Mapping Methods for Total Body Weight Measurement in Critically Ill Patients: A Scoping Review

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Received December 25, 2025
Revised June 17, 2026
Accepted July 03, 2026
Available online August 17, 2026

Abstract

Aims: This scoping review aimed to identify and map existing methods for measuring total body weight in critically ill patients.

Methods: A comprehensive literature review was conducted across seven databases (PubMed, Web of Science, Embase, Medline-OVID, CINAHL, Cochrane, and Scopus) on August 1, 2024, without publication-year restrictions. The terminology keywords: “Critical Illness,” “Intensive Care Units,” “Burn Units,” “Coronary Care Units,” “Respiratory Care Units,” “Critical Care,” “Weights and Measures,” “Ideal Body Weight,” “Body Weight,” “Body Size,” “Data Accuracy.” Eligible records were English-language original studies, validation studies, observational studies, quality-improvement projects, and pilot studies reporting total body weight measurement or estimation methods applicable to critically ill adults.

Results: Twelve studies were included. Four approaches were identified: 1) estimation methods, 2) anthropometric formulas, 3) technology-assisted techniques, and 4) tape measurement methods. The evidence for method performance varied. Visual estimation showed substantial errors, including errors greater than 10% in nearly half of the estimates in one ICU study. Anthropometric formulas showed moderate or population-specific agreement with the measured weights. Technology-assisted methods, including bed or hoist scales and 3D camera systems, generally provide more objective measurements or lower error but require equipment, calibration, and feasibility considerations. The PAWPER XL-MAC adult tape method showed a strong validation performance, with P20 of 96.0% and P10 of 71.3%, respectively.

Conclusion: Technology-assisted methods and standardized anthropometric or tape-based approaches appear to be more clinically useful for critically ill patients. However, their accuracy, validity, reliability, feasibility, and cost-effectiveness vary by setting. Further validation in diverse ICU populations is required before recommending a single, preferred method.

Keywords: body weight, critical illness, weights and measures

Introduction

Measuring body weight is essential for determining the interventions for critically ill patients. Critically ill patients are defined as those with life-threatening illness, vital organ dysfunction, high risk of imminent death without care, and potential reversibility with timely critical care support (Kayambankadzanja et al., 2022). Body weight data are used to calculate weight-based drug doses and reduce dose-related errors (Erstad & Barletta, 2023; Lubsch et al., 2023), determine fluid requirements and monitor fluid status (Mensink et al., 2024; Mishra et al., 2021), and support nutritional assessment and planning in the ICU (Singer et al., 2023). Therefore, inaccurate body weight data may compromise the accuracy and safety of clinical interventions (Anggiri et al., 2025; Monsees et al., 2025; Wells, Goldstein, Alter, 2024).

In critically ill patients, inaccurate body weight data may affect therapy and clinical outcomes because many treatments depend on reliable weight values. An incorrect weight value can contribute to underdosing or overdosing, inappropriate fluid calculation, and inaccurate nutritional assessment, particularly in patients with obesity, organ dysfunction, or rapidly changing fluid statuses (Erstad & Barletta, 2023; Lubsch et al., 2023; Mensink et al., 2024; Singer et al., 2023; Tariq et al., 2026). These risks highlight the need for objective, feasible, and clearly documented body weight measurement methods in critical care settings.

Recent evidence has shown that weight estimation remains a patient safety concern in acute and critical care. A 2025 ICU service evaluation reported that staff-estimated weights had errors greater than 10% in 36% of cases and greater than 20% in 11% of cases, whereas patient self-estimation was more accurate when patients could report their weight (Monsees et al., 2025). A 2025 cross-sectional study also found clinically relevant variations in ICU staff's visual estimates of patient weight and height (Ahmad et al., 2025). For fluid monitoring, a 2024 ICU study found weak correlations between fluid balance and body weight changes, indicating that body weight and fluid balance cannot be used interchangeably without caution (Mensink et al., 2024).

The barriers to body weight measurement in the ICU are related to the clinical instability of critically ill patients, immobility, decreased consciousness, invasive devices, monitoring equipment, and limited access to appropriate weighing devices. Recent studies have shown that staff estimates of ICU patient weight are often inaccurate (Ahmad et al., 2025; Monsees et al., 2025). Evidence syntheses also indicate substantial variation in the performance of adult weight estimation methods and suggest that standardized anthropometric approaches, patient self-estimation when feasible, and emerging 3D camera systems may improve accuracy compared with subjective visual estimation (Wells, Goldstein, Alter, et al., 2024; Wells, Goldstein, Wells, et al., 2024). These findings suggest that weight measurement in critical care remains a persistent patient safety issue, and a scoping review is necessary to map the available methods, summarize their advantages and limitations, and identify evidence gaps.

Methods

Study design

The scoping review followed the five-stage framework outlined by Arksey and O'Malley (Arksey & O'Malley, 2005): 1) formulating research questions, 2) identifying relevant studies, 3) selecting eligible literature and extracting data, 4) charting and mapping the data, and 5) collating, summarizing, and reporting the findings. The research question was formulated using the PCC (Population, Concept, Context) framework: "What methods have been reported for measuring or estimating total body weight in adult critically ill patients or critical-care contexts?" This question was selected because body weight measurement in critical care involves heterogeneous methods, populations, and outcomes, making a scoping review appropriate for identifying the breadth of evidence and gaps.

Eligibility criteria
Literature related to body weight measurement in critically ill patients was included based on the PCC framework. The PCC framework provided a systematic method for formulating the research question and guiding the selection of eligible studies in this scoping review (Table 1). The inclusion criteria focused on empirical studies that provided extractable information on body weight measurements in critically ill adult patients. Book chapters, editorials, letters, commentaries, and non-report studies were excluded because they did not provide original extractable data for evidence mapping.

Table 1. Population, concept, and context of total body weight measurement in critical patients

PCC Component	Description
Population	Critically ill patients
Concept	Total body weight measurement
Context	Different methods of total body weight measurement

Search strategy
Seven electronic databases were searched: PubMed, Web of Science, Embase, Medline-OVID, CINAHL, Cochrane, and Scopus. To enrich the review, relevant articles were not limited to the year of publication. The search was conducted on August 1, 2024. Only English-language studies were included because translation resources were unavailable for this review. No restriction was applied to a specific ICU diagnosis; studies involving adult critically ill patients, adult critical care areas, emergency/transport contexts, or adult pilot populations relevant to critical care weighing were considered. Keywords were selected based on Medical Subject Headings (MeSH), Subject Headings, and Emtree terms and combined using the Boolean operators "OR" and "AND." Search terms included "Critical Illness," "Intensive Care Units," "Burn Units," "Coronary Care Units," "Respiratory Care Units," "Critical Care," "Weights and Measures," "Ideal Body Weight," "Body Weight," "Body Size," "Data Accuracy." Forward and backward citation tracking was performed to identify studies that were not captured in conventional databases.

Identification and selection of literature
After records were retrieved, duplicates were removed, and titles, abstracts, and full texts were screened against the eligibility criteria. Two reviewers (RRA and SI) independently screened the records, and disagreements were resolved through discussion with the research team. The PRISMA-ScR (Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews) flow diagram was used to select articles (Figure 1). The included articles were critically appraised using Joanna Briggs Institute (JBI) tools, as described (Table 2). The appraisal informed the interpretation of the evidence but was not used as an exclusion criterion because the purpose of this scoping review was to map the available methods.

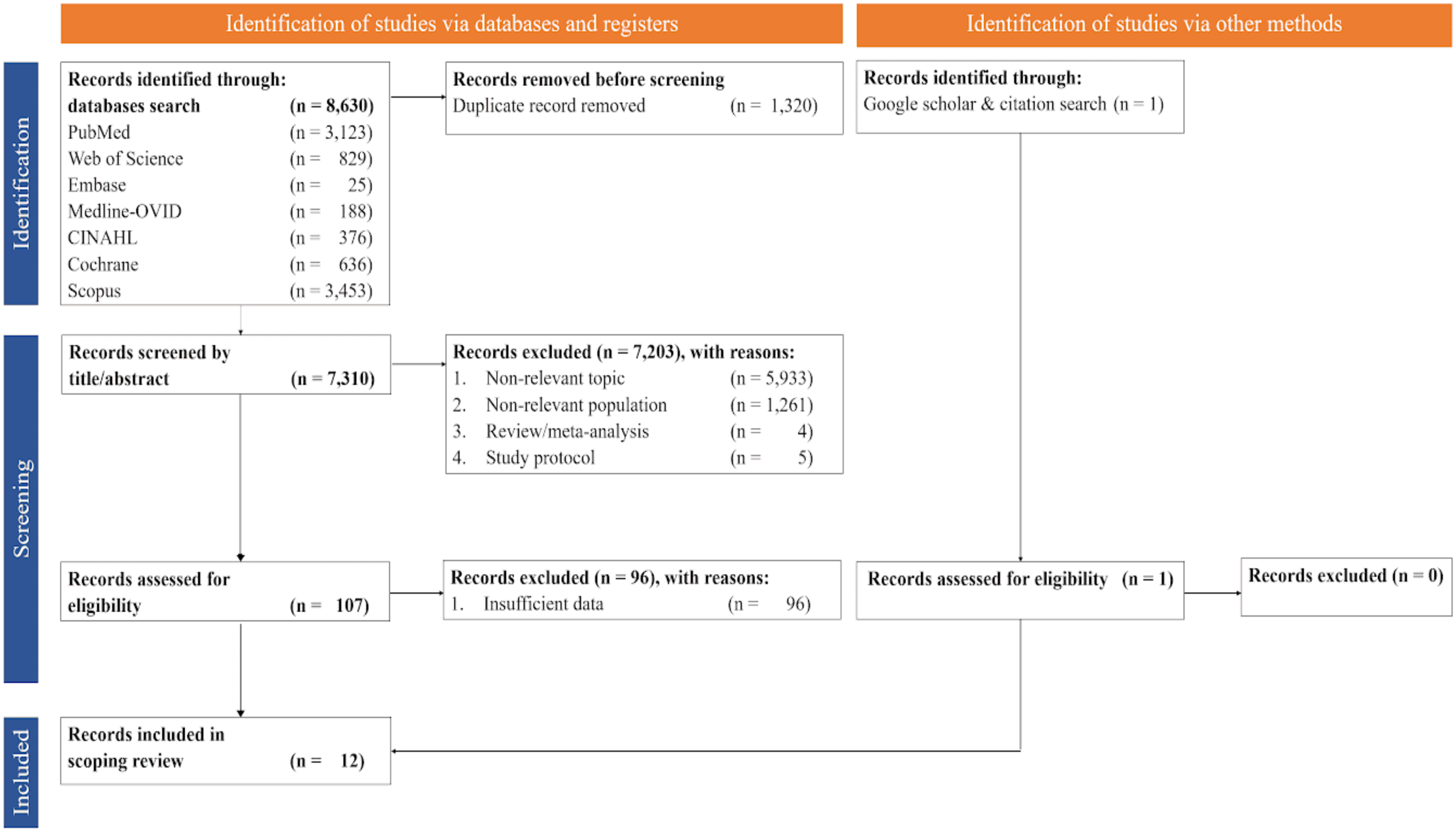

Figure 1. Flow diagram for database searches (PRISMA Extension for Scoping Reviews)

Table 2. Summary table and JBI critical assessment of articles included in the scoping review

No	Author, year	Study design	Sample size	Applications	Body weight measurement methods	Findings	Critical Appraisal
1.	(Leary et al., 2000)	Cross-sectional study	30 adult critical patients	ICU	Estimation of weight by experienced ICU staff	Three of the four observers' estimates differed significantly from the reference measurements ($P < 0.05$).	6/8 75%
2.	(Bloomfield et al., 2006)	Observational cohort study	14 adult critical patients	ICU	Estimation of weight by ICU staff The Arjo Maximove lifting hoist	Weight estimation errors ranged from 34 kg underestimate to 55 kg overestimate. 47% of weight estimates were inaccurate by at least 10%. 19% of weight estimates were inaccurate by at least 20%.	11/11 100%
3.	(Determann et al., 2007)	Cross-sectional study	300 adult critical patients	ICU	Weight asked from patients' relatives Estimation of weight by nurses	The mean difference between the estimated and provided weights was also small: 0.8 ± 0.5 kg, with 95%–limits of agreement from -15.1 to 16.7 kg.	6/8 75%
4.	(Crandall et al., 2009)	Cross-sectional study	1,471 obese adult patients	Critical care	The Crandall formulas	Approximately 90% of weights are estimated to be within 15% error tolerance.	8/8 100%
5.	(Freitag et al., 2010)	Cross-sectional study	100 adult critical patients	ICU	The Hill—Rom bed (Medicraft, Marrickville NSW, Australia) The Mercury bed scale (A&D, Kensington VIC, Australia) The GULDMANN ceiling hoist scale (HLS Ringwood, VIC, Australia)	The Mercury scale is efficient and safe to use for any ICU patient. The Mercury bed scale displayed the narrowest range of 1.6—6.8 kg to the gold standard.	8/8 100%

No	Author, year	Study design	Sample size	Applications	Body weight measurement methods	Findings	Critical Appraisal
					Digital standing scale (Soehnle, Castle Hill NSW, Australia) A chair scale (A&D, Kensington VIC, Australia) The mid-arm-circumference (MAC) measurement		
6.	(Maskin et al., 2010)	Observational cohort study	42 adult critical patients	ICU	Estimation of weight by ICU observer ARDSnet's formulas	Approximately 50% of weight estimations were accurate within ten errors. Weight underestimation occurred in 15.6% of cases. The average error in weight estimation was slightly over 10. Predicted weight estimations were also inaccurate.	8/11 72.7%
7.	(Schneider et al., 2013)	Cross-sectional study	103 adult critical patients after cardiac surgery	Critical care, operation rooms	Electronic bed scale with Hill-Rom (Bayesville, AR) VersaCare bed systems	There is a discrepancy between the weight obtained on the electronic bed and the weight obtained on a regular scale at discharge from the ICU (95% CI, −7.6 to 7.6 kg).	8/8 100%
8.	(Thongprayoon et al., 2014)	Observational cohort study	493 adult critical patients	Critical care	Actual body weight (ABW) with a digital weighing scale. Ideal body weight (IBW) with the formula Adjusted body weight (Adj. BW).	The average measurement results for ABW were 82 (IQR 68-96) kg and IBW 70 (IQR 60-66) kg, resulting in a difference of 10 kg.	11/11 100%

No	Author, year	Study design	Sample size	Applications	Body weight measurement methods	Findings	Critical Appraisal
9.	(Alquran et al., 2018)	Cross-sectional study	22 obese adults	Emergency department, ICU, and operation rooms	Image processing techniques using 3-D camera systems for weight estimation	The method achieved a mean absolute percentage error of 1.42%. Significant parameters are the trunk area and upper arm area. The approach is efficient for different obesity levels. It provides accurate weight estimation in healthcare settings. The algorithm is fast and cost-effective.	8/8 100%
10.	(Kokong et al., 2018)	Cross-sectional study	122 participants	Critical care and ATLS protocol	Calibrated bathroom digital weighing scale (BR 9011 made in China) Estimated body weight (eBW)	Actual body weight ranged from 48.0 kg to 91.0 kg. Estimated body weight ranged from 55 kg to 95 kg. The mean actual body weight was 65.3 kg. The mean estimated body weight was 69.1 kg. Bland-Altman plot established good agreement at 95% confidence.	6/8 75%
11.	(Boehringer et al., 2020)	Observational cohort study	502 adult critical patients	Critical care	Estimation of weight by critical care transport team	The average weight estimation inaccuracy was 9.17 kg.	8/11 72.7%
12.	(Wells et al., 2022)	Cross-sectional study	11,520 adults	Critical care	The modified PAWPER XL-MAC	The modified PAWPER XL-MAC model achieved P20 of 96.0%. P10 accuracy was 71.3% in the validation dataset.	7/8 87.5%

Data extraction
Data were extracted in a matrix format using Microsoft Excel, as this format allows for structured charting and comparison of heterogeneous scoping review evidence. The extracted data included the author, year, research design, research sample, method of measuring body weight, and findings.

Data analysis
Thematic analysis was used to examine the article data and identify key themes that characterize the body weight measurement methods and their applications. An inductive approach was used to extract relevant findings from the included studies and to address the research question. The process followed Braun and Clarke's six-phase approach to thematic analysis (Braun & Clarke, 2006): 1) thoroughly examining the included articles to comprehend the data; 2) developing initial codes based on the information generated in the summary table; 3) identifying themes; 4) evaluating themes; 5) naming and defining themes; and 6) generating reports. In phases two and three, codes were compared across multiple articles rather than focusing on a single source. Phases three, four, and five were conducted with consistent consideration of the research question, ensuring that the themes selected in phase five effectively addressed the inquiry.

Results
This scoping review included 12 articles. Nine studies focused on critically ill patients in the ICU, three focused on healthy or obese adults as pilot/validation populations, and one focused on broader critical care areas. Pilot studies were retained only when the method was designed for supine, emergency, anesthesia, or critical care application and therefore had potential relevance for critically ill patients. Four main themes of body weight measurement in critically ill patients were identified through thematic analysis of the articles (Table 3, Figure 2). There are estimation methods (Bloomfield et al., 2006; Boehringer et al., 2020; Determann et al., 2007; Leary et al., 2000; Maskin et al., 2010), anthropometric formulas (Crandall et al., 2009; Kokong et al., 2018; Maskin et al., 2010; Thongprayoon et al., 2014), technology-assisted techniques (Alquran et al., 2018; Bloomfield et al., 2006; Freitag et al., 2010; Schneider et al., 2013; Thongprayoon et al., 2014), and tape measurement methods for adults (Freitag et al., 2010; Wells et al., 2022).

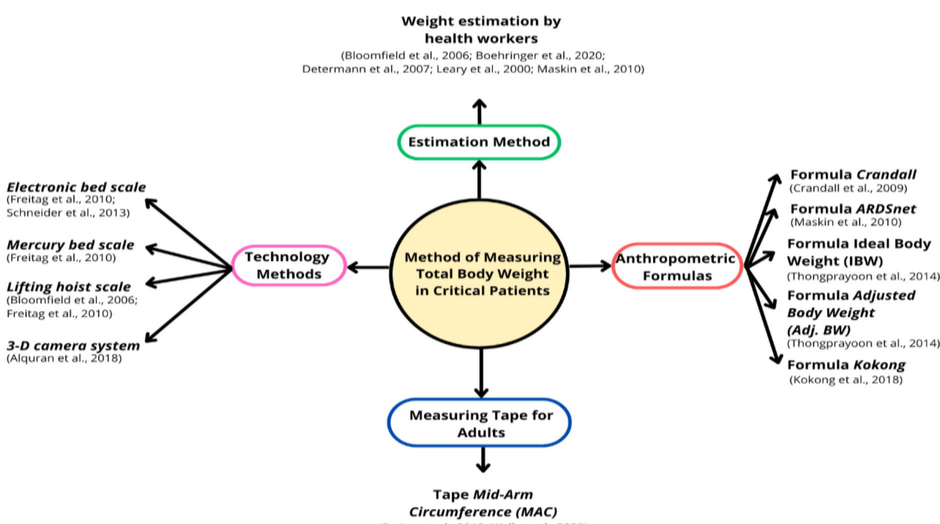

Figure 2. Scope mapping of total body weight measurement in critical patients

Table 3. Method of total body weight measurement in critically ill patients

Body weight measurement methods	Description	References	Advantages	Weaknesses/limitations	Number of studies
Estimation methods					
Healthcare provider estimation	Healthcare professionals, including physicians, nursing staff, and emergency medical technicians, often estimate a patient's weight. However, there is significant variability in the accuracy of these estimations among individual providers, with frequent substantial errors that are not correlated with experience. The precision of weight estimations may be considerably reduced for patients who are underweight, overweight, or obese.	(Bloomfield et al., 2006; Boehringer et al., 2020; Determann et al., 2007; Leary et al., 2000; Maskin et al., 2010)	Fast, requires no special equipment, and can be used in emergency or immobilized patients when immediate clinical decisions are needed.	High observer variability and clinically important errors are common. Accuracy may decrease in underweight, overweight, or obese patients and may affect drug dosing, ventilation settings, and fluid or nutrition decisions.	5
Anthropometric formulas					
Crandall formula	Females: TBW = (MAC x 2.15) + (H x 0.54) − 64.6 Males: TBW = (MAC x 3.2) + (H x 0.43) − 93.2	(Crandall et al., 2009; Maskin et al., 2010)	Uses simple bedside measurements and showed approximately 90% of estimates within a 15% error tolerance in the derivation population.	Derived from obese adults; generalizability to non-obese, fluid-overloaded, edematous, or critically ill ICU populations is uncertain. It estimates weight rather than directly measuring it.	1
ARDS's formula	Females: TBW = 45.5+0.91*(height (cm) – 152.4)		Simple and useful when actual body weight is unavailable, especially for	It predicts body weight rather than actual total body weight. Errors can occur if height is inaccurately estimated, and	1

Body weight measurement methods	Description	References	Advantages	Weaknesses/limitations	Number of studies
	Males: TBW = 50+0.91*(height (cm) – 152.4)		ventilator-related calculations that require predicted body weight.	the formula does not ref,lect acute fluid accumulation, edema, or body composition changes.	
IBW (Ideal Body Weight) formula	Females: IBW = 45.5 kg+2.3 kg x height (inch)-60] Males: IBW = 50 kg+2.5 kg x [height (inch)-60]	(Thongprayoon et al., 2014)	Easy to calculate and widely used for clinical classifications and dose-related decisions when direct measurement is difficult.	IBW may differ substantially from actual body weight and does not represent total body weight in patients with obesity, cachexia, edema, or acute fluid shifts.	1
Adj. BW (Adjusted Body Weight) formula	Patients with ABW greater than 1.3 times the IBW will be added to the Adjusted IBW. Adj.BW = [IBW+0.4 x [ABW-IBW]]	(Thongprayoon et al., 2014)	Provides a compromise between actual and ideal body weight, especially for obese patients where IBW alone may be too low for some clinical calculations.	Requires ABW and IBW inputs and remains formula-dependent. It may not capture rapid weight changes from fluid balance, edema, or critical illness-related body composition changes.	1
Kokong formula	TBW = (H−1) x 100	(Kokong et al., 2018)	Simple, quick, and showed strong agreement with actual body weight in the study population, making it potentially useful where weighing equipment is unavailable.	May slightly overestimate weight and was evaluated in a limited population. Further validation is needed in critically ill ICU patients and across different ethnic/body habitus groups.	1
Advanced technology					
Electronic bed scale	A method of measuring body weight using an integrated scale automatically installed on	(Freitag et al., 2010; Schneider et al., 2013)	Practical for bedbound or immobilized patients because weighing	Accuracy can be affected by calibration, zeroing, bedding, equipment attached to the patient, and	2

Body weight measurement methods	Description	References	Advantages	Weaknesses/limitations	Number of studies
	a critical patient's bed. Examples of electronic bed scales are The Hill-Rom—Rom bed (Medicraft, Marrickville NSW, Australia) and Hill-Rom (Bayesville, AR) VersaCare bed systems.		can be performed without transferring the patient from the bed.	bed accessories. Cost can be high, and discrepancies with reference weights have been reported.	
The Mercury bed scale (A&D, Kensington VIC, Australia)	The Mercury bed scale can accommodate up to 450 kg and is suitable for all intensive care unit patients. Weighing a patient requires about 10 minutes and involves specific preparation. The system consists of four weighing pads in front of each bed wheel. Two nurses must roll the bed onto these pads for accurate measurement.	(Freitag et al., 2010)	Reported as efficient, safe, economical, and suitable for ICU patients. It had a relatively narrow difference range compared with the gold standard in the included quality improvement project.	Requires preparation, staff assistance, and correct positioning of the bed wheels. Availability may be limited, and the procedure may be less convenient in patients with multiple devices or urgent instability.	1
Digital standing scale (Soehnle, Castle Hill NSW, Australia)	Weight scales are used to measure the patient's weight while standing. In critical patients, weighing can be done with a unique digital standing scale, especially for patients who can move around without disturbing the intervention or treatment.	(Freitag et al., 2010; Thongprayoon et al., 2014)	Simple, familiar, low-cost, and potentially close to a direct measured weight when patients are mobile and clinically stable.	Not feasible for unconscious, sedated, ventilated, unstable, or immobilized critically ill patients. Transfer or mobilization may increase safety risks.	2
A chair scale (A&D, Kensington VIC, Australia)	Patient weight scale integrated with patient wheelchair. This allows critical patients to weigh	(Freitag et al., 2010)	Useful for patients who cannot stand but can sit safely; may reduce physical	Not suitable for fully bedbound, unconscious, hemodynamically unstable, or highly dependent	1

Body weight measurement methods	Description	References	Advantages	Weaknesses/limitations	Number of studies
	themselves sitting down without disturbing their treatment.		burden compared with standing scales.	patients. Requires transfer to the chair and may be limited by lines, tubes, or monitoring devices.	
The lifting hoist scale	This specialized scale measures the weight of critically ill patients confined to bed. The device features hoist scales and weighing attachments that connect to the spreader bar of the hoist via hooks or links. The patient's weight is determined by calculating the downward force applied to the scale. Examples of electronic bed scales include the Guldmann ceiling hoist scale (HLS Ringwood, VIC, Australia) and the Arjo Maximove lifting hoist.	(Bloomfield et al., 2006; Freitag et al., 2010)	Can weigh immobilized patients using a non-standing approach and may be useful where bed scales are unavailable. Device calibration may provide nominal measurement accuracy.	Requires hoist equipment, sling placement, trained staff, and careful handling of tubes and lines. Poor precision and wide limits of agreement have been reported in some ICU evaluations.	2
Weight scale using 3-D camera systems	Most researchers have employed RGB-D cameras, such as the Microsoft Kinect, to obtain body images. To estimate weight, these images are subsequently analyzed using automated anthropometry or body volume calculations. Machine learning techniques have been predominantly utilized in	(Alquran et al., 2018)	Non-contact, rapid, and promising for supine patients and different obesity levels. The included study reported a low mean absolute percentage error.	Evidence remains limited and algorithm-dependent. Validation in real ICU settings is needed, especially with edema, devices, patient positioning constraints, privacy requirements, and diverse body habitus.	1

Body weight measurement methods	Description	References	Advantages	Weaknesses/limitations	Number of studies
	developing algorithms for this purpose.				
Tape measure for adults					
MAC tape for adults	This measuring device employs supine length and MAC to calculate an approximation of weight. It demonstrates high precision in pediatric patients, and initial research utilizing the unmodified systems on adults has shown potential for recalibration. The method has been evaluated and found user-friendly in emergencies involving children. Should it be successfully modified for adult use, it could prove beneficial.	(Freitag et al., 2010; Wells et al., 2022)	Portable, inexpensive, standardized, and usable when weighing equipment is unavailable. The modified PAWPER XL-MAC model achieved high proportions of estimates within 20% and 10% of reference standards.	Produces estimated rather than directly measured weight. Performance may be affected by edema, abnormal body habitus, amputation, positioning limitations, or limited adult critical care validation.	2

Discussion

This scoping review maps the methods for measuring body weight in critically ill patients. Critically ill patients require appropriate body weight measurement strategies because they often experience decreased consciousness, limited mobility, clinical instability, and dependence on invasive devices for survival. The analysis of 12 articles identified four method categories: estimation methods, anthropometric formulas, technology-assisted techniques, and adult tape measurement methods.

Accurate measurement and estimation of body weight in critically ill patients is essential but challenging for intensive care unit (ICU) personnel. Across the included studies, visual or staff-based estimation consistently showed clinically important errors and should therefore be considered a low-reliability fallback method rather than a preferred measurement strategy. A prospective study reported average percentage errors of 11.4% and 14.6% for actual and predicted weights, respectively, with errors exceeding 20% in 15% and 24% of cases, respectively (Maskin et al., 2010). Another study reported errors from 34 kg underestimation to 55 kg overestimation, with 47% of estimates being at least 10% inaccurate and 19% at least 20% inaccurate (Bloomfield et al., 2006). More recent ICU evidence also supports this concern, showing persistent discrepancies between estimated and measured body weights (Ahmad et al., 2025; Monsees et al., 2025).

Multiple studies have examined weight estimation by experienced ICU staff. The three observers' estimates differed significantly from the reference measurements, and combining the estimates improved the accuracy but did not eliminate clinically relevant errors. Visual estimation may lead to underestimation at lower weights and overestimation at higher weights, which can affect drug dosing and other weight-based interventions (Leary et al., 2000). The mean difference between the estimated and provided weights was small at 0.8±0.5 kg, with 95% limits of agreement (-15.1 to 16.7 kg), indicating limited precision for individual patients (Determann et al., 2007). The average inaccuracy in weight estimation was 9.17 kg in a critical care transport setting (Boehringer et al., 2020).

These errors are clinically meaningful because body weight is used for medication dosing, ventilation settings, fluid prescription, and nutritional calculations. Recent medication safety and critical care literature emphasizes that current body weight is needed to support safe medication dosing and that dosing in critically ill patients, especially those with obesity or organ dysfunction, may require careful selection of total, ideal, adjusted, or lean body weight (Erstad & Barletta, 2023; Lubsch et al., 2023; Tariq et al., 2026). Some included studies found that combining estimates from several observers could improve accuracy, but the improvement was not sufficient to make visual estimation dependable. Therefore, estimation may be acceptable only when immediate treatment is required and no measurement device or reliable patient/family report is available. In such cases, the estimate should be documented as an estimated weight and replaced with a measured or more objective value as soon as feasible.

In critically ill patients, body weight measurement using formula-based approaches can be classified into Crandall formulas, ARDSnet formula, ideal body weight (IBW), adjusted body weight (Adj. BW), and Kokong formulas (Crandall et al., 2009; Kokong et al., 2018; Maskin et al., 2010; Thongprayoon et al., 2014). Anthropometric formulas are useful when direct weighing is not feasible, particularly for medication dosing, fluid calculation, ventilation-related parameters, and nutritional assessments. However, these formulas estimate weight rather than directly measuring total body weight, and their performance may vary according to body habitus, fluid status, edema, and patient characteristics (Davies et al., 2019; Mishra et al., 2021).

All four anthropometric approaches use simple body measurements to estimate body weight when direct weighing is not feasible, making them practical alternatives in clinical settings. Height is the common measurement across all methods, while some formulas incorporate additional variables, such as sex or arm circumference, to improve estimation accuracy. Overall, these approaches have demonstrated acceptable agreement with measured body weight in their respective validation studies. However, their accuracy may be influenced by patient characteristics, particularly obesity, edema, fluid shifts, and changes in body composition during critical illness (Crandall et al., 2009; Kokong et al., 2018; Maskin et al., 2010; Thongprayoon et al., 2014).

Despite these similarities, the methods differ in the variables included and their intended clinical applications. The Crandall formula combines height and arm circumference to estimate actual body weight and demonstrated that approximately 90% of estimates were within 15% of measured weight, although it was developed in obese adults, which may limit its applicability to other populations (Crandall et al., 2009). In contrast, the ARDSNet formula uses height and sex to estimate predicted body weight for ventilator management rather than actual body weight (Maskin et al., 2010). Likewise, ideal body weight and adjusted body weight formulas rely on height and sex but are primarily used for medication dosing and nutritional assessment, particularly in patients with obesity, and should be interpreted according to their specific clinical purpose (Maskin et al., 2010; Thongprayoon et al., 2014). The Kokong formula estimates actual body weight using height alone and demonstrated good agreement with measured body weight, although it tended to slightly overestimate weight in some patients (Kokong et al., 2018).

Technology-assisted techniques include electronic and mercury bed scales, digital standing scales, chair scales, lifting hoist scales, and 3D camera systems (Alquran et al., 2018; Bloomfield et al., 2006; Freitag et al., 2010; Schneider et al., 2013; Thongprayoon et al., 2014). These methods generally offer more objective measurements than visual estimation; however, their performance depends on device availability, calibration, patient position, staff training, and the ability to account for equipment attached to the patient or bed.

All methods are designed to measure or estimate body weight in critically ill patients who cannot stand or be transferred safely, making them practical alternatives when conventional weighing is not feasible. Unlike anthropometric formulas, these methods rely on specialized equipment or imaging technology rather than body measurements to obtain weight estimates. The methods can facilitate body weight assessment in ICU settings, but their implementation depends on equipment availability, staff training, calibration, and patient-related factors that may influence measurement accuracy (Alquran et al., 2018; Bloomfield et al., 2006; Freitag et al., 2010; Schneider et al., 2013).

Despite these similarities, the methods differ in their measurement principles, accuracy, and operational requirements. Electronic bed scales and mercury bed scales obtain direct body weight measurements while the patient remains in bed, although electronic bed scales require attention to calibration and implementation costs, whereas mercury bed scales are relatively inexpensive but require appropriate preparation and positioning

(Freitag et al., 2010; Schneider et al., 2013). Lifting hoist scales also provide direct weight measurements for bed-bound patients but require hoist equipment, sling placement, and trained personnel, and they have shown limited precision for monitoring weight changes (Bloomfield et al., 2006; Freitag et al., 2010). In contrast, the 3D camera system estimates body weight using image-processing technology and demonstrated lower estimation error than several traditional methods, although further validation is needed in ICU settings because edema, medical devices, patient positioning, and privacy considerations may affect its performance (Alquran et al., 2018).

The Pediatric Advanced Weight Prediction in the Emergency Room Extra Large Mid-Arm Circumference (PAWPER XL-MAC) tape estimates body weight in critically ill adult patients. It combines body length measurements while lying down and mid-arm circumference (MAC) measurements to calculate the ideal body weight (IBW) and lean body weight (LBW). The system uses MAC ranges to determine the habitus scores for each weight segment on the tape. This offers a more objective and standardized approach to weight estimation than the subjective visual assessment of body habitus (Wells et al., 2022). The tape method provides standardized weight estimation across various populations, including age, sex, ethnicity, and body type. Specifically, the PAWPER XL-MAC model demonstrated superior accuracy compared with many existing body weight estimation techniques. It achieves over 95% of IBW and LBW estimates within 20% of the recognized reference standards, and over 70% of estimates are within 10% of those standards (Wells et al., 2022). Additionally, quality improvement studies have highlighted the effectiveness of MAC measurements. MAC measurements show a range of 0.8–25.5 kg, which is the most comprehensive range compared to the gold standard (Freitag et al., 2010).

Limitations

This scoping review outlines the techniques for determining the weight of critically ill patients. A limitation of this review is the lack of a direct comparison with the gold standard across all the included methods. A systematic review could be used in future studies to evaluate the precision of different body weight measurement methods in critically ill patients, with a specific comparison of validity, reliability, feasibility, and cost. Despite these limitations, the strength of this review is that it maps the available methods, summarizes the clinical advantages and limitations, and highlights evidence gaps related to accuracy, reliability, feasibility, and implementation in nursing practice.

Contribution to global nursing practice

Measuring body weight is essential for determining interventions in critically ill patients. This scoping review identified four categories of total body weight measurement: 1) estimation methods, 2) anthropometric formulas, 3) technology-assisted techniques, and 4) tape measurement methods for adult patients. These findings have several implications for critical care nursing practice. First, nurses should avoid relying on visual estimation when a measured or standardized alternative is available. Second, hospitals should develop protocols for weighing immobile ICU patients, including device calibration, timing of measurement, documentation of attached equipment, and verification of estimated weight. Third, standardized methods, such as bed/hoist scales, validated anthropometric approaches, adult tape systems, or digital technologies, should be selected according to the patient's condition, available resources, and safety considerations. Fourth, nurses should clearly document whether weight is measured, estimated, calculated, or self/family reported, because this distinction affects medication dosing, fluid therapy, nutrition assessment, and clinical interpretation.

Conclusion

Body weight in critically ill patients can be obtained through patient/family reports, healthcare provider estimations, anthropometric formulas, technology-assisted scales, 3D imaging, and adult tape-based methods. The evidence suggests that visual estimation is the least dependable approach, whereas technology-assisted and standardized tape or anthropometric methods may offer better accuracy and clinical usefulness when feasible. However, no single method can be recommended for all critically ill patients because accuracy, validity, reliability, cost, safety, and feasibility vary across settings. Future research should prioritize head-to-head validation studies in ICU populations, standardized reporting of accuracy and reliability metrics, cost-effectiveness analyses, and implementation protocols for nursing practice.

Author Contribution

RRA: Writing– review and editing, Writing original draft, methodology, format analysis, Data curation, Conceptualization. SI: Writing original draft, writing review and editing, methodology, format analysis, data curation, conceptualization. RR: Methodology, format analysis, data curation, and conceptualization. SS: Format analysis, data curation, and conceptualization.

Conflict of interest

The authors declare no conflict of interest related to this manuscript

Acknowledgment

The authors sincerely thank Universitas Diponegoro for their valuable support in enabling this research and for providing access to scientific databases.

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