Neonatal Hydrostatic Weighing

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Abstract

In the neonatal period of life, it is very important that the measured weight of the newborn is as accurate as possible. An inaccurate weight prevents healthcare professionals from being able to assess and gain accurate information regarding the newborn's health. Our solution to this, is to use hydrostatic weighing. The hydrostatic weighing method is one of the most accurate methods, and if employed, it could serve as a helpful tool in analyzing a newborn's health. In order to test whether this method would be plausible for newborns, a watermelon was used to simulate a hydrostatic weighing set-up. This experiment is significant because it sets out to revolutionize the way that newborn's are weighed. By conducting this experiment, we will determine if this method is plausible and potentially introduce a new form of neonatal measurement in the medical field.

Introduction

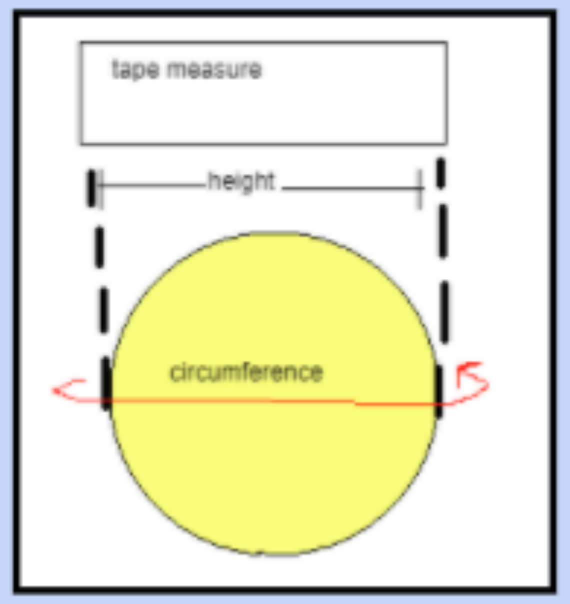
Hydrostatic weighing is a body composition measurement that derives heavily from Archimedes Principle (Brožek *et al.*, 1963). Archimedes explained how buoyant force that is placed on an object is directly proportional to the displacement of the water (Archimedes & Heath, 1897). Therefore, explaining the procedural set up of hydrostatic weighing. The purpose of our experiment is to investigate how small test subjects affect the results of hydrostatic weighing with respect to accuracy and validity. This experiment will allow our team to see if hydrostatic weighing is a viable measuring system for neonatal, medical, purposes. The test object used for this experiment is a watermelon. From the results of hydrostatically weighing the watermelon, our team will be able to draw conclusions on whether or not hydrostatic weighing makes sense for smaller objects, and- potentially- testing of small, live, subjects in the medical field.

Methods

Procedure

1. A clean and dry 25 gal plastic tub was obtained.
2. A gallon canister was filled with purified water and poured into the tub.
3. A permanent marker was used to mark '1 gal' on a side of the plastic tub at the height the water's surface reached. This was repeated 15 times.
4. Five additional gal marks were made. Four sub-measurements were equidistantly placed between all of the marks.
5. The watermelon was placed into the tub of water.
6. The water displacement (gal) was quickly recorded by observing the mark that the water rose to.
7. The watermelon was removed, to avoid absorption of water by the watermelon.

Results



Converting Displacement to Weight

The recorded displacement in gal was converted to kg using dimensional analysis

$$\frac{0.75\ gal}{1} \times \frac{3.79\ L}{1.00\ gal} \times \frac{1.00\ kg\ water}{1\ L} = \mathbf{2.8\ kg}$$

Displacement *Conversion to L* *Conversion to kg*

Dry Body Fat % Calculation with BMI

Body fat % was calculated with formula *(1.39 x BMI) + (0.16 x age(yrs))-(10.34 x gender*) - 9*

Gender = 1 for male, 0 for female

a. *(1.39 x 27.45) + (0.16 x 0.5) - (10.34 x 0)*
b. *38.15 + 0.08 =* ***38.23%*** *Body fat percentage from BMI*

Hydrostatic Body Density Equation

X = 3.0 kg / (((3.0 kg - 2.8 kg)/(1.0g/mL))-(89.5mL + 100 cm³))

3.0 kg - 2.8 kg = 0.2 kg

1 g = 0.001 kg *Conversion factor*

$$\frac{0.2\ kg}{1} \times \frac{1\ mL}{0.001\ kg} = 200\ mL$$

1 mL = 1 cm³ *Conversion factor*

(200mL)-(89.5mL + 100mL) = 10.5 mL

3.0 kg / 10.5 mL = ***0.28 kg/mL*** *Body density*

The Siri equation

495/0.28 = 1,767

1,767- 450 = ***1,317%***

Table 1: Calculations based on dry weight.

Weight	Height	BMI	Body Fat %
3.0 kg	13 in	27.45	38.23%

Table 2: Calculations based on wet weight.

Displacement	Res. Lung Volume	Body Density	Body Fat %
2.8 kg	89.5 mL	0.28 kg/mL	1317%

Discussion

Referencing our results, our group found that the experiment did not yield results that we found to be relevant for our future intended purposes. Our results from the dry measurements were reasonable: yielding a body fat percentage of 38.23%. The percentage we received from calculations based on hydrostatic weighing, however, was 1317%. This is likely a product of many factors. it is plausible that smaller objects simply do not generate enough water displacement for a proper result. As well, the fact that we used a watermelon and not a live object- while necessary- inherently portrayed a different body density than an infant, for example, because they are physically composed differently. In addition, the residual lung volume (mL) we used for calculations was a mere estimation of what an object of this size's residual lung volume (RLV) would be based on literature because this was a variable needed for the equations used, but watermelons do not have lungs. Lastly, with handwritten marks to measure the water displacement and a small tub as a result of our inaccess to expensive equipment, there is chance of error in our recording of how much water was displaced.

Conclusion

The findings of this experiment have the potential to provide a much more accurate neonatal weighing method. The weight of a newborn provides information regarding health and development. In this experiment, while the results we gained were far fetched at times, we did gain some believable results. However, in order to truly determine the plausibility of this weighing method, we plan to use a different test subject in the future. We believe that this will give us a reliable answer as to whether or not neonatal hydrostatic weighing is possible. What this specific experiment has shown us, is that there is potential in the findings.

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