

BMI-based figure rating scale (FRS) as an adjunctive aid in nutritional screening and assessment in a resource-limited setting

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Objectives: Many existing malnutrition screening and diagnostic tools require body mass index (BMI) and quantification of weight change to detect malnutrition or risk thereof. This is often a challenge in South African public hospitals due to missing data, including patient records. This study investigated the extent to which hospitalised patients can gauge their current and usual body size from a validated BMI-based figure rating scale (FRS). It also ascertained whether a relationship exists between a change in clothing size and a change in perceived BMI, derived from the FRS.

Methods: A total of 196 adult patients participated in a cross-sectional study, in three Eastern Cape public hospitals. Data were collected by consulting medical files, patients and taking anthropometric measurements. Validated FRSs were used to determine patients' accuracy of actual and usual BMI. Data were analysed with Statistica® and Microsoft Excel 2016.

Results: Some 66% ($n = 131$) of participants were accurate in selecting an image representative of their BMI, which was statistically significant ($r^2 = 0.80$; $p < 0.001$). Female participants were more likely to select the correct corresponding BMI image ($p < 0.05$; $r^2 = 0.77$ for males; $r^2 = 0.82$ for females). Altogether, 61% ($n = 79$) of participants with a known previous weight were accurate in selecting an accurate image representative of their usual BMI, also statistically significantly ($r^2 = 0.71$; $p < 0.001$).

Conclusion: An existing FRS may be a useful adjunctive aid in clinical practice to estimate certain anthropometric indices when not otherwise available. This may be especially relevant to nutritional screening practices conducted by frontline healthcare professionals, e.g. nurses and doctors not specifically trained in anthropometry. This in turn may improve malnutrition detection rates and facilitation of appropriate nutrition care pathways.

Keywords BMI, figure rating scales, limited resources, malnutrition, missing data, nutrition screening, weight change

Introduction

Adult malnutrition is one of the leading challenges to patient care in many hospitals worldwide, leading to a well-documented range of adverse consequences for the patient and increased costs for health care.¹

Recent South African studies estimated prevalence rates of malnutrition (in the form of undernutrition) to be between 27% (BMI $< 18.5 \text{ kg/m}^2$) and 48% (mid-upper arm circumference [MUAC] $< 23 \text{ cm}$)^{2,3} and malnutrition risk to be between 69.8%⁴ (based on NRS-2002⁵ score ≥ 3) and 72%^{2,3} (based on the Malnutrition Universal Screening Tool [MUST])⁶ 48% high risk score ≥ 2 ; 24.1% medium risk score ≥ 1).

Early detection of malnutrition or the risk thereof is vital for the treatment of or delay in progression of the condition, thereby assisting in preventing or reducing the severity of the associated complications and costs.⁶ However, it often goes undetected and untreated,^{3,7} with a recent South African study showing that only 20% of underweight and high malnutrition risk patients were referred to dietetic services.³

In order to improve malnutrition detection rates, all hospital in-patients should be screened on admission and weekly thereafter.^{8–10} It has been proposed that this should become mandatory practice in South African public hospitals.³

The Global Leadership Initiative on Malnutrition (GLIM) recently launched a two-step model for global use, starting

with malnutrition risk screening, followed by assessment for diagnosis and grading severity.¹¹ It is recommended that it should be performed by all healthcare professionals, using methods that are widely available.¹¹ The National Institute for Health and Care Excellence (NICE) recommends that screening should assess body mass index (BMI) and percentage unintentional weight loss; also that it should consider the time over which nutrient intake has been unintentionally reduced and/or the likelihood of future impaired nutrient intake.⁹ Additional parameters that may be required for screening tools and malnutrition diagnostic tools include disease burden and an indicator of muscle mass or function.¹¹

However, access or viability of these parameters are often restricted in the clinical setting, especially where there are limited resources. This could be due to compromised mobility or consciousness of in-patients for direct anthropometric measurements, limited skills and time of non-nutrition healthcare professionals (doctors and nurses), lack of equipment and poor documentation in patient files.^{2,3,12} It is then difficult to obtain the necessary information or to perform calculations and interpretation, such as BMI and percentage weight loss.^{2,13–16} Self-reporting of weight by patients in South African public hospitals is further constrained by patients often not owning scales to weigh themselves at home, and language barriers that prevent effective extraction of information.¹⁴ Although trained nutritional professionals, for example dietitians, are skilled in extracting this information, it becomes a challenge to obtain through non-nutrition professionals, such as nurses and

doctors. This is particularly difficult in a resource-limited setting, such as South African public hospitals.^{2,3}

Valid, easy-to-use, surrogate measures, which can be quickly performed, are needed in order to facilitate routine screening and consequent diagnosis of malnutrition by non-nutrition healthcare professionals in resource-limited public hospitals. To this effect, the use of MUAC has been proposed as a relatively easy singular measurement to identify patients at risk of malnutrition (both under- and overweight) in South African public hospitals. This has been shown to correlate well (chi-square = 38.816; $df=2$; $p < 0.001$) with the validated Malnutrition Universal Screening Tool (MUST). It is, however, acknowledged that recent significant unplanned weight loss may remain undetected with MUAC only,³ a parameter often required for malnutrition diagnostic and in-depth assessment purposes.

Figure rating scales (FRS) depicting body size have been used to assess body size perceptions.^{13,17,18} Its usefulness as an inexpensive indicator of nutritional status, when direct anthropometric measurements are not possible, have been observed. Harris *et al.* (2008), who developed the FRS used in this study (Figure 1), found a strong positive correlation between measured current BMI and selecting an FRS image with a BMI corresponding to their usual BMI, in 400 American adults ($r^2 = 0.94$ for men and 0.86 for women; $p < 0.001$).¹⁷

Two studies focused on the use of FRS developed or adapted for African populations. Cohen (2015) developed FRS for the Cameroonian population and included both front and side-view profiles of the body scales, which may provide superior representation of abdominal obesity (Figure 2). A total of 161 participants were included in this study and acceptably strong correlations ($r^2 = 0.72$ for males and 0.59 for females; $p < 0.001$) between self-perceived current body size and BMI were found.¹⁸

Yepes *et al.* (2015) assessed the validity of the Pulvers silhouettes,¹⁹ as a simple self-reported survey measure for body size, adapted to reflect African populations' distinct morphology.

The study included 1 240 participants from the Republic of Seychelles, and also found strong positive correlations ($r^2 = 0.64$ for men and 0.66 for women; $p < 0.001$) between measured BMI and self-reported silhouette rankings.¹³ The study did, however, acknowledge the FRS developed by Harris *et al.* to be more accurate than theirs.

This article proposes the use of BMI-based FRS as surrogate measures for BMI and weight change for malnutrition diagnostic and assessment purposes, in circumstances where it is not possible or feasible to obtain such BMI and weight change. The study's aim was to determine to what extent hospitalised patients can gauge their current and usual body size from a previously validated FRS, developed by Harris *et al.*,¹⁷ comprising images with known body mass indexes (Figure 2). It also ascertained whether a relationship exists between a change in clothing size and a change in perceived BMI according to the FRS. According to the authors' knowledge, this will be the first study globally to test the use of BMI-based FRS as a supportive proxy to obtain 'missing information' in the clinical setting. It will also be the first study to investigate the use of FRS to guide clinicians with regard to weight change of patients when historical data are not otherwise available.

The figures are labelled from A to J, each representing a BMI range, as can be seen in Table 1.

Methods

Study design and participants

A descriptive correlational design was used in three public hospitals in the Eastern Cape province of South Africa. The three hospitals were purposely selected as they are the three largest public hospitals in the Nelson Mandela metropolitan area, and have a high bed occupancy. Data were collected over a seven-day period in May 2018 by a trained fieldworker (final-year dietetics student), via interviewer-administered questionnaires, anthropometric measurements and medical files.



Figure 1. BMI-based figure rating scales developed by Harris *et al.*¹⁷

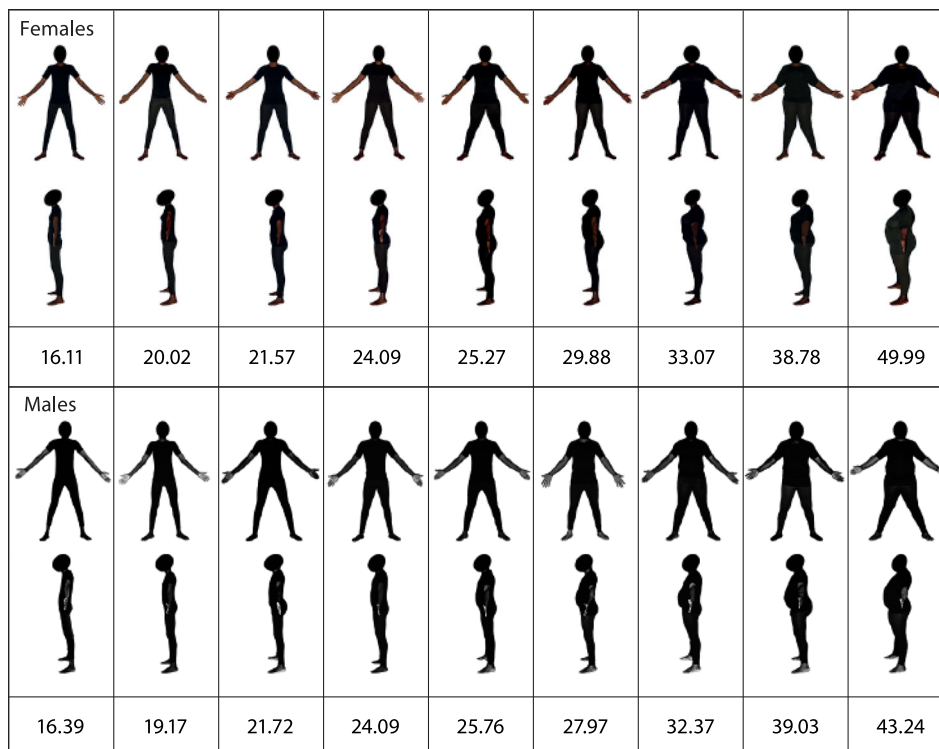


Figure 2: BMI-based figure rating scales developed by Cohen *et al.*¹⁸ depicting male and female models with their corresponding BMI.

Table 1: Figure rating scales classification¹⁷

Symbol	BMI	Interpretation
A	< 18.5 kg/m ²	Underweight
B, C	18.5–24.9 kg/m ²	Normal weight
D	25.0–29.9 kg/m ²	Overweight
E, F	30.0–34.9 kg/m ²	Class I obesity
G, H	35–39.9 kg/m ²	Class II obesity
I, J	≥ 40 kg/m ²	Class III obesity

Study participants

The study sample comprised all consenting adult in-patients who were present during data collection in the general surgical, medical, cardiothoracic, cardiology, ear, nose and throat (ENT), orthopaedic, oncology, haematology and burns wards, using a consecutive sampling approach. Patients were excluded if they were under the age of 18 years, presented with psychiatric illnesses or mental disability or were unwilling or unable to provide consent. Patients were also excluded from the study if they were unable to stand unassisted to have their direct weight and height measured.

Anthropometrics

A calibrated SECA scale (Seca GmbH, Hamburg, Germany), SECA stadiometer, and a non-stretchable measuring tape were used to obtain anthropometric measurements, including weight, height and MUAC according to standardised procedures, and read to the nearest 0.1 kg and 0.1 cm respectively.²⁰

Current weight and BMI in this study refer to the weight and BMI of participants at the time of data collection. BMI was calculated by dividing the weight (kg) by the height (m) squared²⁰ and was categorised according to the WHO (2018) cut-offs as follows: underweight (BMI values < 18.5 kg/m²), normal or desirable

weight (BMI values 18.5–24.9 kg/m²), overweight (BMI values 25.0–29.9 kg/m²), obese Class I (BMI values 30.0–34.9 kg/m²), obese Class II (BMI values 35.0–39.9 kg/m²) and extremely obese (BMI values > 40.0 kg/m²).²¹

Usual weight and BMI in this study refer to the weight or BMI of participants three to six months prior to data collection. It was obtained from the patient (self-reported) if it was known and/or from the medical files. The documented weight was also used to verify the self-reported usual weight, after which the usual BMI was calculated.

MUAC was classified as not malnourished (> 23 cm) and malnourished (≤ 23 cm).²²

Change in clothing size

Patients were asked about any changes in their clothing size over the previous three to six months, where males and females were asked about their pants and dress size respectively. To this end, both their self-reported current and usual clothing sizes were obtained. This information was used to determine the relationship between percentage weight change and a change in clothes size.

Use of figure rating scales

The accuracy of patients’ perceptions of body size was determined with the FRS developed by Harris *et al.*¹⁷ The authors preferred this version in comparison with the Cohen *et al.* FRS, as BMI ranges are given for each image instead of a specific cut-off, which made it easier to categorise participants’ responses. Furthermore, it was the authors’ view that the Harris *et al.* FRS provides more lifelike images of human bodies, and more distinct differences in body size images in comparison with the Cohen *et al.* version.

The Harris *et al.* FRS comprises 10 individual body images (A–J), representing women and men ranging from underweight (BMI < 18.5 kg/m²) to Class III obese (BMI ≥ 40 kg/m²) as shown in Figure 1.

Participants were asked to select one image that best resembles their perceived *current* body size, as well as their perceived *usual* body size (referring to the three to six months prior to data collection). The *calculated current* BMI was correlated with the *perceived current* BMI-based FRS image, in order to determine patients' precision in evaluating their body size using an FRS. In addition, the *calculated usual* BMI (based on self-reported weight or weight obtained from the medical file), was correlated with the *perceived usual* BMI-based FRS image selected by participants.

Reliability and quality of data

A pilot study was conducted on seven patients in one of the hospital's urology wards, after which some alterations were made to the researcher-administered questionnaire to improve the content validity. Alterations included the insertion of units of measurements, and specifying whether usual weight was self-reported or obtained from the medical file. The data from the pilot study were not included in the final results.

To improve the reliability and validity of the data, standardised procedures²⁰ were followed to measure anthropometric indices by the trained fieldworker, who had successfully completed a previous anthropometry module, and had regular practice and evaluation sessions on anthropometric measurements as part of dietetics undergraduate training. The previously validated Harris *et al.* FRS¹⁷ was used to determine patients' ability to identify their actual and usual BMI, and weight change.

Statistical analysis

Each participant's data were recorded on a researcher administered questionnaire. The data were then transferred to Microsoft Excel spreadsheets (Microsoft Corp, Redmond, WA, USA) for statistical analysis.

Data were analysed using Statistica® (version 13) (TIBCO Software Inc, Palo Alto, CA, USA) and Microsoft Excel 2016 with the assistance of a statistician from the Nelson Mandela University. Continuous variables, such as age, were presented as means and standard deviations. Categorical variables, such as gender, ethnicity and nutritional status classifications, were presented as frequencies. Pearson's correlation coefficients were used to determine the strength and direction of the linear relationship between BMI, change in clothing size and FRS images. A *p*-value < 0.05 was considered statistically significant.

Ethical considerations

Ethical approval and permission to conduct the study in the three hospitals were obtained from the Ethics committee of the Nelson Mandela University (H15-HEA-DIET-005), the Eastern Cape Health Research committee (EC_2015RP_34_316) and the CEOs of the three hospitals. Participants were informed about the objectives, procedures and confidentiality aspects of the study, and provided their written informed consent. Stored and captured data were non-identifiable and are filed securely at the university for a period of five years. All procedures were guided by the ethical principles detailed by the Declaration of Helsinki.²³

Table 2: Nutritional status according to BMI and MUAC

BMI	<i>n</i>	Percentage of study population (%)
Underweight (BMI < 18.5 kg/m ²)	45	23
Normal weight (BMI 18.5–24.9 kg/m ²)	74	37.7
Overweight (BMI 25–29.9 kg/m ²)	39	19.9
Class I obesity (BMI 30–34.9 kg/m ²)	16	8.2
Class II obesity (BMI 35–39.9 kg/m ²)	7	3.5
Class III obesity (BMI ≥ 40 kg/m ²)	15	7.7
Total	196	100

MUAC	<i>n</i>	Percentage of study population (%)
Malnourished (≤ 23 cm)	73	37.2
Not malnourished (> 23 cm)	12	68.8
Total	196	100

Results

A total of 196 participants, meeting the inclusion criteria, consented to participate in the study. The mean age of the participants was 43.4 years (SD = 15.7) and 58.2% (*n* = 114) were female. The ethnic distribution consisted of 71.9% (*n* = 141) black, 26.5% (*n* = 52) coloured and 1.5% (*n* = 3) white participants.

Ward specialties included general medical (52%, *n* = 101), surgical (23%, *n* = 46), oncology (11%, *n* = 21), orthopaedics (4%, *n* = 8), ENT (3%, *n* = 6), cardiology (3%, *n* = 5), burns (3%, *n* = 5), cardiothoracics (1%, *n* = 2) and haematology (1%, *n* = 2).

Prevalence of malnutrition

Some 23% (*n* = 45) of the study population were underweight (BMI < 18.5 kg/m²), 37.2% (*n* = 73) malnourished (MUAC ≤ 23 cm), whilst 39.3% (*n* = 77) were either overweight (BMI 25–29.9 kg/m²) or obese (BMI > 30 kg/m²) as can be seen in Table 2.

Obtainability of usual weight

In all, 24% of the participants (*n* = 47) had a previous weight (within the past three to six months) recorded in their medical files, whilst 43% (*n* = 84) were able to self-report their usual weight; 33% (*n* = 65) of participants did not know their usual weight, neither was it recorded in their medical files.

Performance of the figure rating scale to determine current weight

Among the total study population, 67% (*n* = 131) were able to select an FRS image with a BMI range corresponding to measured BMIs (Table 3). The most accurate responses were from participants categorised as underweight, normal weight and overweight, with a decreasing trend towards the obesity ranges.

Figure 3 shows a strong positive correlation between the *measured current* BMI of participants and mid-point of BMI images selected on the FRS, which was statistically significant (linear regression, *p* < 0.001; *r*² = 0.80).

Female participants were significantly more likely to select an accurate corresponding BMI image, although both males and females were able to select an image within a reasonable degree of accuracy (linear regression, *p* < 0.05; *r*² = 0.77 for males and *r*² = 0.82 for females).

Table 3: Ability of participants to correctly identify their current and usual weight with the use of FRS

BMI	Number of participants in each BMI category		Participants that correctly chose corresponding image on FRS	
	Current BMI		n	%
Underweight (BMI < 18.5 kg/m ²)	45		39	87
Normal weight (BMI 18.5–24.9 kg/m ²)	74		51	69
Overweight (BMI 25–29.9 kg/m ²)	39		25	64
Class I obesity (BMI 30–34.9 kg/m ²)	16		9	56
Class II obesity (BMI 35–39.9 kg/m ²)	7		0	0
Class III obesity (BMI ≥ 40 kg/m ²)	15		7	47
Total	196		131	67
Usual BMI				
		n	n	%
Underweight (BMI < 18.5 kg/m ²)	15		9	60
Normal weight (BMI 18.5–24.9 kg/m ²)	55		35	64
Overweight (BMI 25–29.9 kg/m ²)	27		11	41
Class I obesity (BMI 30–34.9 kg/m ²)	14		12	86
Class II obesity (BMI 35–39.9 kg/m ²)	4		1	25
Class III obesity (BMI ≥ 40 kg/m ²)	15		11	73
Total	130		79	61

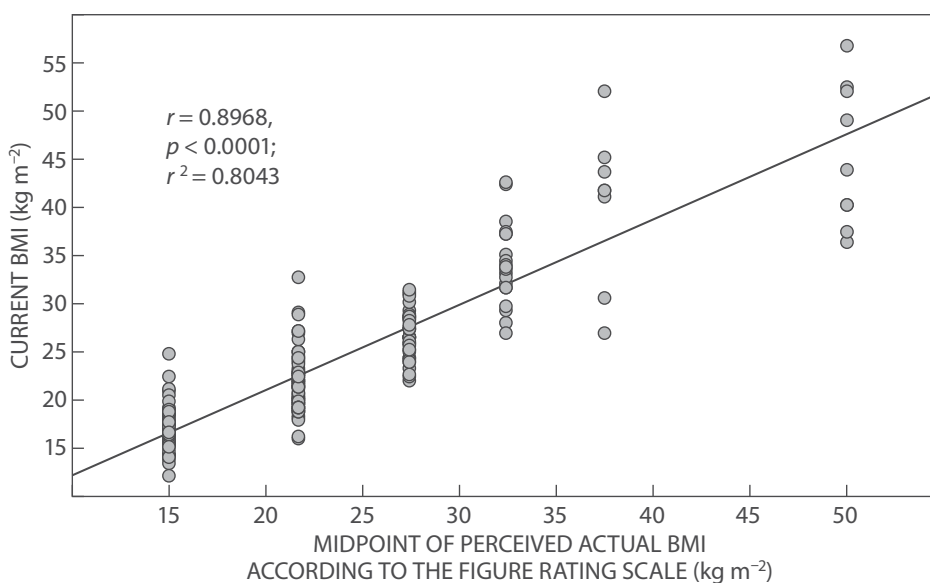


Figure 3: Scatterplot of actual BMI against midpoints of perceived actual BMI according to figure rating scale.

Age did not have a significant effect on the accuracy of participants in selecting an image with a similar BMI to their actual body size from the FRS (linear regression, $p = 0.28$).

Performance of the figure rating scale to determine usual weight

Altogether, 61% ($n = 79$) of participants with a known *previous* weight (i.e. documented or self-reported), were accurate in selecting an FRS image with a BMI corresponding to their *usual* BMI (Table 3). Figure 4 illustrates a very significant relationship between the two variables (linear regression, $p < 0.001$; $r^2 = 0.71$).

There was no statistical difference between BMI based on weight obtained from the medical file, and BMI based on

weight reported by the patients ($n = 47$; linear regression, $p = 0.19$) as illustrated in Figure 5.

A moderate negative correlation ($r^2 = 0.44$) was found between weight change and change in clothing size (Figure 6), indicating that as weight loss increases there was a decrease in clothing size. For every unit change in clothing size, the average weight change was 2.1 kg (linear regression, $p < 0.0001$), with an average reduction of 2.6% weight lost, which was statistically significant (linear regression, $p < 0.0001$; $r^2 = 0.32$).

Discussion

This study is unique in that it is the first to use BMI-based FRS as an adjunctive aid to determine current and/or usual BMI or weight change in the clinical setting. The majority of participants were accurate in self-selecting an FRS image with a BMI range

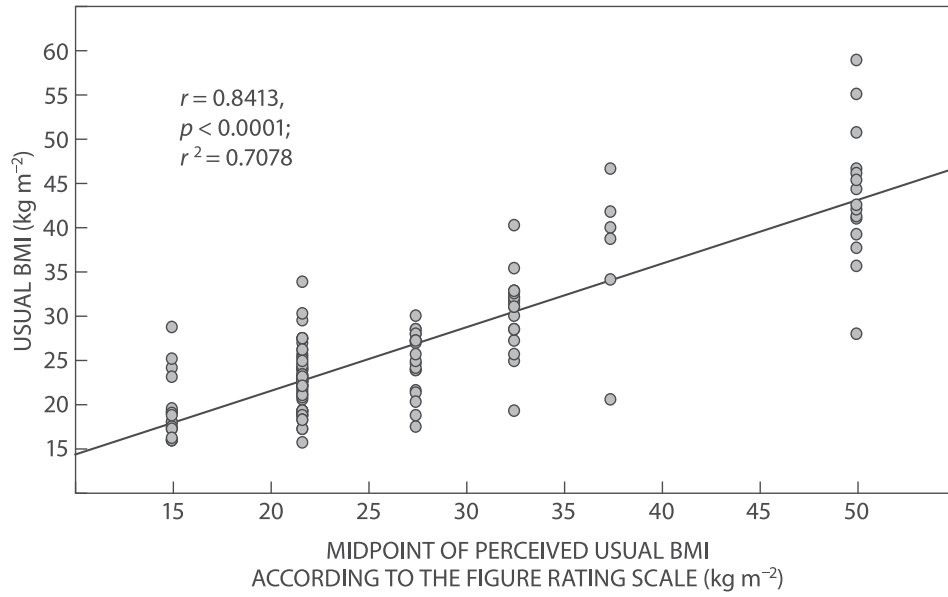


Figure 4: Scatterplot of usual BMI against midpoints of perceived actual BMI according to figure rating scale.

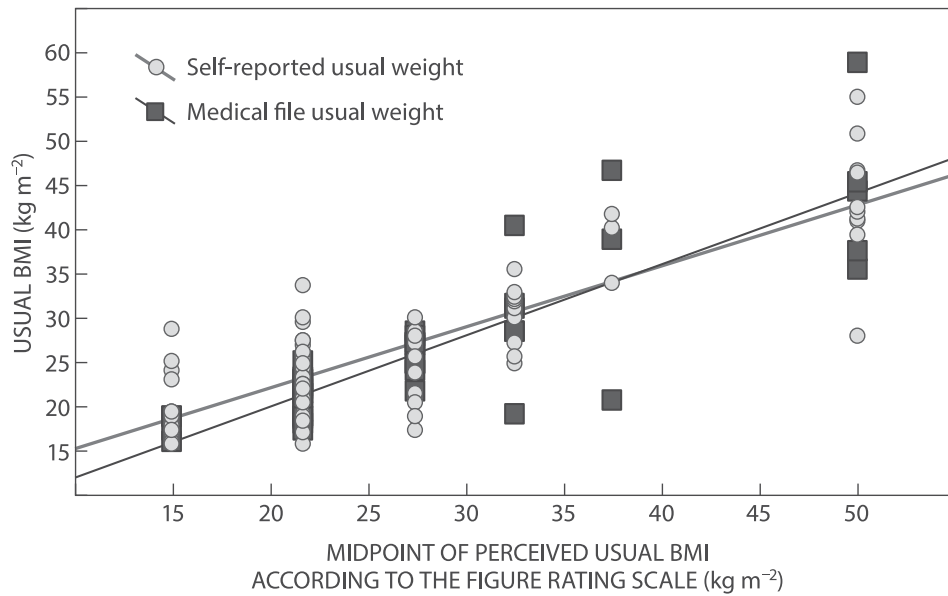


Figure 5: Scatterplot of usual weight obtained from the file versus usual weight reported by patients.

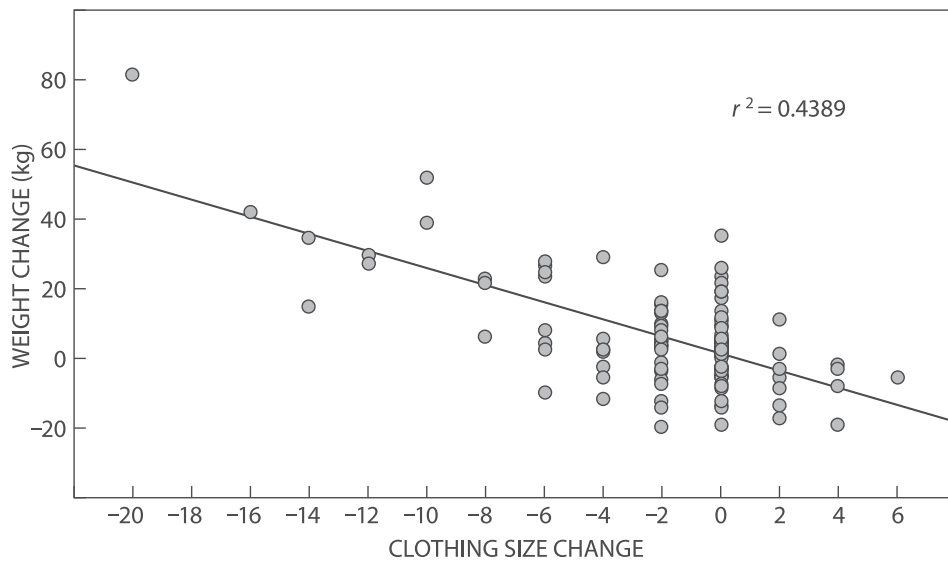


Figure 6: Scatterplot of weight change against clothes size change.

corresponding to their *current* and *usual* BMIs. Although the FRS used in this study was originally developed for obesity research and depicts a greater number of higher BMI values, participants classified as underweight and normal weight were more accurate in selecting an FRS image corresponding to their current BMI.

The study affirms that information typically required for nutritional screening or malnutrition diagnosis is often poorly documented and may be difficult to obtain from patients; for example, difficulty of direct weight and height measurement in immobile patients, or patients not knowing their usual weight.^{2,3,24} These 'missing data' are likely to hamper the identification of malnourished patients, who may benefit from more in-depth assessment and nutrition support interventions. This may be to the detriment and cost of individuals, healthcare services and society as a whole.⁶

The use of BMI-based FRS shows potential as an adjunctive aid in estimating anthropometric parameters, such as BMI and weight change, where it is otherwise unobtainable in limited resource settings. This in turn will enable calculation of weight change, which is an important parameter to detect nutritional risk.²⁵

It may therefore assist frontline healthcare professionals such as nurses and doctors to detect (through screening) and diagnose malnutrition, and facilitate appropriate nutrition care pathways.

This study also investigated whether a correlation exists between a change in clothing size and weight change, as well as the quantification thereof, as there is a lack of information available in the literature.²⁶ Although a moderate negative correlation was found, results must be interpreted with the acknowledgement of lack of standardised sizing guides, which may differ between designers, manufacturers and retailers.²⁷

The study further supports previous findings that a high prevalence of malnutrition, in the form both of under- and over-nutrition, exists in Eastern Cape public hospitals.^{2,3}

Limitations

The BMI-based FRS used in this study was developed for Caucasian adults, whereas the majority of this study's participants were from non-Caucasian ethnicity groups. However, this did not seem to hinder responses in either the pilot or research study. Self-reported usual weight by participants was prone to error in this study, and there were limited documented weights found in medical records to verify correctness. Due to the variation in adherence to standardised sizing guides for clothes, accurate interpretation of weight change quantifications observed in this study was difficult, and should be interpreted with due acknowledgement in this regard.

Conclusion and recommendations

This study identified a new approach to quantify weight change, which is often elusive in the hospital setting, especially where resources are limited. It may be particularly relevant to frontline healthcare professionals, such as nurses and doctors, to conduct nutrition screening and malnutrition diagnosis.

Further research is recommended to generalise the findings to adult hospitalised patients and other settings, such as clinics and care centres, in South Africa. It is recommended that existing FRSs, developed or adapted for African populations, be

validated for South Africa; specifically FRSs that include images of both front and side-view body scales, as developed by Cohen *et al.*¹⁸ Further research in a setting where *usual* weight is accurately documented is recommended to strengthen the validity in correlation with selected FRS images. Longitudinal research, where standard international sizing guides are used during follow-up, will assist in improved quantification of weight change associated with a change in clothing size.

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