Feasibility and Accuracy of a Three-Parameter Nomogram in Adult Weight Prediction: A Pilot Study

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Abstract: ***Background**: Accurate prediction of body weight is essential in clinical practice, particularly when direct measurement is not feasible. A three-parameter nomogram has been developed for weight estimation, but its accuracy requires validation in adult populations. **Aim**: To validate and assess the accuracy of a three-parameter nomogram in predicting body weight among adult healthcare professionals at AIIMS, New Delhi. **Methods**: A cross-sectional pilot study was conducted among 30 healthcare professionals. Socio-demographic data and anthropometric measurements (height, waist circumference, hip circumference) were collected. Actual body weight was measured using a standard calibrated weighing scale, and predicted weight was calculated using the three-parameter nomogram. Statistical analysis included descriptive statistics, correlation analysis, regression analysis, paired t-test, and Bland–Altman analysis. **Results**: The mean age of participants was 35.6 ± 9.86 years, with the majority being male (53.3%) and married (66.7%). The mean actual body weight was 68.63 ± 14.70 kg, while the mean nomogram-predicted weight was 67.43 ± 15.32 kg. A strong positive correlation was observed between actual and predicted weights ($r = 0.953$, $p = 0.001$). Regression analysis showed that 97.6% of the variance in actual body weight could be explained by nomogram-predicted weight ($R^2 = 0.976$). Bland–Altman analysis demonstrated good agreement between the two methods, with a mean difference of 1.2 kg (95% CI: -0.53 to 2.93). The paired t-test showed no statistically significant difference between actual and predicted weights ($t = 1.416$, $p > 0.05$). **Conclusion**: The three-parameter nomogram demonstrated high accuracy and agreement with actual body weight measurements, indicating its potential utility as a reliable tool for weight prediction in adults when direct measurement is not feasible. Further large-scale studies are recommended to confirm these findings.***

Keywords: Bodyweight estimation, Nomogram, Anthropometric parameters

1. Introduction

Weight is a key biometric parameter in the physical assessment of patients in acute medical care settings. It forms a fundamental part of the initial nursing assessment and is essential for evaluating nutritional status, selecting appropriate drugs, determining correct dosage and route of administration, and guiding therapeutic activities across emergency, medical, and surgical units. Over time, two primary methods of weight measurement have been used: the spring scale, which measures weight relative to gravity, and the balance, which compares unknown mass with a standard. The human body weight is commonly measured using the spring scale method. However, in many practical situations, these strategies are not feasible.[1]

In pediatric populations, various formulas such as Luscombe-Owens and Nelson have been employed for weight estimation, alongside parental and healthcare worker estimation, though accuracy varies significantly.[2, 3] In adults, accurate measurement may be impossible in emergencies for bed-bound, unresponsive, or immobile patients. Physicians often rely on visual estimation, which risks under- or overestimation, potentially leading to errors in drug dosing, tidal volume, and fluid management, thereby compromising care.[4]

Accurate weight recording is critical for prescribing, fluid monitoring, nutritional and obesity screening, and ensuring safe patient handling.[5] It guides physicians, nurses, and dieticians in determining nutritional needs, protein and fluid requirements, dose calculations, and nutritional planning. Conversely, inaccurate weight may result in inappropriate treatment.[8]

Given these challenges, there is a pressing need for simple, reliable, and validated methods for predicting weight in critically ill and immobile patients. Tools such as anthropometric nomograms could play a crucial role in bridging this gap Validation of such predictive models in diverse populations is crucial before they can be adopted in clinical practice.[9] Since healthcare professionals represent a relatively healthy and accessible group, they provide a suitable sample for preliminary testing. The current pilot study was aimed to test whether the three-parameter nomogram developed for the German population is valid and accurate in predicting body weight among Indian adults.

2. Materials and Methods

This research employed a quantitative methodology characterized by a descriptive, cross-sectional design. The pilot study was conducted at the All India Institute of Medical Sciences (AIIMS) in New Delhi, a tertiary care teaching hospital renowned for its advanced research and patient care capabilities. The study focused on healthcare professionals engaged in neurosurgical units, who constituted the reference population for evaluating the three-parameter nomogram initially designed for the German demographic. A total of 30 healthcare professionals were selected through convenience sampling, adhering to established inclusion and exclusion criteria. Participants were adults who consented to take part, had no physical deformities, and were employed in the neurosurgical units. Informed written consent was secured from all participants after elucidating the study's objectives. The confidentiality and anonymity of the data were preserved throughout the research process. Ethical approval was granted by the Institutional Ethics Committee of AIIMS, New Delhi, along with authorization from the Head of the Department of Neurosurgery and the relevant ward nursing administration. Data collection was executed using four standardized instruments. Tool 1 consisted of a demographic profile sheet designed to gather information such as age, gender, marital status, religion, residence, education, and occupation. Tool 2 was the three-parameter nomogram, which utilizes height, waist circumference, and hip circumference to estimate body weight. Tool 3 involved a standard measuring tape, uniformly applied to all participants for the assessment of anthropometric parameters. Tool 4 was a standard calibrated weighing scale, which provided the actual reference weight for each participant. The data collection process commenced with the documentation of the socio-demographic characteristics of the participants. Anthropometric measurements, including height, waist circumference, and hip circumference, were recorded following standardized protocols. Utilizing these measurements, the predicted body weight was calculated.

3. Ethical Considerations

Ethical clearance for the study was obtained from the Institutional Ethics Committee of AIIMS, New Delhi (IECPG-250/24.03.2021, RT-22/28.04.2021). Written informed consent was obtained from all participants prior to data collection. Confidentiality of the information provided was ensured, and anonymity of the participants was strictly maintained throughout the study.

4. Results

The study included 30 health care professionals, with a mean age of 35.6 ± 9.86 years, indicating a predominantly middle-aged adult group. The majority were male (53.3%), married (66.7%), and all participants resided in urban areas. Most participants were graduates (70%) and working as nursing officers (76.7%). The anthropometric assessment revealed a mean height of 165.43 ± 11.8 cm, mean waist circumference of 89.40 ± 11.73 cm, mean hip circumference of 92.90 ± 10.17 cm, and mean actual body weight of 68.63 ± 14.70 kg. The three-parameter nomogram predicted a mean weight of 67.43 ± 15.32 kg.

Table 1: Socio-demographic variables of adult heathy volunteers, N=30

Variables	Details
Age (in years)	Mean ± SD: 35.6 ± 9.86
Gender	Male: 16 (53.3%), Female: 14 (46.7%)
Marital status	Married: 20 (66.7%), Unmarried: 10 (33.3%)
Religion	Hindu: 17 (56.7%), Christian: 12 (40%), Muslim: 1 (3.3%)
Residential area	Urban: 30 (100%)
Education	Diploma: 9 (30%), Graduate: 21 (70%)
Occupation	Nursing officer: 23 (76.7%), Senior Nursing Officer: 4 (13.3%), Assistant Nursing Superintendent: 3 (10%)

Table 2: Anthropometric Variables of adult healthy volunteers, N=30

Variables	Mean ± SD
Height/ Length in Cm	165.43 ± 11.8
Waist Circumference	89.40 ± 11.73
Hip Circumference	92.90 ± 10.17
Body Weight (Actual) in Kg	68.63 ± 14.70
Body Weight (Nomogram Generated) Kg	67.43 ± 15.32
Mean Difference in body weight, Kg	**1.2 ± 4.64**

The mean height of participants was 165.43 ± 11.8 cm. The average waist and hip circumferences were 89.40 ± 11.73 cm and 92.90 ± 10.17 cm, respectively. The mean actual body weight was 68.63 ± 14.70 kg, while the nomogram-generated body weight was 67.43 ± 15.32 kg. The mean difference between actual and nomogram-predicted body weight was 1.2 ± 4.64 kg, indicating that the nomogram provided an estimation closely comparable to measured values.

A strong positive correlation was observed between actual body weight and nomogram-generated weight ($r = 0.953$, $p < 0.001$), indicating high predictive accuracy. Linear regression analysis demonstrated that 97.6% of the variance in actual body weight could be explained by the nomogram-generated weight ($R^2 = 0.976$, Adjusted $R^2 = 0.974$, $p = 0.001$). Paired t-test analysis showed a mean difference of 1.2 kg between actual and predicted weights, which was not statistically significant ($t = 1.416$, $df = 29$, 95% CI: -0.53 to 2.93). Bland-Altman analysis further confirmed good agreement between the two methods, supporting the validity of the nomogram in predicting body weight among healthy adult volunteers.

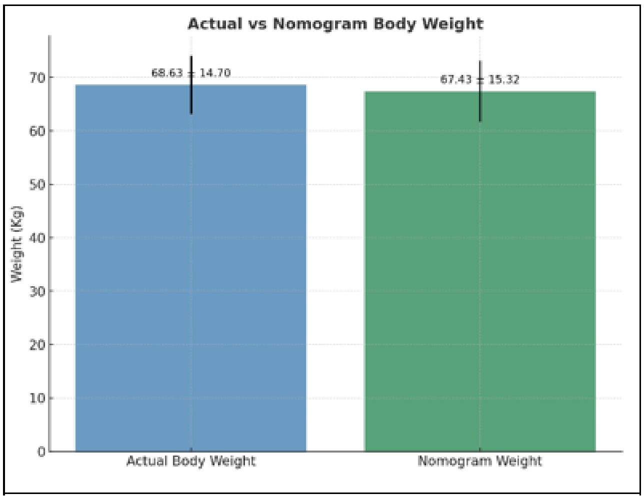

Figure 1: Comparison of Actual and Nomogram-Estimated Body Weight

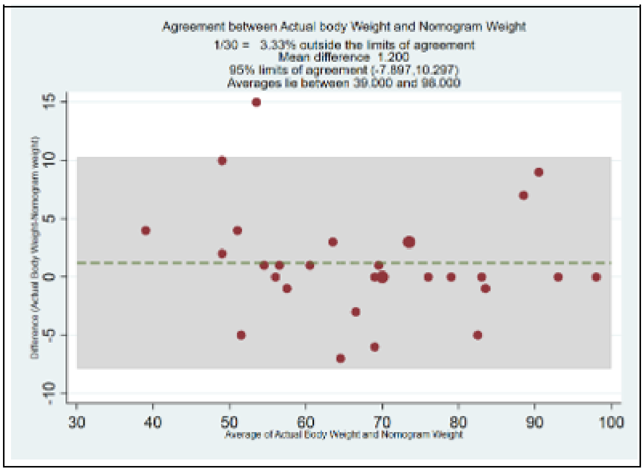

Figure 2: Measures of agreement- Bland Altman plot for comparison of actual body weight and nomogram weights of healthy volunteers

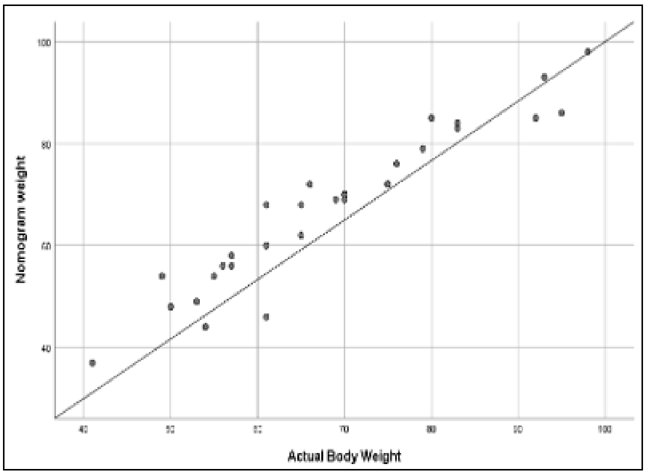

Figure 3: Correlation between Actual body weight and Three parameter Nomogram weight

5. Discussion

The present pilot validation study was conducted among healthy adult volunteers with the objective of assessing the accuracy and feasibility of the proposed weight estimation method. The findings of this study demonstrate that the tool/nomogram (or method—replace with your specific technique) showed acceptable accuracy when compared with actual measured body weight. This suggests its potential utility in clinical settings where direct weight measurement is difficult or impossible, such as in critically ill, immobile, or emergency care patients.[6]

Accurate patient weight is a cornerstone for multiple clinical decisions including drug dosing, fluid therapy, ventilator settings, and nutritional planning. Previous studies have highlighted the limitations of visual estimation by healthcare providers, which often leads to underestimation or overestimation of body weight and can directly influence treatment outcomes.[1–3] In contrast, age- or height-based predictive formulae and nomograms have been employed in pediatric practice with varying degrees of reliability.[4] The present study attempted to translate such predictive strategies into the adult population, which is an area with limited published data.

The results of this pilot study are consistent with earlier research that demonstrated the feasibility of using anthropometric parameters for estimating body weight.[5,7] However, certain variations were observed between estimated and actual body weight, which could be attributed to differences in body composition, nutritional status, and individual variability among participants. While the level of agreement in this study appears promising, further refinement and large-scale testing are required to improve precision and reduce bias.

The major strength of this study is that it was carried out under controlled conditions among healthy volunteers, which minimized confounding factors such as critical illness, immobility, or edema that often complicate weight estimation in clinical practice. Moreover, this pilot trial provided valuable insights into feasibility, data collection procedures, and statistical approaches that will guide the design of a larger validation study.

Nevertheless, several limitations need to be acknowledged. First, the sample size was small, which restricts the generalizability of findings. Second, the study population included only healthy adults, and therefore the results may not fully represent patient groups encountered in emergency or critical care units. Third, inter-observer variability was not assessed, which is an important consideration for practical clinical application.

Despite these limitations, the findings support the potential application of this method in situations where direct weight measurement is not feasible. For clinical practice, an accurate, simple, and rapid weight estimation tool could enhance patient safety by reducing errors in drug and fluid management. Future studies with larger, more diverse populations, including patients with varying body mass indices and clinical conditions, are warranted to establish robust validation and external applicability.

6. Conclusion

This pilot validation study among healthy adult volunteers demonstrated that the proposed weight estimation method is feasible and provides acceptable accuracy compared to actual measured weight. Although minor variations were noted, the findings suggest that this approach could serve as a practical alternative in clinical situations where direct weight measurement is not possible, such as in emergency or critical care settings. As a preliminary investigation, the study has highlighted both the potential benefits and areas requiring refinement. Larger studies across diverse patient populations are recommended to confirm validity, enhance precision, and establish the method's clinical utility.

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