epidemic' (see Chapter 2, page 11)

b. Statement from the Chairman of the WHO committee (available on request)

c. Leading UK charities and professional bodies citing the University of Glasgow waist circumference Action Levels as a means to monitor the need for weight reduction/disease risk:

- Diabetes UK: How do I know if I need to lose weight?
- British Heart Foundation: Your weight; further information on this available on request
- NHS Choices: Why is my waist size important?
- British Dietetic Association: Measure your waist: are you an apple or a pear?
- Public Health Agency, Northern Ireland information leaflet 'Is your waistline creeping up on you?'

d. Leading international bodies citing waist circumference as a means to monitor the need for weight reduction/disease risk:

- US Centers for Disease Control and Prevention: Assessing your weight
- Heart and Stroke Foundation of Canada: Healthy waists
- National Heart Foundation of Australia: Measure your waist

e. Clinical guidelines on the management of obesity citing Glasgow waist circumference Action Levels:

- SIGN guideline 115 (2011) (WHO report cited as ref 4; pg 10–11, Table 3)
- NICE guideline on obesity (2006, reviewed in 2011) (WHO report cited as ref 44 and Lean *et al.* 1995a cited as ref 20; see pg 199 and 218-225; Tables 5.2, 5.6, 5.7, 5.9 and 5.10)
- Australian National Health and Medical Research Council (2013) (WHO reported cited [no ref number given]; section 4.3.1, pg 26)
- World Gastroenterology Organisation Global Guideline (2011) (Table 2, pg 15)
- New Zealand Ministry of Health guideline on weight management (2009) (Cites the WHO report; Table 1, pg 25)
- ESC/EAS guideline on dyslipidaemia (2011) doi:10.1093/eurheartj/ehr158 (Table 4, pg 1780–1781)

  International Atherosclerosis Society Position Paper Global Recommendations for the Management of Dyslipidemia (2013) (Cites WHO report; Table 2, pg 7)

f. Health surveys:

- Scottish Health Survey (2011)
- Health Survey for England (2011)