

# Estimate and Calculate Body Surface Area

**Y**OUR SKIN has many functions. Those functions include protecting the body from foreign matter, regulating temperature and water loss, absorbing medications, and maintaining **homeostasis**, which is the ability or tendency of an organism to maintain internal equilibrium and balance. But did you ever stop to think about how much skin you really have? How do you measure skin? In this unit, you will learn more about the concept of surface area. You will learn why it is sometimes important for doctors to figure out a person's body surface area and what methods can be used to do that.



## Objective:



Explain how to calculate body surface areas.

## Key Terms:



- area
- body surface area (BSA)
- homeostasis
- Mosteller Method
- surface area
- Wallace's "Rule of Nines"

## Understanding Body Surface Area

The skin is the largest organ of the body. The average adult has approximately 3,000 square inches of skin surface. Doctors often need to estimate a patient's body surface area to prescribe the proper dosage of medication or to assess a burn. You may know how to find the area of a perfect rectangle, but it is more complicated to find the surface area of a human body. Doctors routinely use methods that allow them to quickly estimate a person's body surface area.

## AREA AND SURFACE AREA

**Area** is the number of square units in a region or the space, measured in square units, of any two-dimensional object. The formula to find the area of a rectangle is  $\text{length} \times \text{width}$ . The same formula can be used to find the area of a square, or you can use  $s^2$ , where “s” is the length of one side.

**Surface area** is the total area of the surface of a solid or the sum of all the areas that cover the surface of an object. The formula for finding the surface area of a cube is  $6x^2$ , where “x” is the length of one of the six equal sides of the cube. The formula for finding the surface area of a three-dimensional rectangle, such as a brick, is  $2(lw + wh + lh)$ . In that equation, “l” is length, “w” is width, and “h” is height.



4 in.

6 in.

**Formula:  $\text{length} \times \text{width} = \text{area}$**

$$6 \times 4 = 24 \text{ square inches}$$

FIGURE 1. Area of a rectangle.



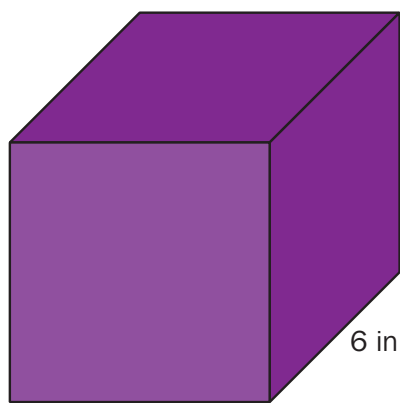
10 cm.

10 cm.

**Formula:  $s^2$**

$$10 \times 10 = 100 \text{ square centimeters}$$

FIGURE 2. Area of a square.



6 in.

6 in.

6 in.

**Formula:  $6x^2$**

$$x^2 = 6 \times 6 = 36$$

$$36 \times 6 = 216 \text{ square inches}$$

FIGURE 3. Surface area of a cube.



1 ft.

2 ft.

3 ft.

**Formula:  $2(lw + wh + lh)$**

$$\text{length} \times \text{width} = 3 \times 2 = 6$$

$$\text{width} \times \text{height} = 2 \times 1 = 2$$

$$\text{length} \times \text{height} = 3 \times 1 = 3$$

$$2(6 + 2 + 3) = 22 \text{ square feet}$$

FIGURE 4. Surface area of a rectangular brick.

## BODY SURFACE AREA

**Body surface area (BSA)** is a measurement of the skin that covers the body. It is a measurement or calculation of the total surface area of the human body. There are many reasons why health care professionals may need to find a body surface area. For example, doctors use BSA to make an assessment of burn victims. The total percentage of BSA burned correlates with patient outcomes. **Wallace's "Rule of Nines"** is a mathematical representation of the body surface area in which the body is divided into sections of 9 percent, or multiples of nine. It is used in first aid and emergency medical services to rapidly estimate the percentage of body surface area burned to determine the proper amount of emergency medications, I.V. fluids, and other treatments.

Body surface area can be used to determine the dosage for certain powerful medications, such as steroids, antibiotics, and chemotherapy agents. In these cases, doctors need a more accurate measurement than the Rule of Nines provides. The **Mosteller Method** is a com-

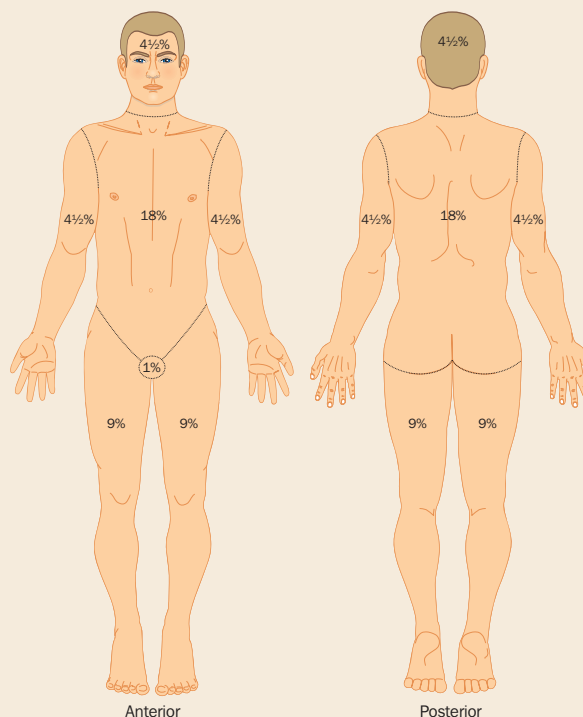


### EXPLORING OUR WORLD...

#### SCIENCE CONNECTION: Rule of Nines

Wallace's "Rule of Nines" allows medical professionals to quickly estimate the percentage of an adult body that has been burned. For this method, body parts are divided into multiples of nine, with the exception of the groin, which is 1 percent.

- Head = 9 percent
- Anterior torso (chest and abdomen) = 18 percent
- Posterior torso (back and buttocks) = 18 percent
- Right arm = 9 percent
- Left arm = 9 percent
- Right leg = 18 percent
- Left leg = 18 percent
- Groin = 1 percent



Using this formula, you would assess a person who was burned on both arms as having burns on 18 percent of the body ( $9 + 9 = 18$ ). You may have to divide the percentages, as well. For example, if a person is burned on the upper chest, but not the abdomen, and one arm, you would divide 18 percent (for the anterior torso) by 2 ( $18 \div 2 = 9$ ) and then add 9 percent for the arm ( $9 + 9 = 18$ ). Therefore, 18 percent of the body would be burned in this example, too.

monly used formula for calculating BSA in health care. Two versions of the formula exist: metric and metric/English.

The metric version uses the formula:

$$x = \sqrt{\frac{\text{weight (kg)} \times \text{height (cm)}}{3,600}}$$

In this equation, “x” is the body surface area in square meters (BSA m<sup>2</sup>; from weight in kilograms and height in centimeters).

Find the BSA (metric) of a person who weighs 72 kg and is 178 cm tall.

$$\sqrt{\frac{72 \text{ kg} \times 178 \text{ cm}}{3,600}}$$

$$72 \times 178 = 12,816$$

$$12,816 \div 3,600 = 3.56$$

$$\sqrt{3.56} = 1.89 \text{ square meters}$$

The metric/English version uses the formula:

$$x = \sqrt{\frac{\text{weight (lbs)} \times \text{height (in.)}}{3,131}}$$

In this equation, “x” is body surface area in square meters (BSA m<sup>2</sup>; from weight in pounds, and height in inches).

Find the BSA (metric/English) of a person who weighs 120 pounds and is 63 inches tall.

$$\sqrt{\frac{120 \text{ lb} \times 63 \text{ in}}{3,131}}$$

$$120 \times 63 = 7,560$$

$$7,560 \div 3,131 = 2.41$$

$$\sqrt{2.41} = 1.55 \text{ square meters}$$

## Summary:



Area is the number of square units in a region or the space, measured in square units, of any two-dimensional object. Surface area is the total area of the surface of a solid or the sum of all the areas that cover the surface of an object. It is not possible or practical to figure the exact surface area of an irregular shape, such as the human

body. When doctors assess a burn patient, they use Wallace's "Rule of Nines" to estimate the percentage of the body that has been burned. When doctors need an estimation of BSA to properly prescribe a medication, they use the Mosteller Method.

## Checking Your Knowledge:



1. What is the area of a shape, and how do you find it?
2. What are the two methods of estimating body surface area?
3. List the percentages represented by each body part in Wallace's "Rule of Nines."
4. What are the formulas used in the Mosteller Method?
5. Using the Mosteller Method, find the BSA of a person who weighs 145 pounds and is 65 inches tall.

## Expanding Your Knowledge:



Think of at least three emergency situations in which it might be necessary to find a person's BSA. Write out a scenario, and add all the details someone would need to calculate the BSA, such as the person's height and weight. Use your scenarios to quiz your classmates. First, ask whether they should use the Rule of Nines or Mosteller Method to estimate the BSA. Then instruct your classmates to find the estimated BSA, and use your own work to check their answers.

## Web Links:



### Assessing Burns

<http://www.uwhealth.org/emergency-room/assessing-burns-and-planning-resuscitation-the-rule-of-nines/12698>

### Body Surface Area

<http://www.medterms.com/script/main/art.asp?articlekey=39851>

### BSA Calculator

<http://www.patient.co.uk/doctor/Body-Surface-Area-Calculator-%28Mosteller%29.htm>