Biological and Clinical Sciences Research Journal
eISSN: 2708-2261; pISSN: 2958-4728
www.bcsrj.com
DOI: https://doi.org/10.54112/bcsrj.v2024i1.652
*Biol. Clin. Sci. Res. J., Volume, **2024**: 652*
Original Research Article

IMPROVING THE ACCURACY OF CALCULATION WEIGHTS BY VISUAL INPUT: A PILOT STUDY IN THE EMERGENCY DEPARTMENT OF A LOW MIDDLE-INCOME COUNTRY

IRFAN A*, IJAZ Z, ALI AF, KHAN AS

Department of Emergency, Shifa International Hospital Islamabad, Pakistan
**Corresponding author email address:* dr.adeela@yahoo.com

(Received, 10th October 2023, Revised 30th November 2023, Published 14th February 2024)

Abstract: *Accurate weight estimation is critical in emergency medical scenarios requiring immediate interventions. This pilot study explores the feasibility of improving weight calculation accuracy through visual input, focusing on height-based estimations. The research aims to contribute valuable insights to weight estimation methodologies, particularly in resource-constrained settings. The objective of the pilot study is to explore the feasibility of improving weight calculation accuracy through visual input, focusing on height-based estimations. Data was collected encompassing diverse height ranges from 1.45 to 1.94 meters. Comprehensive datasets included actual body weights, estimated weights, standard deviation, and standard error. eBW(kg) = (N − 1)100 is the estimated body weight method, where "N" is the height measured in meters. Body weight classifications were employed to analyze the accuracy of estimations further. Correction factors for everyone were computed. The correction factor separates the obtained data into underweight, close to actual weight, and overweight. Following optimization, the average correction factor for every category is updated. These updated correction factors improve weight estimation precision. Linear regression analyses were conducted to compare actual and estimated weights, visually representing the discrepancies. The calculated correction factors are essential to improving weight calculations in medicine. The thorough research and improvement procedure resulted in revised correction factors significantly improving the precision of weight estimates in the medical field. We can say that the following equation provides a more accurate weight estimate. Wt corrected = (N-1) x 100 x Correction Factor. This revised weight is an enhanced estimate that considers the updated correction factors. The calculated correction variables are essential to improving weight estimations in medicine. The thorough research and improvement procedure resulted in revised correction factors that significantly improved the precision of weight estimations in the medical field. The derived correction factors demonstrate their effectiveness in enhancing weight estimations, notably in specific patient groups. The investigation classifies patients and delivers precise modifications to improve weight estimations, ensuring safer prescribing procedures. The proposed correction variables will be critical in evaluating emergency medicine doses for individuals.*

Keywords: Weight estimation, Height-based, Resource-constrained settings, Correction factors, Precision

Introduction

Body weight is a vital anthropometric feature essential for medical surveillance of patients and pharmacological dosage advice. Nevertheless, patients are frequently unable to be weighed in hospitals (Pfitzner et al., 2018; Phelan et al., 2015).

When ordering drugs, dosage mistakes can happen, particularly in emergencies. It has been shown that these errors happen twice as frequently in intensive care units (ICUs) and emergency rooms than they do in non-ICUs (Cullen et al., 1997; Hall II et al., 2004). It may not be able to measure weight, particularly in cases of extreme urgency, in extremely sick individuals, or before anesthesia (Bloomfield et al., 2006; Takata et al., 2001). Patients commonly present comatose or in emergencies in the operating theatre, and it can be challenging or impossible to acquire an accurate weight assessment in these stressful situations (Nasiri and Nasiri, 2013). To close this disparity, medical professionals frequently relied heavily on rudimentary estimating techniques, weighing 70 kg for men and 60 kg for women in critical care scenarios. (Stehman et al., 2011) Weight underestimation would lead to inadequate dosing, whereas weight overestimation would raise the The calculated dose of strict weight-based drugs possibly leads to severe adverse reactions. As a result, an incorrect estimation of total body weight in an emergency carries some risk (Cullen et al., 1997; Wells et al., 2017). Therefore, estimating or measuring weight accurately is vital to providing the best possible clinical care for critically sick patients. To reduce medication error, an estimating approach that is rapid, easy to remember, and close to the "ideal" or "actual" body weight is required. There are simple-to-use formulae for determining weights in emergency circumstances in youngsters. (Luscombe and Owens, 2007; Luscombe et al., 2011). However, in adults, several researchers had noted an association between weight and height a few centuries earlier, which gave rise to a variety of formulas, many of which are complex; these include Lorenz/Crandell's calculations and the application of tibial size (Cattermole et al., 2017; Stehman et al., 2011) across several others, none of which have been proven to be helpful in emergency medicine yet.

Thus, this study aimed to assess the reliability, precision, and degree of concordance of a Novel Quick Bedside method for quickly estimating adult weights utilizing a stable, easily accessible anthropometric measurement—

[Citation: Irfan. A., Ijaz, Z., Ali, A.F., Khan, A.S. (2024). Improving the accuracy of calculation weights by visual input: a pilot study in the emergency department of a low middle-income country. *Biol. Clin. Sci. Res. J.,* **2024***: 652*. doi: https://doi.org/10.54112/bcsrj.v2023i1.652]

height. The primary goal of this research is to evaluate the reliability of weight predictions according to height variations in various individuals in a low-middle-income nation.

Methodology

The study included all undergraduate degree medical students and staff members at Shifa International Hospital who had reached at least 18 years of age, accomplished the inclusion criteria, and provided their consent. This prospective cross-sectional study included participants using a convenience sample.

The Institutional Review Board approved this study. We acquired informed consent. Inclusion criteria involved every undergraduate with an age greater than 18 years who gave their consent. Patients unwilling to participate were barred, and those with connective tissue disorder were not involved in the research.

Researchers were trained in how to make use of the digital scale and criteria for inclusion and exclusion. All individuals' weights were recorded on an entirely new, calibrated smart scale, and heights were recorded in meters on a standardized, calibrated wall. Everyone wore no shoes, little clothes to balance their weight, and trimmed hair to balance their height. Patient demographic data was gathered. Their biodata was utilized to compile the data. We assessed their heights using a standardized calibrated wall to the closest 0.01 m and their body weights to the closest 0.01 kg. To hide identity, initials were utilized.

The estimate of weight was calculated using the following formula: estimate body weight (eBW) in kilograms = (N-1)100, where "N" is the height that was taken in meters, which can also be determined in an emergency or by using a measuring tape for those who are very sick.

The procedure for evaluating the data begins with the computation of estimated weight employing the formula previously stated, followed by determining the difference between real and estimated weights. After that, the correction factor is computed by division of the true weight by the predicted weight. The information being collected is divided into three separate categories depending on the correction factor:

- Underweight: Determined Correction Factor <0.95.
- Close to real weight: $0.95\leq$ Determined Correction Factor≤1.05
- Overweight: Determined a correction factor greater than 1.05

With the GRG Nonlinear solution approach, this investigation uses the Solver add-on in Excel for optimization. The optimization procedure iterated on the correction factors to reduce the objective function. The goal is to reduce the total of errors to zero, showing the fact that the correction factors have been changed to make the predicted weights more like the actual weights.

SPSS version 21.0 was used for statistical analysis. First, the descriptive statistics of the two weight measurements were compared. Simple descriptive layouts, tables, figures, and drawings conveyed the results. Data was taken that ranged in height between 1.45 to 1.94 m. Accurate body weights, expected weights, standard deviations, and standard errors were all included in large datasets. Body weight classes were used to investigate and estimate accuracy further. Linear regression studies compared real and estimated weights with visual representations of the differences. The data was analyzed for patterns such as mean accuracy and the effect of the patient's height on estimated weight.

Results

Table 1 displays complete data that includes height categories (in meters) and their related mean absolute weights of individuals (in kilograms), as well as statistical dispersion parameters such as standard deviation and standard error.

The height is separated into distinct intervals that range from 1.45-1.49 m to 1.90-1.94 m. In particular, the number of observations fluctuates in each height group. For example, the height category ranging from 1.70-1.74 meters had the highest frequency of 23, indicating that this height bracket has the most individuals or data points. The average weight rises as the torso range increases. For example, Participants in the 1.45-1.49 meter range have an average weight of 59 kg, whereas those who fall into the 1.70-1.74 meter range possess a considerably greater mean weight of roughly 72.7 kilograms. Standard deviation, which reflects the degree of difference from the mean, is an important observation. The standard deviation for the height group 1.75-1.79 meters is 14.83, indicating a wider variety of weight within this range compared to others.

Finally, the standard error provides information on the accuracy of the mean weight, providing an estimate of population weight. Lesser standard errors indicate that the group's mean is a more precise estimate of the population mean.

Table 2 compares actual and predicted weights according to Body Mass Index (BMI) classes. BMI, measured in kilograms per square meter, determines potential health risks associated with weight problems. The BMI categories are divided into five primary categories, shown in Table 2. The information presented thoroughly details the incidence and percentage of occurrence for both actual and estimated weights across each BMI group.

For example, in the normal BMI range (18.5-24.5), the actual weight frequency is 41, accounting for 42.70% of the sample. In comparison, the predicted weight under this category increases dramatically to 89, representing 92.70% of the total number of participants. Certain classes, such as 'Overweight' (25.0-29.5), show significant differences between actual and projected weights. The natural weight has an average frequency of 26 (27.8%), although the projected count is only 7 (7.29%).

Furthermore, the estimating tool or approach favors the standard BMI categorization, frequently disregarding or under-representing other important weight groups.

Table 3 compares actual weights to estimated weights across several height categories (measured in meters). These weight numbers in kilograms offer insight into the usefulness and precision of the weight measurement techniques or procedures used. Beginning with the most miniature height variety, 1.45-1.49 meters, the actual and predicted weights are similar, with just 11 kg separating them. Moving through the chart, we see that some height categories have excellent consistency between actual and estimated estimates, like the 1.55-1.59 meter assortment, where the disparity is only 0.4kg.

[Citation: Irfan. A., Ijaz, Z., Ali, A.F., Khan, A.S. (2024). Improving the accuracy of calculation weights by visual input: a pilot study in the emergency department of a low middle-income country. *Biol. Clin. Sci. Res. J.,* **2024***: 652*. doi: https://doi.org/10.54112/bcsrj.v2023i1.652]

Additionally, height categories, on the other hand, show substantial variation. For instance, those in the 1.70-1.74 meter range possess an actual mean weight of roughly 72.7 kg, whereas the predicted value is considerably smaller at around 67.55 kg—a difference of more than 5 kg. Similarly, the height range of 1.75-1.79 meters shows a reversal tendency, with the predicted weight being about 4 kg lower than the actual average weight.

These disparities highlight the difficulties in adequately predicting weight based purely on height. Although height is an essential component, other parameters such as body structure, strength of muscles, and bone density are also important in defining an individual's weight.

A linear regression study between Actual Weight (aBW) and Estimated Weight (eBW) across several data points is shown in the graph below. The horizontal axis displays distinct number intervals, which could correspond to height ranges, and the vertical axis depicts weight in kilograms, which runs from 30 to 90 kg. The purple line shows the Actual Weight (aBW), whereas the light purple line shows the Estimated Weight (eBW).

There are noteworthy deviations and intersections among the two lines over the shown intervals, indicating locations where the predicted weight generally exceeds or falls short of the actual weight. The projected weight appears to be considerably more excellent than the actual weight in the first parts, from around 1.45 to 1.59. The pattern then swings, with both lines indicating values in the range of 1.60-1.74. As we proceed farther down the graph, specifically in the 1.75-1.88 area, the predicted weight line once again exceeds the actual weight, rising prominently at the 1.89 mark.

While the projected weight follows a relatively similar pattern to the actual weight, there are notable differences. Such differences highlight the significance of improving estimating methods or tools to align better with accurate weight measurements, particularly in real-world situations where accuracy is critical.

Underweight (BMI <18.5) and Overweight (BMI ≥25.0) are the two BMI categories given in Table 3. The table shows the frequency and proportion of actual and anticipated weight for people who fit into these categories. Six people are Underweight, accounting for about 6.25% of the studied population. This group appears to have no estimated weight data since the incidence and % for anticipated weight are 0. In comparison, the Overweight group has more persons, with 49 people classed as overweight, accounting for about 51.04% of the population assessed. Seven people are in this category for estimated weight, accounting for approximately 7.29% of the population. The table is most likely derived from a more extensive dataset or research to determine the weight variation within a particular group. Actual weight relates to the weight measured during the investigation, whereas estimated weight refers to the weight obtained using the abovementioned formula.

Table: height range in meters, absolute body weights, standard deviation, and standard error

Height range(m)	Frequency	Mean weight(kg)	Standard deviation	Standard error
1.45-1.49	1	59	0	0
1.50-1.54	6	68.1	6.41	2.91
1.55-1.59	17	65.4	12.97	3.51
1.60-1.64	16	65.1	9.47	2.27
1.65-1.69	9	65	10.41	3.82
1.70-1.74	23	72.7	14.73	3.24
1.75-1.79	19	70.56	14.83	3.54
1.80-1.84	3	64	9	7.17
1.85-1.89	1	58	0	0
1.90-1.94	1	80	0	0
	Total=96			

Table 2: Weight categorization based on BMI by comparing actual to estimated weight

BMI (kg/m2)	classification	Actual weight		Estimated weight	
		Frequency	Percentage	Frequency	Percentage
Less than 18.5	Underweight	6	6.25	0	0
18.5-24.5	Normal	41	42.70	89	92.70
25.0-29.5	Overweight	26	27.08	7	7.29
30.0-34.5	Obesity class 1	10	10.41	0	0
35.0-39.5	Obesity class 2	0	0	0	0
Greater than 40	Obesity class 3	13	13.54	0	0
		Total=96			

Table 3 Range and corresponding actual weight and estimated weight

Height range(m)	Actual weight(kg)	Estimated weight (kg)
1.45-1.49	59	70
1.50-1.54	68.1	70.9
1.55-1.59	65.4	65.8
1.60-1.64	65.1	71.85
1.65-1.69	65	71.35

[Citation: Irfan. A., Ijaz, Z., Ali, A.F., Khan, A.S. (2024). Improving the accuracy of calculation weights by visual input: a pilot study in the emergency department of a low middle-income country. *Biol. Clin. Sci. Res. J.,* **2024***: 652*. doi: https://doi.org/10.54112/bcsrj.v2023i1.652]

1.70-1.74	72.7	67.55
1.75-1.79	70.56	66.76
1.80-1.84	64	56
1.85-1.89	58	68
1.90-1.94	80	77

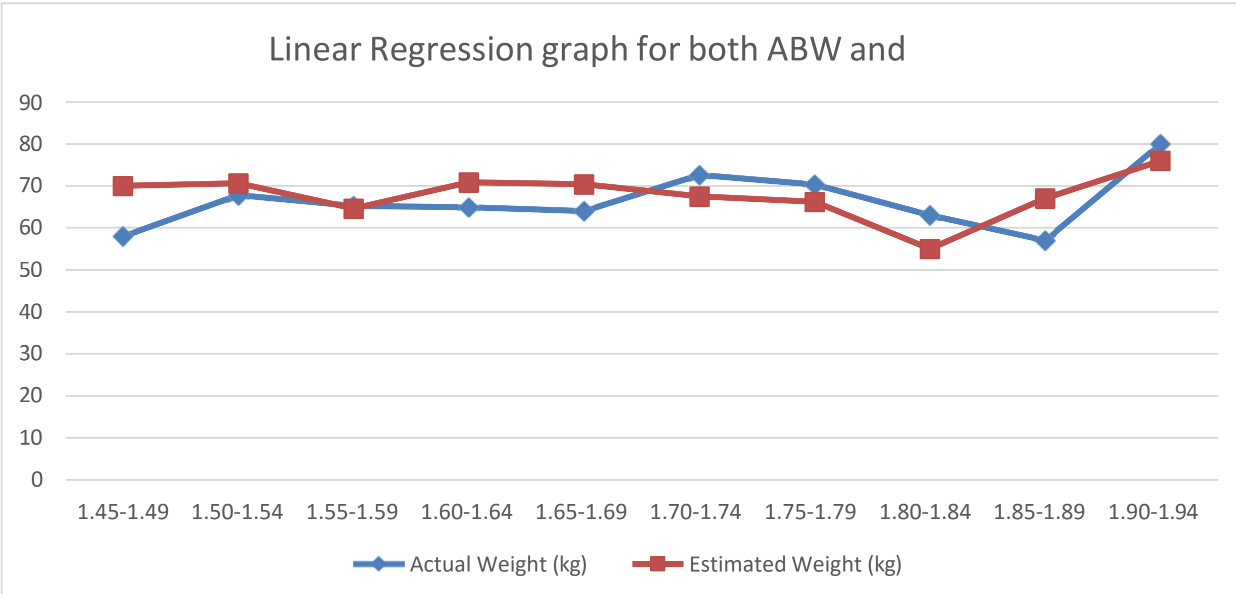

Figure 1: linear Regression graph showing comparison of actual to estimated weight.

Table 4: BMI weight categorization comparing actual and predicted weight

BMI (kg/m2)	**Classification**	**Actual weight**		**Estimated weight**	
		Frequency	Percentage	Frequency	Percentage
Less than 18.5	Underweight	6	6.25	0	0
18.5-24.5	Normal	41	42.70	89	92.70
Greater than 24.5	Overweight	49	51.04	7	7.29
	Total	96	100	89	100

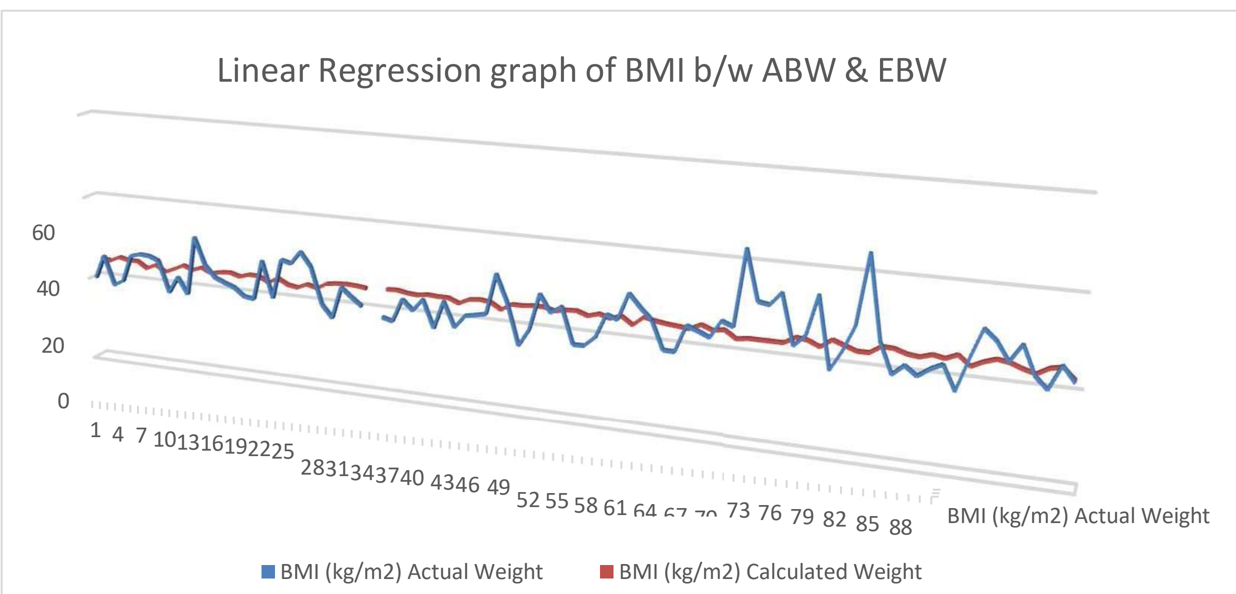

Figure 2: Linear regression comparing BMI between actual and estimated weight.

[Citation: Irfan. A., Ijaz, Z., Ali, A.F., Khan, A.S. (2024). Improving the accuracy of calculation weights by visual input: a pilot study in the emergency department of a low middle-income country. *Biol. Clin. Sci. Res. J.*, **2024**: *652*. doi: https://doi.org/10.54112/bcsrj.v2023i1.652]

The mean correction factor for all categories is updated after optimization. The following are the mean correction factors associated with each category:

- Correction Factor = 0.81 for underweight
- Correction Factor = 1.02 for Near Actual Weight
- Overweight: = 1.18 correction factor.

These enhanced correction factors provide precise changes for the underweight, near actual, and overweight groups, resulting in better weight estimation precision. These updated correction factors offer a more exact estimate of the adjustment required for underweight, near-accurate weight, and overweight categories.

The last thing to do is to recalculate the expected weights using the updated equation:

Wt corrected=(N-1)×100×Correction Factor

This reevaluated weight is an enhanced estimate that considers the updated correction variable.

Discussion

The cohort sample size, which comprised 51.5% of the research population, is comparable to the sample size used in a study evaluating the precision of popular age-based weight estimation formulas for children and the weight approximation in stroke patients before thrombolysis. The so-called WAIST research (Ackwerh et al., 2014; Breuer et al., 2010), an 11-month observational dose-finding investigation carried out in Germany on 109 stroke patients taking the thrombolytic Alteplase, was conducted to estimate weight in these patients.

The gender component in weight estimation may have been considered in the study cohort's demographics, which included both genders at a male-to-female ratio of 2.7:1. Additionally, the age range of 21 to 38 years old confirms that the data are from adults, excluding pubertal participants due to changing patterns during puberty. Consequently, the study's height range of 1.45 m to 1.95 m was met. The average heights for a population with a normal distribution have been reported to be between 1.2 and 2.1 meters (Aasvee et al., 2015; Fletcher, 2019). Thus, data from such a population may be considered valid. The mean, standard deviation, and standard error for each height category for eBW and ABW are analyzed in tandem with each other using descriptive statistical analysis. The minimal standard errors of 2.1 for ABW and 1.6 for eBW are noteworthy. The amount of ambiguity in a sample statistic is expressed as standard error. Standard error of measurements may also be used to express how reliable the estimations are. It is a projection of the frequency of mistakes of a specific magnitude. The correction factor for each category is identified after optimization and, when put into the formula described above, gives the correct estimate of the weight, which is more or less closer to the actual weight of the subject. Even though this method tends to yield estimates that are somewhat higher than the actual body weight. Overall, a considerable majority was within the accepted allowable estimate error limit of ± 10% mean percentage error; the Luscombe and Owen formula, which is presently used in the Advanced Pediatric Life Support Protocol and is widely used in pediatrics worldwide, likewise shows a finding of marginal over-estimation (Luscombe and Owens, 2007; Luscombe et al., 2011).

Our research also has a few limitations since the device used to measure height can only provide estimates to two decimal places; predicted weights of the body are not in decimals. Adults less than 1.20 m or taller than 2.00 m may find the formula unsuitable. There may be a limitation with the sample size, necessitating future large-scale population investigations. A population's current obesity rates would determine how well the equation will perform. Our method, eBW = (N −1)100*correction factor, was developed by trial and error using observational power and supported by statistically verified data; further fine-tuning of the mathematical formula could be necessary to account for some constraints. Future studies in this field are also warranted.

Conclusion

The computed correction factors represent a significant advancement in medical weight estimation. Revisions to the correction variables from the extensive research and improvement process significantly increase the accuracy of weight estimations in the medical domain. The obtained correction factors show how well they may improve weight estimates, especially for some patient populations. By categorizing patients based on these parameters, the study enables targeted precision and guarantees that adjustments are made exactly where they are most needed. The increased weight predictions in these adjustment factors contribute to safer and more accurate prescription practices in clinical settings, which makes them practically significant. When determining the appropriate dosage of medication for patients experiencing trauma, collisions, or crises, the recently suggested adjustment factors will be crucial.

Declarations

Data Availability statement
All data generated or analyzed during the study are included in the manuscript.
Ethics approval and consent to participate.
Approved by the department concerned.
Consent for publication.
Approved
Funding
Not applicable

Conflict of interest

The authors declared absence of conflict of interest.

Author Contribution

ADEELA IRFAN (Resident Doctor)
Conception of Study, Development of Research Methodology Design, Study Design, Review of manuscript, final approval of manuscript
Coordination of collaborative efforts.
Coordination of collaborative efforts.
ZARNAB IJAZ (Resident Doctor)
Conception of Study, Development of Research Methodology Design, Study Design, Review of manuscript, final approval of manuscript

Data acquisition, analysis.
AHMAD FAWAD ALI (Consultant)
Manuscript revisions, critical input.
Coordination of collaborative efforts.
ABDUS SALAM KHAN (Director)
Data acquisition, analysis.
Data entry and Data analysis, drafting article.

References

Aasvee, K., Rasmussen, M., Kelly, C., Kurvinen, E., Giacchi, M. V., and Ahluwalia, N. (2015). Validity of self-reported height and weight for estimating the prevalence of overweight among Estonian adolescents: the Health Behaviour in School-aged Children study. *BMC research notes* **8**, 1-9.

Ackwerh, R., Lehrian, L., and Nafiu, O. O. (2014). Assessing the accuracy of standard pediatric age-based weight estimation formulae. *Anesthesia & Analgesia* **118**, 1027-1033.

Bloomfield, R., Steel, E., MacLennan, G., and Noble, D. W. (2006). Accuracy of weight and height estimation in an intensive care unit: Implications for clinical practice and research. *Critical care medicine* **34**, 2153-2157.

Breuer, L., Nowe, T., Huttner, H. B., Blinzler, C., Kollmar, R., Schellinger, P. D., Schwab, S., and Köhrmann, M. (2010). Weight approximation in stroke before thrombolysis: the WAIST-Study: a prospective observational “dose-finding” study. *Stroke* **41**, 2867-2871.

Cattermole, G. N., Graham, C. A., and Rainer, T. H. (2017). Mid-arm circumference can be used to estimate weight of adult and adolescent patients. *Emergency Medicine Journal* **34**, 231-236.

Cullen, D. J., Sweitzer, B. J., Bates, D. W., Burdick, E., Edmondson, A., and Leape, L. L. (1997). Preventable adverse drug events in hospitalized patients: a comparative study of intensive care and general care units. *Critical care medicine* **25**, 1289-1297.

Fletcher, G. S. (2019). "Clinical epidemiology: the essentials," Lippincott Williams & Wilkins.

Hall II, W. L., Larkin, G. L., Trujillo, M. J., Hinds, J. L., and Delaney, K. A. (2004). Errors in weight estimation in the emergency department: comparing performance by providers and patients. *The Journal of Emergency Medicine* **27**, 219-224.

Luscombe, M., and Owens, B. (2007). Weight estimation in resuscitation: is the current formula still valid? *Archives of disease in childhood* **92**, 412-415.

Luscombe, M. D., Owens, B. D., and Burke, D. (2011). Weight estimation in pediatrics: a comparison of the APLS formula and the formula ‘Weight= 3 (age)+ 7’. *Emergency Medicine Journal* **28**, 590-593.

Nasiri, E., and Nasiri, R. (2013). Accuracy of estimation of total body weight by legs and head weight measuring and comparison method in the anesthetized patients. *Anesthesia, Essays and Researches* **7**, 341.

Pfitzner, C., May, S., and Nüchter, A. (2018). Body weight estimation for dose-finding and health monitoring of lying, standing, and walking patients based on RGB-D data. *Sensors* **18**, 1311.

Phelan, S. M., Burgess, D. J., Yeazel, M. W., Hellerstedt, W. L., Griffin, J. M., and van Ryn, M. (2015). Impact of weight bias and stigma on quality of care and outcomes for patients with obesity. *Obesity Reviews* **16**, 319-326.

Stehman, C. R., Buckley, R. G., Dos Santos, F. L., Riffenburgh, R. H., Swenson, A., Mulligan, S., Mjos, N., and Brewer, M. (2011). Bedside estimation of patient height for calculating ideal body weight in the emergency department. *The Journal of Emergency Medicine* **41**, 97-101.

Takata, M. N., Benumof, J. L., and Mazzei, W. J. (2001). The preoperative evaluation form: Assessment of quality from one hundred thirty-eight institutions and recommendations for a high-quality form. *Journal of clinical anesthesia* **13**, 345-352.

Wells, M., Goldstein, L. N., and Bentley, A. (2017). The accuracy of emergency weight estimation systems in children—a systematic review and meta-analysis. *International Journal of Emergency Medicine* **10**, 1-43.

[Citation: Irfan. A., Ijaz, Z., Ali, A.F., Khan, A.S. (2024). Improving the accuracy of calculation weights by visual input: a pilot study in the emergency department of a low middle-income country. *Biol. Clin. Sci. Res. J.,* **2024***: 652*. doi: https://doi.org/10.54112/bcsrj.v2024i1.652]