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Can Foot and Ankle Surgeons Accurately Estimate Patient Body Mass Index?

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ABSTRACT

The body mass index (BMI) is an objective patient finding that has been established to have a negative effect on the development and outcomes of podiatric pathologic entities and interventions. The objective of the present investigation was to assess the ability of podiatric physicians to estimate the patient BMI from clinical and radiographic observation. For the clinical estimation of the patient BMI, podiatric specialists across 3 levels of experience (i.e., students, residents, and practicing clinicians) performed 294 estimations on 72 patients in 3 clinical situations (standing, sitting in a treatment chair, and lying in a hospital bed). It was more common to inaccurately estimate the patient BMI (77.9%) than it was to correctly estimate it (22.1%), with underestimations being the most common error (48.3%). The estimations were particularly inaccurate when the patients were in the common clinical situation of sitting in a treatment chair or lying in a hospital bed and with patients actually classified as obese. For the radiographic estimation of patient BMI, 150 consecutive lateral ankle radiographs were analyzed, with the ratio of the overlying soft tissue diameter to the underlying bone diameter calculated and compared. Positive, but weak, relationships were observed with these ratios. From these data, we have concluded that podiatric practitioners should perform an actual calculation of the patient BMI during the patient examination and medical decision-making process to fully appreciate the potential risks inherent to the treatment of obese patients.

Podiatric physicians practicing in the United States have been working with a progressively obese patient population. The Centers for Disease Control reported in 2010 that more than one third of U.S. adults (35.7%) and almost 17% of youth were defined as obese according to the body mass index (BMI) (1). The BMI (Table 1) is an objective patient finding that has been established to have a negative effect on the development and outcome of podiatric pathologic entities and interventions. Obese patients could be more likely to develop chronic lower extremity musculoskeletal problems (2–9), experience lower extremity fractures (10–12), and develop diabetic foot pathologic features (13–16). Additionally, obese patients could experience an increased incidence of postoperative complications, including deep vein thrombosis (17–24). From this evidence, it would be reasonable to conclude that podiatric physicians should recognize the additional risks inherent to the treatment of obese patients.

However, it is unclear how many practicing physicians of any specialty, not just foot and ankle surgery, recognize these risks and perform an actual calculation of patient BMI during the medical decision-making process. This is true, although the BMI is a relatively easy, objective measure to calculate using a number of methods, including prefabricated charts commonly found in physician offices, with smartphone software, or within electronic medical records. We are unaware of any investigation that has evaluated how many physicians actually calculate the BMI as part of their standard patient workup, what effect the BMI has on medical decision-making in surgical practices, or even how many physicians currently use electronic medical records. In our practice, which uses an electronic chart, the BMI is calculated within the software; however, the height and weight measurements and data entry are performed by assistants before the formal physician evaluation.

If the BMI is not personally calculated or actively appreciated by the physician during the review of the medical record, this information will either not be used during the medical decision-making process or will be assumed by the physician according to previous experience, whether consciously or unconsciously. We hypothesized that a physician assumption, or comparatively unconscious

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Table 1
World Health Organization interpretation of body mass index

Weight Class	BMI (kg/m^2)
Underweight	<18.4
Normal	18.5–24.9
Overweight	25.0–29.9
Obese	30.0–39.9
Morbidly obese	>40.0

Abbreviation: BMI, body mass index.

estimation, of a patient's BMI could be prone to inaccuracy. It has been our observation that when the BMI has not been directly assessed by physicians, they will often be surprised at the actual measure when the calculation is performed. We further hypothesized that physicians who assume or unconsciously estimate might also be prone to an underestimation of the patient BMI because of a "relative obesity" phenomenon. Thus, because the patient population has become increasingly obese, the average patient has an increased BMI beyond the normal range. Physicians might be prone to thinking in relative terms (i.e., that a patient "is not that obese" relative to the other patients encountered).

The objective of the present investigation was to assess whether the patient BMI can be accurately estimated by podiatric physicians. Our aim was an attempt to evaluate those physicians who do not personally perform or actively appreciate the actual BMI calculation and who might have a tendency to assume the patient's weight.

Patients and Methods

The present study was an observational investigation conducted in 2 parts. The first part involved a clinical estimation of patient BMI. At our institutions, height and weight measurements are taken for all patients during the initial workup by nurses, medical assistants, or students and entered into the electronic record, which automatically calculates the actual BMI measurement. At some point during the normal flow of patient care, a podiatric participant across 1 of 3 levels of training (i.e., student, resident, or practicing clinician) was asked to observe a patient and perform an estimation of that patient's BMI. This is a typical clinical situation for patients at our institution because multiple students and residents will normally be involved in a single patient's care. The estimation was blinded to the participants in that they were not involved in the collection of the height and weight measurements. The participants observed the patients in 1 of 3 clinical situations: (1) sitting in a treatment chair, (2) lying in a hospital bed, or (3) standing or walking in a clinical hallway, depending on availability and the normal flow of patient care. Directly after the participant's estimation, they were given direct feedback by informing them of the patient's actual height, weight, and BMI. No attempt was made to standardize the number of participants, estimations, or clinical situations to be as observational as possible and to not disrupt the flow of patient care. The number of participant estimations was primarily made according to participant availability and the clinical situation the observed patient was in at the time. We considered an estimation within 1.0 BMI point of the actual measurement to be "accurate" and those estimations that were greater than 1.0 BMI point in any direction to be "inaccurate." An estimation ±1 BMI point will equate to a range of approximately 10 to 12 pounds, depending on the height. The estimations were considered for the overall group of patients and stratified by gender, race, and ethnicity.

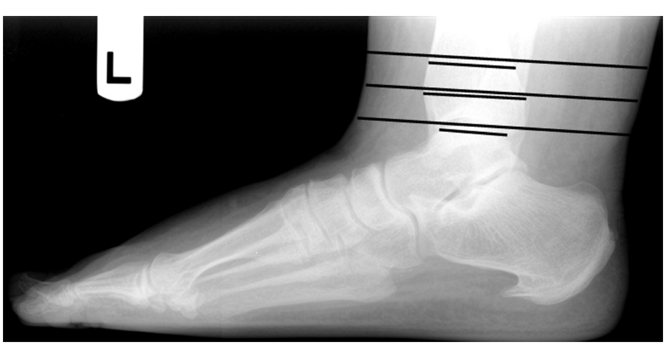

Fig. 1. Lateral radiograph showing lines measured to determine ratio of overlying anteroposterior soft tissue diameter to underlying anteroposterior bone diameter at 3 specific points.

Table 2
Effect of clinical experience level on estimation of patient body mass index

Estimation Outcome	Total (n = 294)	Clinician (n = 40)	Resident (n = 54)	Student (n = 200)
Accurate within 1 BMI point	22.1	32.5	20.4	20.5
Overestimation (>1 BMI point)	29.6	32.5	40.7	26.0
Underestimation (>1 BMI point)	48.3	35.0	38.9	53.5
Correct estimation within BMI weight class	63.3	70.0	59.3	63.3

Abbreviation: BMI, body mass index.
Data presented as percentages.

The second part of our investigation involved a radiographic evaluation of patient BMI. We are unaware of any validated lower extremity radiographic measure that estimates patient weight and did not attempt to do so with this investigation. We did, however, choose to evaluate a weightbearing lateral radiograph for analysis, because it has been our experience that this projection provides a reliable assessment of patient positioning, soft tissue landmarks, and osseous landmarks. A retrospective analysis of 150 consecutive patients with a weightbearing lateral radiographic projection from a single clinic was performed. The inclusion criteria consisted of consecutive patients with a weightbearing lateral ankle radiograph available and without a history of previous ankle surgery or fracture. A calculation was performed of the ratio of the overlying anteroposterior soft tissue diameter to the underlying anteroposterior bone diameter at 3 specific points about the level of the ankle: (1) at the level of the ankle joint, (2) 1 cm above the level of the ankle joint, and (3) 2 cm above the level of the ankle joint (Fig. 1). These ratios were then graphically depicted against the patient's actual BMI on a frequency scatter plot, and a calculation of the correlation coefficient for each location was performed.

The radiographic measurements were performed using digital software (Opal-RAD PACS, Viztek, Garner, NC), which measured to a precision of 0.01 cm. At the level of the ankle joint, 2 points were initially made at the most anterior and posterior aspects of the distal tibial articular cartilage for measurement of the anteroposterior bone diameter. The overlying soft tissue diameter was measured parallel to this same level. A perpendicular line to this line was then calculated, and the measurements were repeated both 1 and 2 cm proximal to the initial measurement. All measurements were performed 1 of us (M.R.W.).

No internal or external funding was received for any portion of this investigation. All data was collected and stored in a personal computer for subsequent analysis. All statistical analyses were performed using Statistical Analysis Systems, version 9.2 (SAS Institute, Cary, NC) by 1 of us (A.J.M.).

Results

Clinical Estimation of Patient BMI

The clinical estimation of BMI was performed on 72 patients (27 males [37.5%]) in both outpatient clinic and inpatient hospital settings. A total of 294 clinical estimations were performed, for a mean of 4.1 estimations (range 1 to 10) per patient. The mean patient age was 52.0 years (range 13 to 93), and the mean patient BMI was 29.3 ± 7.91 kg/m^2 (95% confidence interval 27.45 to 31.17). Of the 72 patients, 5 (7.0%) were classified as "underweight," 19 (26.4%) had a "normal" BMI, 15 (20.8%) were classified as "overweight," 29 (40.2%) as "obese," and 4 (5.6%) as "morbidly obese" (Table 1). Of the 72 patients, 32 (44.4%) were non-Hispanic white, 29 (40.3%) were non-Hispanic black, and 11 (15.3%) were Hispanic.

Of the 294 estimations, 65 (22.1%) were considered "accurate," or within 1 BMI point (Table 2). However, 87 estimations (29.6%)

Table 3
Effect of patient gender on estimation of body mass index

Patient gender	Within 1 BMI Point	Overestimation (>1 BMI point)	Underestimation (>1 BMI point)
Male (n = 103)	20.4	34.0	43.7
Female (n = 190)	22.6	27.4	48.9

Abbreviation: BMI, body mass index.
Data presented as percentages.