



## Determination of Hand Surface Area As A Ratio of Body Surface Area, in Maharashtra Population

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### Abstract

**Introduction :** Estimation of Total Body Surface Area (TBSA) plays crucial role in variety of clinical conditions, such as Renal Clearance, Cardiac Index, Chemotherapy and Glucocorticoid dosage, and also in Thermal Burns related injuries.

In small and patchy burns patients hand is used to estimate percentage of burn which is traditionally 1%, Feet surface area values of this kind are usually estimated as a percentage of TBSA and it is 7% according to Lund and Browder chart. There is a discrepancy about what percentage of TBSA is continued by the Hand, therefore this study was designed to determine correctly the TBSA represented by the palmar surface area of the hand in Maharashtra population.

**Aim And Objective :** To correlate morphometric measurements of Hand with the Total Body Surface Area.

**Materials And Methods :** 512 healthy adult age group from 30 – 40 years of both sexes (255 male and 257 female) are selected. Right and Left Hand Surface area was calculated using hand tracing on plain paper, and Total Body Surface Area was calculated using DuBois and DuBois Formula.

**Result :** The mean hand ratio of both sides for male and female was 0.79% and 0.73% respectively.

**Conclusion :** The Hand surface area is around 0.80% of TBSA in Maharashtra population.

**Keywords:** Hand Surface Area(HAS), Total Body Surface Area(TBSA).

### Introduction

Body surface area is an important indicator of metabolic mass rather than body weight because it is less affected by abnormal adipose mass. Estimation of body surface area is simpler than measurement of volume.

The relationship between body surface of animals and various parameters of their physiology has been observed over many decades. Rubner, in 1883<sup>[1]</sup>, pointed out that small animals utilized relatively more oxygen and produced relatively more heat than

larger animals. He explained that smaller animals had relatively larger surface areas than larger animals and demonstrated that oxygen utilization and caloric expenditure were similar for various mammalian species and differently sized members of the same species when computed on the basis of body surface<sup>[2]</sup>. These observations have been confirmed and extended to human by many investigators, and it has long been a standard practice to express human basal metabolic rate in terms of body surface area rather than body weight<sup>[3]</sup>.

Baker and Kozoll<sup>[4]</sup> determined plasma volumes and total blood volumes in 150 normal adults using iodinated human serum albumin labeled with I-131 and hematocrit determination. The ratio of blood volume to body weight was not constant, but a direct linear relationship was found to exist between body surface area and blood volume, and the authors concluded that surface area was the single most useful basis for deciding the normal total blood volume of an individual.

In clinical medicine it has been found practical to use body surface area to gauge the needs of patients for parenteral fluids and electrolytes<sup>[5]</sup>. The caloric requirements of infants and children, which generally are progressively lower in relation to body weight with increasing age, are almost identical for all ages and weights when related to body surface area.

Estimation of body surface area thus plays crucial role in variety of clinical conditions that's the like<sup>[5,6]</sup>

Estimation of Renal clearance, Estimation of Cardiac index, The Quitlet index, Determination of dosage of Chemotherapy, Determination of Glucocorticoid dosage, and in cases of Thermal Burns & related Injuries<sup>[5,6,7]</sup>.

There are several methods for assessment of burn size<sup>[6]</sup>, which includes the 'Lund and Browder Chart'<sup>[8,9,10]</sup> and 'Rule of nine'<sup>[9,10]</sup>, Sometimes these methods are used in combination. The 'Rule of nine' is convenient and rapid method to estimate the extent of burned surface area, but it is not very accurate in case of patchy burns. There is another Simple, Quick, Non-Traumatic, In-expensive method used in patchy burns in which patient's hand is used to estimate percentage of body surface area which is traditionally 1%<sup>[11]</sup>. There is discrepancy about what percentage of Total body surface area is constituted by the hand.

In India there is a study by Dr. Agarwal and Dr. Sahu<sup>[8]</sup>, who have done work on determination of hand and palm area as a ratio of body surface area by taking morphometric measurements of dominant hand only.

At present no studies for the body surface area are available in Maharashtra particularly in south – west

Maharashtra. which shows the hand area as a ratio of body surface area. It was therefore felt that a study be carried out in this part of Maharashtra using measurement of Hand & Body surface area, to put forth standard values.

### **Aims And Objectives :**

To study the body surface area and hand surface area in healthy male and female teacher population from south – western Maharashtra.

To correlate morphometric measurements of hand with the total body surface area.

**Materials And Methods :** 512 subjects from age group of 30 to 40 years of either sexes (255 Male and 257 Female) are selected. The selected subjects are Teachers in various Colleges and Schools which represents same special class and group.

**Inclusion Criteria:** Normal Hand with 10 normal finger, without any missing or deformed finger.

**Body Height And Body Weight :** Body Height was measured as the vertical distance between the vertex and the floor, while the head Was held in Frankfort Horizontal (F.H.) Plane. Body Weight was measured on Standard weighing machine.

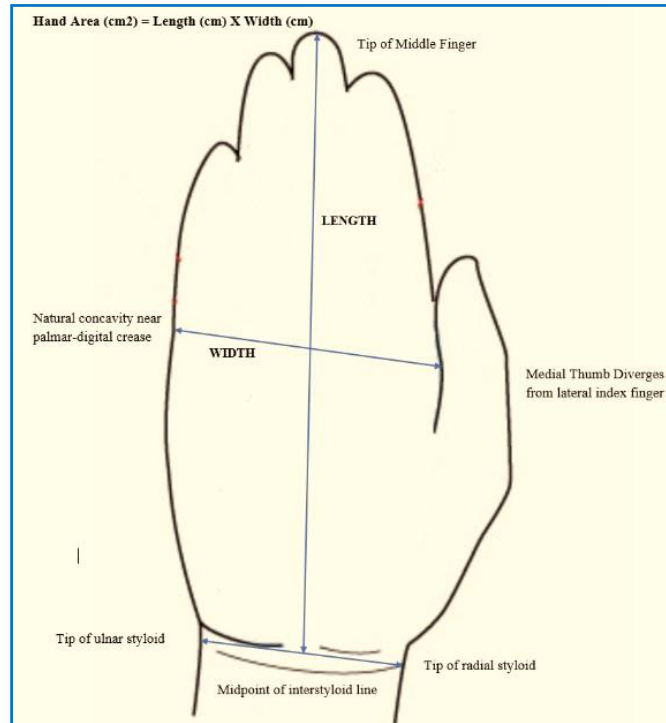
**Hand :** Hand measurements of both sides taken by simple hand tracing method.<sup>[8,11,12]</sup> Each subject ask to place his / her hand on a plane sheet of paper, keeping the fingers together and thumb laying comfortably against the radial aspect of the Hand and Index finger. A tracing was made using pen, the tracing started from tip of the radial styloid and passing all around the hand, ended at the tip of the ulnar styloid . The area of tracing was closed with line drawn between the two styloid tips and termed the Interstyloid line.

**Hand Length :** The length of the hand was measured from the middle of the Interstyloid line to the tip of the middle finger<sup>[8,11,12]</sup>.

**Hand Width :** A line drawn joining the following two points<sup>[8,11,12]</sup>.

- A. From radial side of second metacarpophalangeal joint.
- B. To ulnar side of fifth metacarpophalangeal joint.

**Figure 1 : Hand Area.**



Indices calculated from above parameters are :

The Body surface area calculated with “The Mostellers formula”, which is popular with medical practitioners, for its ease of use & accurate result.

$$\text{Body Surface Area} = [\text{Weight (kg)} \times \text{Height (cm)} / 3600]^{1/2}$$

The Hand Surface area calculated by...

$$\text{Hand Surface Area} = \text{Hand length (cm)} \times \text{Hand Width (cm)}$$

Hand Ratio calculated from above Indices : The Hands Percentage of BSA (Hand Ratio) was determined by dividing hand area by Total Body Surface Area<sup>(6)</sup>.

The mean values of TBSA, Hand Ratio, were tested using ‘t’ test. All means were expressed as Mean standard deviation. The critical level of significance of the results was considered at 0.05 levels i.e.  $P < 0.05$  was considered significant.

**Observations :**

1. *Total Body Surface Area (TBSA)* : In this morphometric Study, the Total Body Surface Area (TBSA) for male was 1.79m<sup>2</sup>, and 1.59m<sup>2</sup> for female. (Table - 1)

**Table 1 : Body Surface Area.**

Body Surface Area	Male ( n = 255 )		Female ( n = 257 )		P - value	Significance
	Mean	S.D.	Mean	S.D.		

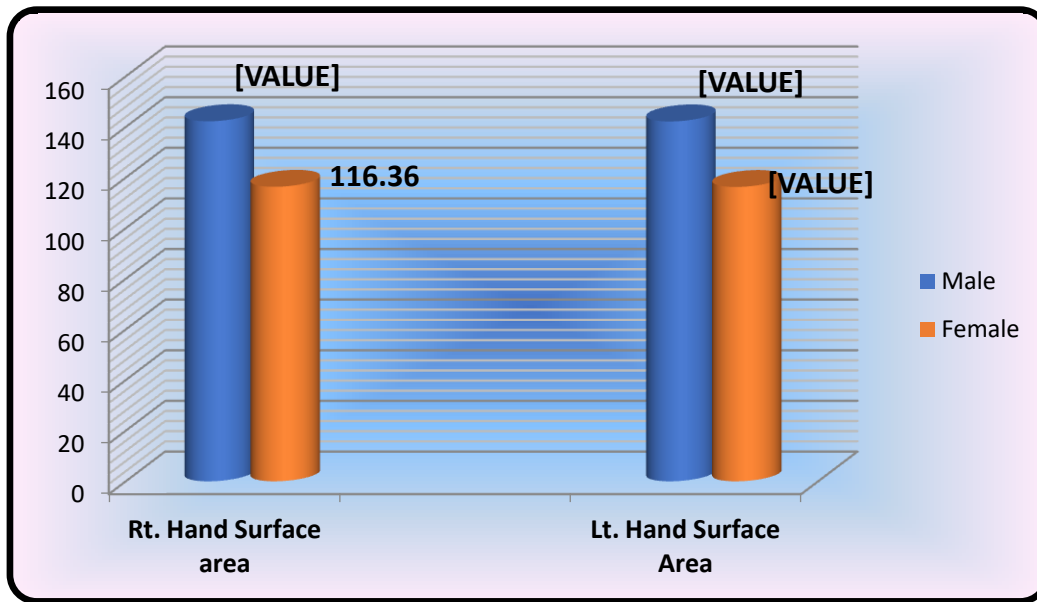
<b>Present Study</b>	<b>1.79 m<sup>2</sup></b>	<b>0.14</b>	<b>1.59 m<sup>2</sup></b>	<b>0.14</b>	0.000	Highly Significant
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2. *Hand Surface Area* : The right hand area mean in adult male was 142.26 cm<sup>2</sup> and mean for left hand area was 142.19 c m<sup>2</sup>, while in adult female right hand area mean was 116.36 cm<sup>2</sup>, and mean for left hand area was 116.30 cm<sup>2</sup>. There is statistically significant difference in the Hand area between male and Female. There is no statistically significant difference in the Hand area between right hand area and left hand area. (Table - 2)

**Table 2 : Hand Surface Area in male and female.**

Hand Surface Area		Male ( n = 255 )		Female ( n = 257 )		P - value	Significance
		Mean cm <sup>2</sup>	S.D.	Mean cm <sup>2</sup>	S.D.		
<b>1</b>	<b>Rt. Hand Surface Area</b>	<b>142.26</b>	<b>13.03</b>	<b>116.36</b>	<b>9.42</b>	0.000	Highly Significant
<b>2</b>	<b>Lt. Hand Surface Area</b>	<b>142.19</b>	<b>12.93</b>	<b>116.30</b>	<b>9.31</b>	0.000	Highly Significant
<b>P - value</b>		0.951		0.942			
<b>Significance</b>		Not Significant		Not Significant			

**Graph 1 : Hand Surface area in male and female.**

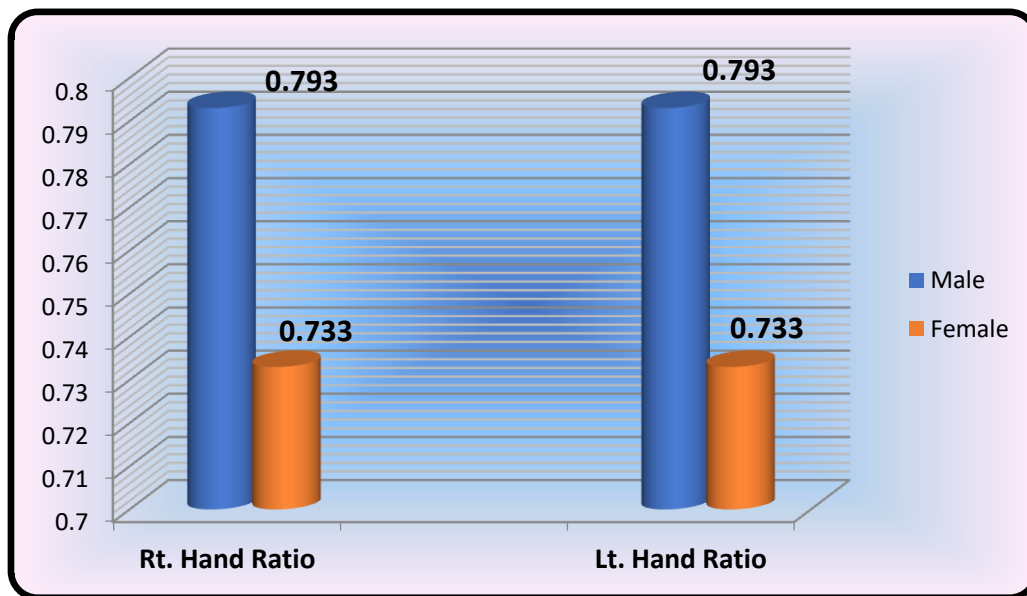


3. *Hand ratio with body surface area* : The right hand ratio in adult male was 0.79%, and left hand ratio was 0.79%, while in adult female right hand ratio was 0.73%, and left hand ratio was 0.73% . There is statistically significant difference in the hand ratio between male and Female. There is no statistically significant difference in the hand ratio between right hand and left hand. ( Table - 3)

**Table 3 : Hand Ratio with Total Body Surface Area**

Hand Ratio with TBSA		Male ( n = 255 )		Female ( n = 257 )		P - value	Significance
		Mean %	S.D.	Mean %	S.D.		
1	Rt. Hand Ratio	0.7935	0.0696	0.7334	0.0706	0.000	Highly Significant
2	Lt. Hand Ratio	0.7932	0.0694	0.7330	0.0692	0.000	Highly Significant
P - value		0.961		0.948			
Significance		Not Significant		Not Significant			

**Graph 2 : Hand Ratio with Body Surface Area**



**Table 4 : Comparison of Body Surface area with Previous Studies**

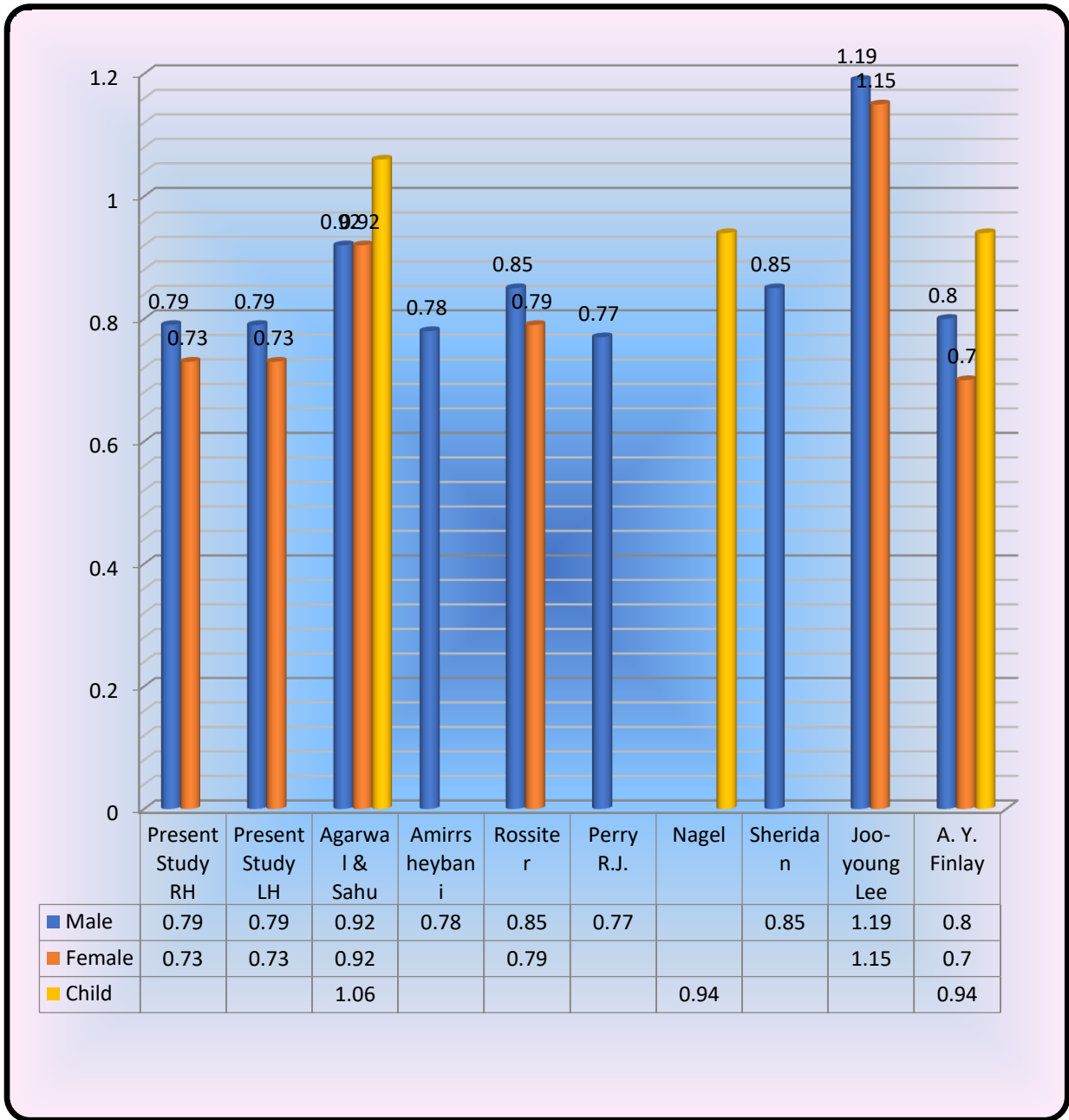
Body Surface Area	Male ( n = 255 )	Female ( n = 257 )	P - value	Significance

	Mean	S.D.	Mean	S.D.		
<b>Present Study</b>	<b>1.79 m<sup>2</sup></b>	<b>0.14</b>	<b>1.59 m<sup>2</sup></b>	<b>0.14</b>	0.000	Highly Significant
<b>Agarwal &amp; Sahu et.al</b>	<b>1.59 m<sup>2</sup></b>	--	<b>1.43 m<sup>2</sup></b>	--	--	Highly Significant
<b>Western Population</b>	<b>1.90 m<sup>2</sup></b>	--	<b>1.60 m<sup>2</sup></b>	--	--	Highly Significant
<b>Dubois &amp; Dubois</b>	<b>1.90 m<sup>2</sup></b>	--	--	--	--	--

**Table 5 : Comparison of Hand ratio with Previous Studies.**

	<i>Male</i>	<i>Female</i>	<i>Child</i>
<b>Present study</b>	Rt. Hand : 0.79% Lt. Hand : 0.79%	Rt. Hand : 0.73% Lt. Hand : 0.73%	
<b>Agarwal &amp; Sahu</b>	0.92%	0.92%	1.06 % male and 1.06 % female
<b>Amirrsheybani</b>	0.78 % (Males and females combined )		
<b>Rossiter</b>	0.85 %	0.79 %	
<b>Perry R.J.</b>	0.77 % (Males and females combined )		
<b>Nagel</b>			0.94 %
<b>Sheridan</b>	0.85 % (Males and females combined )		
<b>Joo-Yopung Lee</b>	1.19 %	1.15 %	
<b>A.Y. Finlay</b>	0.80	0.70	0.94

**Graph 3 : Comparison of hand ratio with Previous Studies**



**Discussion**

Surface area of the human body is extensively used in clinical practice either for normalizing physiological

parameters to express Basal Metabolic Rate, Oxygen Consumption, Cardiac Output, Glomerular Filtration Rate, Drug Dosage, Heat loss and Vital capacity, and to determine average skin temperature, and most importantly for the area affected by Severe Burns. Thermal burns and related injuries which are a major cause of death and disability. The single most important factor in predicting burn-related mortality, need for specialized care, likelihood of complications, treatment plans. Therefore, accurate estimation of size of burn is important.

Several methods are available for burn size, out of them the Hand tracing method is conveniently used in small and patchy burns. Traditionally it considered that hand area is 1% of body surface area. A standard Lund and Browder chart shows that the area from the wrist to the tip of the fingers as 1.5% of total body surface area.

There is discrepancy about what percentage of Total Body Surface Area constituted by the Hand. There is no research work in the field of Hand surface areas in South-western Maharashtra, Population. Previous workers did the work in Hand Surface Area in children group and adult group from various social and cultural backgrounds. So far in India there is no enough work to show the percentage of hand surface area with Body Surface Area. This study was designed to determine correctly the Total Body Surface Area represented by the Hand in south-western Maharashtra, population.

1. *Total Body Surface Area* : The findings as regards body surface area, differ from the study of Agarwal and Sahu, et.al., however they are similar to the studies in western countries population.
2. *Hand Surface Area* : In males, the mean right hand Surface Area is  $142.26 \text{ cm}^2$ , the mean left hand Surface Area is  $142.19 \text{ cm}^2$ . In females, the mean right hand Surface Area is  $116.36 \text{ cm}^2$  the mean left hand Surface Area is  $116.30 \text{ cm}^2$ . In hand surface area of male and female there is significant different which shows the hand surface area of male was larger than the female surface area.
3. *Hand ratio with TBSA* : In present study, Ratio's of Right and Left Hand were studied separately in both males and females which make it a Unique

study. In the Hand Ratio of male and female, there is significant difference which shows the Hand Ratio of male was larger than the female Hand Ratio.

In male the right hand ratio 0.79%, and left hand ratio was 0.79%, while in female right hand ratio was 0.73%, and left hand ratio was 0.73%. which was similar to 0.77% by Perry and 0.78% by Amirshyebani. Nagel found the average area of hand was 0.94% in children, and Sheridan measured 0.85%. The average area of hand was 0.81% in males and 0.67% in females by Rossiter.

As compare to Indian study of Agarwal and Sahu the average area of hand was 0.92% in males and also 0.92% in females. In the study of Joo-Young Lee the average surface area of palm including bottom of fingers was 1.19% in male and 1.15% in females. The difference between male and female hand ratio was statistically significant in the study by Rossiter. and it was not significant in the study by Agarwal and Sahu. In Korean study of Joo-Young Lee hand ratio of males is larger than hand ratio of females but difference was not significant. (Table. 5)

In the study of Sheridan R.L. (1995), Perry R.J.(1996), Rossiter (1996), Amirshyebani H.R.(2001), Joo-young-lee (2007), and Agarwal and Sahu (2010), differ from our study in that they were carried out on dominant hand only. while, Study of Sheridan R.L. (1995), Perry R.J.(1996), and Amirshyebani H.R. (2001), do not mention males and females subjects separately. and The study of Nagel (1997), and A.Y. Finlay (2005) were carried out only on children.

### Result :

1. The Total Body Surface Area mean for male was  $1.79\text{m}^2$ , and  $1.59\text{m}^2$  for female.
2. Mean right hand area in male was  $142.26 \text{ cm}^2$ , and mean for left hand area was  $142.19 \text{ cm}^2$ , while in female right hand area mean was  $116.36 \text{ cm}^2$ , and mean for left hand area was  $116.30 \text{ cm}^2$ .
3. Mean right hand ratio in adult male was 0.79%, and left hand ratio was 0.79%, while in adult female right hand ratio was 0.73 %, and left hand ratio was 0.73%.

Traditionally the hand area is supposed to be 1% of body surface area, but the study shows that it is



around the 0.80 %, which is comparably equals with population in western countries.

### Conclusion

Application of the one percent rule for the surface area of the palmar aspect of the hand leads to overestimation of the size and therefore, an overestimation of fluid and caloric requirements. If the palmer area is taken as one percent, the true requirement for intravenous fluid resuscitation volumes will be overestimated. Our data indicate that the palmar surface of the hand is around 0.80 percent of the body surface area and use of the patients own hand for determination of body surface area is a good compliment to be use of existing burn chart. There is no significant differences in right hand ratio and left hand ratio so, any one hand of patient can be used.

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