

Research Article

Determination of hand and palm surface areas as a percentage of body surface area in Turkish young adults

Pınar Göker^{1*} and Memduha Gülhal Bozkır¹¹Çukurova University, Faculty of Medicine, Department of Anatomy, 01330 Adana-Turkey

Abstract

Background and aim: This study was aimed to determine the total body surface area and percents of both palmar surface of the whole hand (hand surface area) and palm without fingers (palm surface area) in our population.

Materials and methods: The study group consisted of 294 medical students (146 women, 148 men) aged 18–25 years and bilateral hand tracings were obtained from all subjects. Total body surface area was calculated using DuBois Formula and hand and palm surface area was calculated from hand tracings. Additionally, the hand and palm percentages of body surface area was determined by dividing hand- palm area by total body surface area.

Results: The mean value of total body surface area was 1.9 m² and 1.63 m² in men and women respectively. The area of tracing of the hand was 0.83% of the body surface area in men and 0.78% in women. Moreover, palm surface area was 0.43% and 0.39% of the body surface area in men and women respectively.

Conclusion: Using patient's own hand will be more accurate for determination of the area of the hand than the one percent rule to avoid an overestimation of fluid and caloric requirements and drug dosages.

Introduction

The total body surface area (TBSA) is an important parameter in such cases like the administration of drugs, physiological responses, burn therapy and in the work of clinicians, physiologists and ergonomists [1]. The total area of skin burn is determined as a useful guide for prognosis and treatment of burn patients [2]. However, estimation of percentage of surface area burned is not easily calculated. There have been two methods that commonly used for calculation: the Lund and Browder chart and the rule of nines [2-5]. Measurement of hand surface area (HSA) is also an easy, practical method for considering the extent of burns [4]. Traditionally, the palmar surface area of hand has been evaluated to be one percent of total body surface area while determining the irregular patchy burns [2,6,7]. Meanwhile, some reports were shown that HSA of their groups varies from 0.64% to 1.4% TBSA [4,7-9]. Moreover, recreational fires such as barbecues or campfires may cause injury through burns with contact to hot coals, embers resulting in thermal contact burn. In this situation, hands and feet are the most commonly burned areas of the body typically palms and soles. These burns therefore, have serious functional and aesthetic consequences [10]. Thus, studies of palm surface area have been investigated in relation with prognosis and treatment of burns. Using the patient's own hand for estimating the palm surface area is determined as a useful tool in assessing small area of burns or other wounds [11]. However, it has not been clear that the palm means the palmar surface of the whole hand or palm excluding the fingers [6]. There is a confusion about this description. In some studies, it was suggested that the palm of hand does not include the digits and used as a unit of area in estimating the size of burn for skin grafting and fluid resuscitation [12-15]. Moreover, application of the one percent rule for the palm surface area of the hand will be cause to overestimation of burn area and therefore, an overdose of fluid and caloric requirements could be performed. Thus, accurate estimation of size of burn is

important. There is a discrepancy about what percentage of total body surface area is composed by the palm and hand. Therefore, this study was designed to determine values of the total body surface area, the hand surface area (HSA- palm with digits) and palm surface area (PSA- palm without digits) in our healthy adult group and compare them to other populations.

Methods

Bilateral hand tracings were obtained from 294 medical students (146 women, 148 men) between 18 and 25 years of age with no history of trauma or congenital anomalies. The individuals were numbered and age, gender, height, weight, dominant hand were recorded. Each individual was asked to gently place her/his hand over a plain sheet of paper, keeping the fingers closed with the thumb lying comfortably against the radial aspect of the hand and index finger. A tracing of each hand was made using a pen. The tracing was done from the tip of the radial styloid to the tip of the ulnar styloid, a straight line was drawn between the styloid tips. This line is performed the interstyloid. The hand length was measured from the midpoint of the interstyloid to the distal tip of the middle finger. The palm length was measured from the midpoint of the interstyloid to the palmar digital crease of the middle finger. Additionally, the hand width was measured from the ulnar concavity at the base of the small finger to the point where the thumb diverged from the index finger (Figure 1). After these measurements,

Correspondence to: Pınar Göker, Çukurova University, Faculty of Medicine, Department of Anatomy, 01330 Adana-Turkey, Tel: +90 322 338 60 60-3489; E-mail: pkarakas@cu.edu.tr

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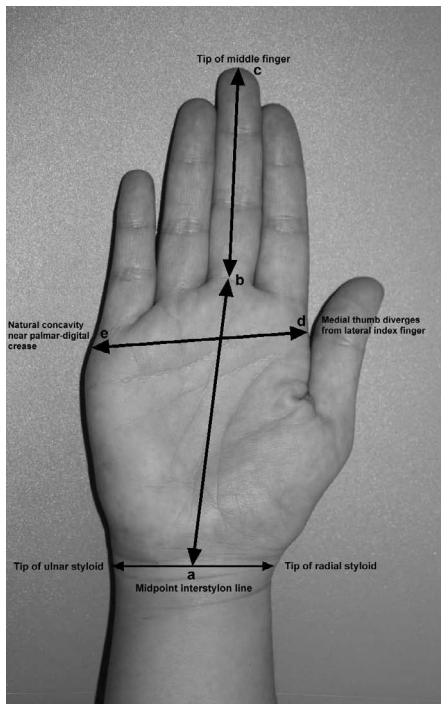


Figure 1. Anthropometric parameters on the hand. ab: Palm length, ac: Hand length, de: Hand width.

Table 1. Characteristics of participants (n=148 men, 146 women)

Parameter	Sex	Mean ± standard deviation	Minimum-maximum
Hand length (cm)	Men	18.65 ± 0.73	16.53-20.27
	Women	17.79 ± 0.95	15.12-19.48
Palm length (cm)	Men	9.77 ± 0.90	7.78-11.89
	Women	8.85 ± 1.11	5.81-10.90
Hand width (cm)	Men	8.48 ± 0.65	5.07-10.14
	Women	7.19 ± 0.78	5.10-8.74
Body mass index (kg/m ²)	Men	22.96 ± 1.90	18.5-24.90
	Women	20.51 ± 1.69	18.5-24.80
Total body surface area (TBSA) (m ²)	Men	1.90 ± 0.12	1.61-2.20
	Women	1.63 ± 0.91	1.49-1.85
Hand area (m ²)	Men	158.34 ± 14.76	92.93-187.99
	Women	127.87 ± 14.75	95.01-155.01
Palm area (m ²)	Men	82.98 ± 10.74	42.89-107.86
	Women	63.91 ± 11.84	32.19-88.83
Hand surface area (% of TBSA)	Men	0.83 ± 0.08	0.47-1.08
	Women	0.78 ± 0.09	0.57-0.96
Palm surface area (% of TBSA)	Men	0.43 ± 0.05	0.22-0.63
	Women	0.39 ± 0.07	0.20-0.56

width of the hand is multiplied with the length of hand and palm to give hand and palm area respectively.

The body mass index was calculated from height and weight and body surface area was estimated using DuBois Formula (Body surface area = $71.84W^{0.425}H^{0.725}$) [16]. W is the body mass in kilograms and H is the body height in centimeters.

A table was created containing subject number, age, gender, weight, height, body mass index, dominant hand, total body surface area, hand and palm areas, and their percentages of body surface area (hand surface area-HSA, palm surface area-PSA). Hand's percentage of body surface area was calculated as dividing hand area by total body surface area and the palm's percentage of body surface area was determined by dividing the palm area by total body surface area.

After these calculations, the data were divided into two groups due to gender and statistical analysis was performed with SPSS 10.0. From these measurements, means, standard deviations and minimum and maximum values were evaluated.

Results

The records of 294 medical students (146 women, 148 men) were assessed. The mean age of participants was 22 years (range 18-25 years). Moreover, in comparing the mean value of area of the dominant hand with that of the nondominant hand, there was no difference between them for all subjects. All the parameters of subjects including hand length, palm length, hand width, hand area, palm area, body mass index, TBSA, HSA and PSA in this study are shown in Table.

When we analyzed the data in this study, the mean values of hand length, palm length, hand width, hand-palm areas and body mass index were found as 18.65 cm, 9.77 cm, 8.48 cm, 158.34 cm², 82.98 cm² and 22.96 kg/m² in men whereas the same values were established 17.79 cm, 8.85 cm, 7.19 cm, 127.87 cm², 63.91 cm² and 20.5 kg/m² in women. Furthermore, after these measurements TBSA, HSA and PSA were calculated and these parameters were found 1.90 m², 0.83 and 0.43 in men and 1.63 m², 0.78 and 0.39 in women.

Discussion

The total body surface area (TBSA) is widely used in scientific studies and clinical practice to normalize various measurements concerning in cardiac function, body heat transfer, renal function, body metabolism, toxicology, development of manual equipments in ergonomics and for the drug dosage in cancer chemotherapy [17-23]. However, the determination of total body surface area has been a problem in the medicine. The investigations in this subject were began in 1793 with Abernathy that used cut paper of known areas to estimate the surface area of the head, hand and foot [2,24]. Techniques have developed but at present there is no accurate method exists direct determination of surface area. There are many equations to estimate the surface area such as classic DuBois Formula, Gehan and George's Formula and Boyd's equation [2,25-26]. Nonetheless, the most common formula used today is that of DuBois [2,23]. In our study, we used DuBois equation for body surface area estimation.

Amirshaybani et al reported the mean value of TBSA as 1.84 m² in men and 1.68 m² in women in USA whereas in Indians this was established 1.59 m² and 1.43 m² in men and women respectively. Additionally, in a study including Chinese adults, the TBSA values were indicated as 1.83 m² and 1.56 m² in men and women respectively [2,4,13]. This parameter was declared as 1.88 m² in men and 1.64 m² in women from Belgium [23]. In this investigation, the TBSA value was 1.90 m² in men and 1.63 m² in women. According to the literature data, our findings were similar to studies in USA and Belgium populations.

Hand surface area (HSA) and palm surface area (PSA) are important reference areas in physiology and medicine and mainly used in emergency room for estimation of burned skin area in burn therapy and skin grafting [27]. Moreover, these areas have been utilized for heat exchange in thermal physiology, exposure assesment in toxicology and the development of equipment in ergonomics [21,28,29]. Traditionally, the patient's whole hand has been used as an estimate of 1% of the total body surface area for assessing the size of burn [6,7,21,30]. Conversely, Advanced Trauma Life Support teaching uses the area of palm alone (not including the fingers) as 1% [6,8,27,30]. There is a problem with the term "palm" as it can mean either the entire palmar surface of the hand or the palmar surface excluding the five digits [8]. By a common

understanding, the palm of the hand does not include the fingers [6,13,21,27]. The definition of the hand surface is still controversy. Therefore, in our study, to avoid the confusion we determined HSA and PSA separately and investigated both definitions that HSA was defined as area of the palm with fingers, and PSA was defined as area of the palm without fingers. Furthermore, when we analyze the both hands' measurement values, there is no difference between dominant and nondominant hands in both genders in the present study. Thus, we presented the dominant hand values. This data confirms previous reports [2,21].

Perry *et al.* measured the PSA and found a value of 0.41% in London Medical School students whereas it was estimated as 0.66% in Korean adults [8,27]. Moreover, the same value was represented 0.49 and 0.51 of the body surface area in men and women respectively in Indians [17]. In our study, this parameter was evaluated as 0.43% in men and 0.39% in women. Due to these reports, we found differences in mean values of Indian and Korean populations compared with our result: they have higher values than us. Our result is closer to that the report from London.

The definition of the area of the hand surface was not clear in literature, some researchers included digits and some groups did not and another group included the thumb [27]. Meanwhile, it was established that standard doctrine for the hand position, for estimating the surface of the hand, digits were extended and adducted so it was used in this paper [30]. When we analyzed the literature for the mean values of HSA, Amirshyebani *et al.* determined the area of the hand 0.78% of the body surface area in adults in USA with using similar method that excluded the thumb for estimating the hand width value [2]. In Chinese population, this was reported as 0.76 and 0.73% in men and women respectively [4]. However, it was assessed 0.92% in men and women in Indians [17]. Furthermore, this value was found greater in Koreans (1.19) [21]. In this paper, it was established 0.83% and 0.78% in Turkish men and women respectively. According to these values, there are some diversities that Koreans and Indians have greater HSA values than us. Conversely, Chinese HSA values are lower than our result.

A comparison between our results and those of previous studies which are reported from China, Korea, India shows that the values of TBSA, HSA, PSA differ from our results [4,17,21]. However, we analyze that there are some similar values with our data and European and American population [2,8,23]. We think that these diversities could depend on some factors like measurement method, race, genetic characteristics, age and individual variations.

Application of the 1% rule for the palmar surface area of the hand in all burn individuals will cause to an overestimation of burn size and therefore, overestimation of fluid and caloric requirements could be occurred [2]. The data obtained in this study determine the palmar surface of the hand and whole hand surface area is not one percent of the body surface area in our group. Therefore, using patient's own hand method is more accurate and easy in assessing small area of burns or other wounds.

In this paper, it was demonstrated that it is not necessary to have an integrating planimeter, a computer assisted methods or etc. All one needs to do is measure the width of the hand and length. Thus, it is readily available to make a simple tracing of a patient's hand. We propose that a burn's patient hand tracing be obtained during physical examination and used as a tool to estimate the size of the burn. This is especially useful when the burn area is irregular or burn extends over

convexities. So hand tracing method may be used to complement the standard Lund and Browder chart.

Furthermore, as we mentioned before, for estimating hand area, hand length and hand width were measured and these parameters were multiplied. In Table, the mean values of hand length-width were also presented. The normal values of these parameters could be used in some studies which are investigated Marfan's syndrome, hypothyroidism and hypopituitarism to examine this possibility [11].

In summary, estimation of burn area could be made with Lund and Browder Chart and the rule of nines. But, we suggest that the patient's own hand tracing could be used to complement the above rules. Our study indicates that the areas of the surface of the whole hand 0.83 and 0.78 percent of body surface area in men and women and palmar hand surface area 0.43 and 0.39 percents of body surface area in men and women in our population. Thus, these values could determine the relationship of the area of the hand to TBSA.

As a result, we believe that study with using hand tracing method is more accurate than the commonly used one percent rule for the palmar surface area of the hand and this could be helpful for preventing the undesirable situations like overestimation of fluid and caloric requirements for the burn patient and will aid in patient care.

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The authors declare that they have no conflict of interest.

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