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Clinical measures of obesity and weight loss in men

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OBJECTIVES: (1) To determine the relationship between waist circumference and body weight in overweight men both before and after participation in a weight loss program; and (2) to make recommendations for the appropriate use of these measures at various stages of weight loss.
DESIGN: Weight and waist circumference measures were taken in two diverse groups of men both before and 1–2 y after commencing a men's 'waist loss' program. Regression analyses were used to assess the relationship between weight and waist measures.
SUBJECTS: One group of 42 retired Caucasian men from New South Wales, and one group of 45 indigenous men from the Torres Strait region of Northern Australia.
RESULTS: There were differences in the relationships of weight and waist circumference before the program and change in weight and change in waist circumference after weight loss. These differences were similar in both groups of men (indigenous men and retired Caucasian men), with a 1 cm waist loss being on average equivalent to about 3/4 kg, but with wide variability, suggesting inter-individual variation in fat losses from different depots. This variation suggests that neither weight nor waist alone is a sufficient measure of fat loss for men.
CONCLUSIONS: Weight and waist circumference should both be used at various stages in the clinical situation to assess change in body fat in men involved in obesity reduction.
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Introduction

There are a number of measures now available for estimating fatness in humans.[1] These range from simple anthropometry, to complex imaging techniques. Yet while many of these have relevance for research, it is not clear what are the most appropriate for clinicians, even though the clinical setting provides one of the best opportunities to reduce a health risk that has now achieved epidemic proportions.[2]

Some measures, such as body mass index (BMI), are valid at the population level, but they and their main component, body weight, are less useful in individuals or sub-groups.[3] Mesomorphic males, for example, may have low body fat but be rated as obese using weight or BMI. Skinfold thicknesses are widely used, but measuring these requires experience, and their reliability is low in obese people.[4] Modern imaging techniques such as magnetic resonance, computerized tomography and dual X-ray absorptiometry (DEXA) are more accurate, but are expensive and not feasible in the clinical situation.

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The criteria for a good clinical measure of body fat, apart from the validity, reliability and sensitivity expected of any good measure, include ease of use and patient acceptability. Accuracy and ease of self-measurement would also be an advantage. A good measure, or combination of measures, should have value as an absolute measure of disease risk as well as be responsive to changes in body fat.

Since the original work of Vague,[5] abdominal fat stores have now been accepted as more dangerous than fat stored elsewhere.[6] This has led to the use of waist-to-hip ratio (WHR) as a suggested clinical measure of risk.[7,8] However, because gluteal fat, as well as subcutaneous abdominal fat can decrease in some individuals with weight loss, the sensitivity of WHR in picking up changes in body fat is low. On the other hand, waist circumference alone may be sufficient as a predictor of risk. Several researchers have shown this to be a good predictor of potentially dangerous visceral adipose tissue.[9,10] A waist circumference of greater than 100–102 cm in males or 88–90 cm in females has been suggested as indicating a need to reduce body fat.[11,12] Clinical recommendations based on waist circumference are shown in Table 1. Waist circumference, in males at least, has also been shown to be sensitive to fat loss and can be used as a practical measure of progress in any fat loss program.[13] Finally, it is a simple and easily explained measurement.

Table 1 Clinical recommendations based on waist size (adapted from Refs 11 and 12)

Waist size (cm)		
Males	*Females*	*Recommendation*
> 100	> 90	Reduce weight
94 – 100	80 – 90	Avoid weight gain
< 94	< 80	Maintain current weight

The quantitative relationship between waist size and the more traditional measure of body weight is not well documented, especially for obese people. Nor is there a well-established association between waist loss and changes in body weight. There are individual variations in the sensitivity of fat depots.[14] Hence waist circumference as an indicator of fat loss may vary between individuals. Similarly, because fat loss can be accompanied by increases in muscle tissue or energy stores, [15] particularly in men, weight loss is not necessarily a sensitive measure of fat loss in some people, at least in the early stages.

In the current study we have used data on weight and waist in two widely different samples of men involved in a men's 'waist loss' program in Australia. Regression analysis on baseline measures and changes in weight and waist 1 – 2 years after commencing the program have been carried out to determine the quantitative association between the two measures. These data are then used to propose recommendations for the clinical assessment of body fatness in obese men.

Subjects and methods

The subjects were men from two widely different groups involved in the GutBuster program in Australia. Results from the two studies have been reported elsewhere.[13,16] The first group (RT) consisted of 42 retired men from the mid-north coast of New South Wales, Australia; the second (TS) were 45 indigenous men from the Torres Strait Islands between Australia and Papua New Guinea.

The GutBuster program, developed in Australia for men, focuses on 'waist' rather than weight loss.[17] The long-term goal of the program is a waist circumference of 100 cm or less for all men, and the short-term goal is a 1% waist loss per week over the initial 5 weeks. Men are asked to determine their own mid-term goal. Weighing has been discouraged because it was found that this can give a false representation of changes in body fatness, at least in the early stages of fat loss. For this reason, data have not been available for this study with all of the large numbers of men who have otherwise been through GutBusters to date (now > 50,000).

Weight and waist measurements were carried out in these two groups of men for research purposes before the commencement of a GutBuster program, and at several stages throughout the program. In the case of RT, men were provided with a measuring tape as part of the program and initially shown how to measure themselves (using the umbilicus as a guide, with the measurement tape horizontal). Initial measurements in the RT group were validated against expert measurements and training on how to do this was provided. No further validation of self-measurement was made. Each man also used personal body weight scales, and each was asked to use the same scales for all follow-up measurements. In the case of TS, measurements were taken by researchers four times over the course of a year as part of a larger, anthropometric survey. Portable Tanata BIA scales (Tanata Co., Tokyo, Japan) were used for measuring weight and body fat, and a standardized tape was used for measuring waist circumference. Where abdominal aprons had excessive subcutaneous fat stores hanging, as in the case of three men, this was overcome by getting men to lift the waist apron manually until the umbilical level was horizontal. Umbilicus is used as the marker for waist measurement in men in the GutBuster program, primarily because of its easy siting and hence greater prospect for reliability of self-measurement.

The men were given an initial 5-week period of instruction in modified versions of the GutBuster program. RT men were measured four times over 2 y, but measurements at baseline and after 2 y only were used for the current analysis. TS men were measured four times over 1 y as part of a more extensive evaluation of an obesity reduction program in indigenous men.[16]

Simple and multiple regression analyses were used to determine the relationship between weight and waist both at baseline and change in weight and change in waist after participation in the program (2 y for RT and 1 y for TS).

Results

Characteristics of both samples of men are shown in Table 2. Both groups lost significant weight and waist size. Figure 1 shows the relationship between initial

Table 2 Initial characteristics and weight and waist changes in RT and TS men: means and standard deviations

	RT (retired men) n = 42	*TI (Torres Islanders) n = 45*
Age (y)	55 (6.2)	41 (12.3)
Initial weight (kg)	94.1 (13.5)	106.4 (17.8)
Initial waist (cm)	113.8 (9.1)	117.8 (13.4)
Δweight (kg)	− 5.05 (4.83) after 2 y	− 3.25 (3.48) after 1 y
Δwaist (cm)	− 6.02 (4.81) after 2 y	− 4.01 (3.54) after 1 y

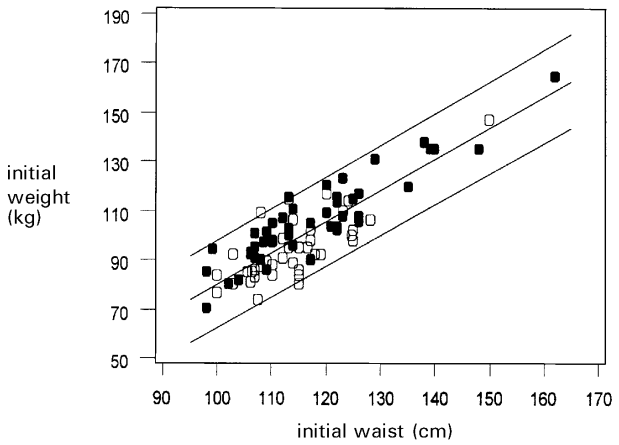

Figure 1 Initial weight plotted against initial waist size for each group (open squares for TS and solid squares for RT) together with the regression line (weight = − 45.543 + 1.260 waist, r^2 = 74.5%) and 95% prediction limits.

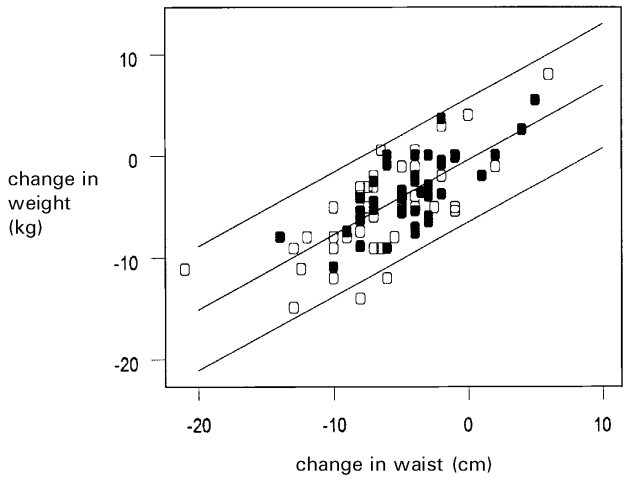

Figure 2 Changes in weight (Δweight) plotted against changes in waist (Δwaist) for each group (with open squares for TS and solid squares for RT) and the regression line (Δweight = − 0.396 + 0.734 Δwaist, r^2 = 55.4%) and 95% prediction limits.

weight and waist circumference and Figure 2 shows the relationship between changes in these two measures. Regression analyses allowing different slopes and different intercepts for the two groups were performed, but as the differences between the groups were small and made no improvement to the models, the results shown here are for all data combined. For the relationship between changes in weight and changes in waist, the initial values also made little difference to the model fit so they are omitted in the results presented here.

The regression equation for the initial measurements was weight = − 45.543 + 1.260 waist with *r*-squared = 0.745. Hence, for a man with a girth of 120 cm the predicted weight was 106 kg with a 95% prediction interval of 88 − 123 kg (Figure 1).

The regression equation for the changes, Δweight and Δwaist, was: Δweight = − 0.396 + 0.734 Δwaist with *r*-squared = 0.554. Thus a 1 cm reduction in waist was associated with a mean 734 g loss of weight. As an example, for a man who lost 5 cm, the predicted weight change was − 4.1 kg with a 95% prediction interval of − 9.8 − 1.7 kg (Figure 2).

Discussion

Regression analyses of body weight and waist size before, and changes in these two measures after a successful weight loss program, were used to determine the relationship and effectiveness of both measures in two different groups of men. The regression of weight on waist size showed no differences between the two groups, indicating a consistency in the association. There was also a high correlation between initial weight and waist size (correlation co-efficient = 0.86) and changes in these two measurements (correlation co-efficient = 0.74). However there were important differences in the relationships between waist size and weight in the initial cross-sectional data, and between changes in these two measures in the follow up data. A 1 cm difference in waist size between men measured at baseline, equated to an average weight difference of 1.26 kg. Yet a 1 cm waist loss within men was equivalent to an average weight loss of approximately 0.75 kg. This suggests that there may have been fat (or lean body mass) losses from areas other than the waist in some men, making waist alone an insufficient measure of weight loss in these cases. Practical experience using reduction in waist circumference alone as an indicator of success on the GutBuster program supports this finding. Particularly during the early stages of a program, some men lose dimensions from around the chest or neck or even gluteal region and thighs, while maintaining waist size. It might be hypothesized that this discrepancy could be based on initial body shape, although this could not be tested with the current data.

An explanation for why waist loss is not always reflected in weight loss in men could be found in changes in muscle tissue with exercise. Increases in muscle tissue and the hydrophilic qualities of glycogen in muscle stores with an increase in physical

Table 3 Recommendations for sequential measures of fat loss in men

Baseline	*Weeks 1 – 4*	*Post week 4*
Weigh	Weigh only if no decrease in waist size	Weigh (infrequently), but only if no continued change in waist
Measure waist	Measure waist (weekly)	Measure waist (~weekly)

activity could increase, or at least maintain weight, while decreases occur in body fatness. This might be expected, at least in the early stages of a weight loss program, before significant fat loss is eventually reflected in weight change.

The implications of these findings are that neither weight nor waist circumference alone is sufficient to provide a true reflection of fat loss in men. Use of both these measures may be necessary at different stages of a program to get a true indication of relative success in men, although the greater emphasis may still be put on the more potentially dangerous abdominal fat stores through waist circumference measures. Because paradoxical weight changes are more likely to occur in the early stages of a program, our experience has shown that after baseline weight and waist measurements are taken, weight should not be measured again for some time, possibly 4–6 weeks for best results. An exception to this may be as a check where no waist loss appears to be occurring in this time. While abdominal fat stores are primary in men and are likely to be more reactive than peripheral fat stores on the basis of lipolytic reactivity,[18] use of both weight and waist measures in the sequence recommended in Table 3 allows for individual variations in the reactivity of fat depots between men.

The metabolic implications of losses in weight *vs* waist size might be expected to differ, particularly as a result of more direct changes in visceral fat through waist losses.[19] Despres *et al*[20] for example have shown that improvements in metabolic indices can occur through decreases in abdominal, and subsequently visceral fat, in the absence of normalization of body weight. More research is required to establish how these inter-individual differences in depot store changes affect the health of individual men.

Our data suggest that, in the clinical situation, the use of both measures of weight and waist size at various stages of fat loss may provide a more comprehensive picture than either measure alone. These data, however, only refer to measurements for obese males. Comparative measures for obese females and less overweight people require further testing.

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