ORIGINAL RESEARCH

Determination of Hand Surface Area as a Percentage of Body Surface Area: A Preliminary Cadaveric Study

EAST Edirisinghe[1], BCIJ Nanayakkara[2], LC Weerabhahu[1], PH Dissanayake[1], SG Yasawardena[1], I Ilayperuma[3]

[1] *Department of Anatomy, Faculty of Medical Sciences, University of Sri Jayewardenepura*
[2] *Department of Surgery, Faculty of Medicine, Kotalawala Defense University*
[3] *Department of Anatomy, Faculty of Medicine, University of Ruhuna*

Abstract

Introduction: Estimating body surface area (BSA) is vital in several clinical fields. Routinely height and weight are used to calculate BSA. Due to practical limitations, alternative methods like hand surface area (HSA) are used to estimate BSA. In clinical practice, it is assumed that HSA is equal to 1% BSA. Ethnicity, age and sex are factors that can influence percentage HSA.

Methods: We used 65 formalin-fixed cadavers (n = 65; 34 males and 31 females; ages 58–76) provided to the Department of Anatomy, University of Ruhuna, Sri Lanka for this study. Standard anthropometric techniques were used to record the height and weight of the cadaver. A digital sliding caliper that could measure to the closest 0.01mm was used to measure the length and width of the hands. The DuBois-DuBois formula was used to calculate BSA, and %HSA (HSA/BSA × 100%) was computed.

Results: Mean ages of the study subjects (male: 70.66 ± 5.09 years; female: 69.49 ± 7.69years) were not significantly different between the genders. Mean weight (male: 63.26±12.59kg; female: 50.42±11.46 kg) and height (male: 167.23±6.91cm; female: 1age.61±6.20cm), hand length (male: female:), hand width (male: female:), HSA (male: female:), BSA was found to higher in males, compared to females and was statistically significant ($P < 0.01$). The %HSA was 0.87% for males and 0.85% for females.

Conclusion: The findings reinforce ethnic and gender variations observed in %HSA, providing reference data pertaining %HSA for an adult Sri Lankan population, thus emphasizing the necessity for population-specific values to minimize potential errors in assuming 1% rule for HSA.

Key words: Hand; Body; Surface area; Sri Lanka; Adults

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Corresponding Author
EAST Edirisinghe
email: edirisinghe@sjp.ac.lk

https://orcid.org/0000-0002-8360-5157

Introduction

Body surface area (BSA) has a significant application in a variety of medical fields such as burn therapy (1), cancer chemotherapy (2) and assessing cardiac index (3). Further, fluid resuscitation and calculation of nutritional needs in management of critically ill patients and acute settings, heavily rely on the estimation of BSA (1). Over the course of history, BSA estimations have been attempted using variety of direct and indirect approaches. Direct methods include body coatings, 3D laser scanning, alginate method and geometric methods (4). Although direct methods yielded more reliable and accurate BSA estimates, it has been a challenging, time consuming and a labor-intensive task making it practically impossible to carry out in day-to-day hospital settings. Hence as an alternative, different formulae which utilize two anthropometric variables, body height and weight, are in use for estimation of BSA. The formula proposed by DuBois and DuBois has been most widely used for BSA estimation throughout the world (5–7). However, BSA estimation formulae which utilizes stature and weight of a patient may practically be unfeasible in critical care settings where many life-saving procedures require BSA estimation. In this context, the importance of surrogate measures of BSA estimation cannot be underestimated.

The palmer surface area of the hand termed as the hand surface area (HSA) has been considered as 1% of BSA (6,8,9). However, a large body of evidence shows that the percentage HSA in relation to the BSA vary widely on ethnicity, age, gender and BMI (6,9–13). The aforementioned variations complicate and raise serious concerns over the application of the 1% HSA rule for the BSA. Therefore, it is important to know the precise % HSA, in relation to BSA, in order to avoid adverse consequences due to lapses in dosage regimens based on 1% HSA.

There is a significant knowledge gap on the % HSA in adult Sri Lankans, despite its practical importance. A preliminary study was undertaken to determine in-detail the gender specific HSA in relation to BSA of an adult Sri Lankan sample.

Methods

34 male and 31 female cadavers were utilized from those donated to the Department of Anatomy, Faculty of Medicine, University of Ruhuna, Sri Lanka for the routine gross anatomy dissections. Participants in the study exhibited no physical or spinal column anomalies and seemed to be in good health during the time of death. Those with a history of fractures, surgeries, or hand trauma were excluded. The age ranged 58 to 76.

All measurements were recorded according to standard anthropometric procedures. The personal stature was recorded as the distance between vertex of the skull and the heel of the foot measured using a flexible steel measuring tape capable of measuring to the nearest 0.1 cm. The body weight was recorded to the nearest 0.1 kg using a hanging balancer (Avery, USA). Using a digital sliding caliper (Mitutoyo, Japan) that could measure to the nearest 0.01mm, the individuals' right hands were used to measure their hand length (HL) and hand breadth (HB). HL is the straight distance between the most anterior projecting point of the middle finger and the midpoint of the radial and ulnar styloid tips; HB is the straight distance between the most medially projected point on the head of the second metacarpal and the most laterally projected point on the head of the fifth metacarpal when the hand is extended. In order to avoid differences caused by inter-observer bias and diurnal variation, the same researcher took the aforementioned measurements at a set time between 14.00 and 16.30 hours.

The BSA was calculated using the formula proposed by DuBois-DuBois: Weight (kg) $^{0.425}$ × Height (cm)$^{0.725}$ × 0.007184 (5). The hand surface area was calculated as HSA = (HL x HB) x100; The hand percentage of BSA (% HSA) was calculated as % HSA = HSA/BSA.

The data, which were displayed as mean ± SD, were analyzed using the Statistical Package for Social Sciences (SPSS), 25th version (Illinois, USA). The mean values of the data were compared between the genders using the independent t-test. Statistical significance was defined as a p value of less than 0.01.

Results

There was no significant difference between the study subjects' mean ages (male: 70.66 ± 5.09 years; female: 69.49 ± 7.69 years). Gender differences with respect to stature (male: 167.23±6.91cm; female: 156.61±6.20cm) and weight at time of death (male: 63.26±12.59Kg; female: 50.42±11.46 Kg) was found to be significantly higher in males compared to females ($p<0.01$).

The results of the various anatomical dimensions of the body and hand according to gender are shown in Table 1. Males had a significantly greater HL, HW, BSA, HSA was as opposed to females ($P<0.01$). Percentage hand surface area with respect to BSA was less than 1% for both genders.

Table 1. Height, weight, BSA, HL, HW, HAS and % HSA of the subjects according to the gender

Parameter	Male	Female
Body height (cm)	167.23±6.91	156.61±6.20
Body weight (Kg)	63.26±12.59	50.42±11.46
BSA (m^2)	1.70±0.18	1.48±0.17
Hand length (cm)	17.93 ± 2.02	16.54 ± 0.74
Hand width (cm)	8.34 ± 0.53	7.52 ± 0.46
Hand surface area (m^2)	0.015 ± 0.002	0.012 ± 0.001
Hand surface area (% BSA)	0.87 ± 0.12	0.85 ± 0.08

Data is expressed as mean ± standard deviation; (P<0.01)

Discussion

The results provide an insight pertaining to the percentage HSA with respect to the BSA in a group of adult Sri Lankans. It is commonly known that the BSA can be estimated using the patient's own hand. The palmar surface of the hand, including the digits, is described in surgical textbooks as 1% of BSA (14). Nonetheless, the palmer surface area of the hand (HSA) from the wrist to the tips of the fingers is defined as 1.5% in the conventional Lund and Browder chart (15).

Over the course of this study HSA has been defined as the palmar surface of the entire hand including the digits and evaluated using direct measurements of hand dimensions in order to accurately determine the % HSA in an adult Sri Lankan population (16). This approach needs minimum resources, like a digital sliding caliper or merely a measuring tape which would be available even in peripheral rural settings of a developing country. It is a simple, cost effective, practically feasible method as it does not require any sophisticated equipment or special skills. Further, it is repeatable and quick to perform even in an emergency setting.

Clinical assessment of % HSA is of great practical importance. Percentage HSA is used to assess the body surface area involvement in various pathological conditions such as toxic epidermal necrolysis and to measure the severity of psoriasis (17,18). In burn therapy, using percentage HSA, a quick estimation of the BSA is essential during the initial management of burns. The BSA thus calculated not only determines the dose of drugs to be administered in order to resuscitate the patients but also assesses the surface area of the skin that needs transplantation (16). Therefore, the significance of precise estimation of %HSA cannot be overemphasized.

A growing body of evidence indicates a wide variation in the percentage of BSA constituted by the hand (%HSA) in different ethnic populations which is different from standard 1% rule for the HSA. It is reported that % HSA of Americans: 0.78%; (6), Indian: 0.92% (19), Koreans: 1.19% (9); Turks: 0.83% (male) & 0.78% (female) (11), Chinese: 0.76% (male) & 0.73% (female) (12)(Liao CY); UK: 0.81% (male) & 0.67% (female) (13). Results obtained from this study show that in Sri Lankans % HAS accounts for 0.87% (male) & 0.83% (female) of BSA. Hence our results further reinforce the ethnic variation in %HSA. Taking together, the need for population-specific values for %HSA is evident.

It is stated, that the application of the 1% rule for the HSA in estimation of BSA will cause an overestimation of fluid and caloric requirements (5,6,11–13,19). Furthermore, significant overestimation of burn size estimation using %HSA has been reported leading to life-threatening errors (20,21). Application of BSA estimation using % HSA, without considering patients ethnicity, age, sex and BMI have been attributed to BSA misestimating (22).

As the body dimensions and the morphometry of the hand are influenced by the ethnicity, gender and age of an individual, the need for gender specific reference values is proven beyond doubt (10,23). Given these constraints, the current study reports gender-specific %HSA which is practically applicable for an adult population of Sri Lankans. In order for the reference values to encompass the features of the specific population in which they would be utilized; it is equally crucial that they only be utilized for that population.

Taken together, it appears that the most important question which needs to be addressed regarding the %HSA is its impact on clinical and emergency procedures and, ultimately and most importantly, patients' chance of survival. Therefore, an explicit knowledge of the %HSA cannot be overemphasized.

Limitation of the study: Postmortem changes and the influence of cadaveric preservatives could lead to alterations in physical dimensions, which could be considered as the study's main drawback. To rectify this issue follow-up study on live participants is advised.

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