Doubly labeled water

Anthony C. Hackney PhD, DSc, in exercise, sports and bioanalytical chemistry, 2016Doubly labelled water (DLW), developed in the early 1950s by Nathan Lifson and colleagues, is the gold standard for estimating TEEs due to its high degree of accuracy.1.11 It can be used in a wide range of populations, even vulnerable such as pregnant and nursing women. It is very suitable for use in a free life context, is non-invasive and imposes a minimum burden on participants. The assessment is usually carried out over a period of several days, depending on the required analytical approach and age of the participants. The DLW does not provide specific information on daily physical activity, although it does provide an accurate measure of TEE for the selected number of days or weeks, from which average daily energy expenditure can be calculated. It also does not quantify the type of activity, intensity or duration of energy consumption. In the application of the technique, daily urine samples are usually collected for 7-14 days and analyze the mass spectrometry of the isotope ratio (IRMS). Stable deuterium isotopes (2H) and oxygen-18 (18O) are administered orally as a dose of drinking water, and elimination from the body is monitored. The difference between elimination rates of 2H to 18O is equal to the CO2 production rate, which can be converted by standard stoicometric equations into an average TEE.8.10M. Nelson, in the encyclopedia of human nutrition (second edition), 2005Doubly labelled water and urinary nitrogen excretion are particularly useful for assessing the validity of prospectively recorded diets as the test time frame and reference measures may coincide. A third technique for assessing validity can be used with potential records and diet recalls. It is based on energy and therefore has limitations validating marker relating to a single nutritional factor. However, it has the advantage of being able to apply to all subjects in the dietary survey as no external reference measure is required. It is a biomarker in the sense that it relies on biological measure (body weight) and is best applied when measures of physical activity are available on an individual level. The assumption is that there should be reasonable elephanting between the estimated requirement and the estimated intake. Schofield equations can be used to estimate basal metabolic rate (BMR) based on age, gender and body weight. An individual whose reported energy intake is below the level of energy consumption likely to be needed to carry out daily activities is likely to have underreported his diet. The typical break point for an acceptable ratio of energy intake to the ratio of BMR to an individual is 1.2, taking into account daily variations in energy intake over a period of 7 days of nutrition recording and allowing for inaccuracies of the BMR assessment schofield equations. A decrease of 1.2 will identify only those entities that do not report and whose activity levels are low. For respondents with higher levels of activity (e.g. estimated from the questionnaire reply), proportionately higher points of interruption of activity are appropriate. It is also possible to estimate a higher likely level of energy consumption (e.g. 2.5 times BMR, depending on the normal level of activity) and subjects with reported intake levels above this value may be considered overreporters.W.A. Cuckoo, in the Encyclopedia of Human Nutrition (Second Edition), 2005Combaries between DLW and calorimetry suggest a precision of 4 or 5%, but it should be borne in mind that studies of this type are highly controlled and do not have to properly reflect the actual situation to which the method is intended to be applied. The closest useful estimates, then, may be those provided by the analysis of test/retest situations in which the same subjects were measured in more or less the same physiological conditions. Figure 5 shows a compilation of such data. In addition to workers who studied in the tropics, where the accuracy of estimates may have been limited by known high rates of water traffic, the data is fairly consistent, with a mean rate of 8%. Subtracting a likely contribution of 4% from the total measurement error indicates a variation within the case of 7%. Figure 5. Repeatability of the DLW method. (Data from Schoeller DA and Hnilick JM (1996) Reliability of the double-labeled water method for measuring total daily energy expenditure in free-living subjects. Journal of Nutrition 126: 348S-354S.) Beibei Wang, ... Xiaoli Duan, in China's most important manual on exposure factors (adults), the inhalation rates for 2015 relate to the volume of breathed air per unit (GM Richardson and Stantec Consulting Ltd., 2013). Recommendations include long-term and short-term inhalation rates. Based on activity levels, short-term inhalation rates could be further divided into sleep inhalation rates, dry seam behavior and light, moderate, high-intensity and very high intensity activity. There are three approaches to getting the inhalation rate. (1) Double-labeled water measurementsTwo forms of stable isotopically labelled water (2H2O and H218O) are used, and the difference in the disappearance rates of the two isotopes in the subject's body represents energy consumed over a period of 1-3 half lives of marked water. (2) Relationship between inhalation rate and heart rate Such an approach measures the inhalation rates and heart rate of the representative population and establishes a model of the relationship between them. The inhalation rates of the target population can then be calculated on the basis of a model (USEPA, 2011). (3) Method of human energy consumption Everywhere, IR: Inhalation rate, L/min; H: volume of oxygen consumed to produce 1 kcal energy 0.05 L/kJ); VQ: fan equivalent (usually 27); E: energy consumed per unit, kJ/d.A. Raman, D.A. Schoeller, in the Encyclopedia of Human Nutrition (Second Edition), 2005This is an isotope dilution technique in which deuterium and heavy water marked with oxygen (double-labeled water, DLW) are given to individuals and collected time-limited urine samples to measure the elimination rate of 2H and 18O in urine. 2H label from DLW is mixed with body water and eliminated as water in the urine. Similarly, the 18O mark from the DLW is eliminated as water, but it is also used in bicarbonate synthesis and is therefore also eliminated on breath as CO2. The difference in isotope 2H-H and 18O water turnover rates is proportional to CO2 production. Energy consumption, oxygen consumption, water intake and metabolic water production can be calculated using standard indirect calorimetry equations with estimated RER (Figure 5). Figure 5. Time course on the log scale for enriching stable isotopes of 18-oxygen and deuterium when applied to the subject. Both enrichments of the trackers increase rapidly in the pool with body water until they reach the balance of distribution (2–4 h). Enrichment then begins to decline as the body's water rotates during metabolism. 18-Oxygen is eliminated faster because it is excreted as water and CO2 in the breath, while deuterium is eliminated only as water. The difference in the elimination rates of these two trackers is proportional to the rate of CO2 production by the entity. In practice, the measured dose of DLW is given to the entity whose energy consumption should be measured. Body water samples, such as blood, urine, saliva or breathing water, are collected before reaching and after achieving balance. Rates of isotopic disappearance of 18O and 2H as CO2 in breath or H2O in urine, saliva or breath water were determined by changing isotopic enrichment of samples before and after balance. The double-labeled method of water is simple and non-invasive. It has been confirmed in different animals and humans, and the CO2 production rate shows a mean measurement error of less than 5%. Unlike most other methods, the double-labelled water method provides a measure of the average energy consumed over a period of 3 to 21 days without restricting the subject's movements and thus provides a better estimate of normal energy expenditure than other methods. However, the double-labeled water method does not provide any information about the pattern or intensity of any activity during this time, but about the overall average energy consumption. This method is also expensive due to the cost of 18O and requires sophisticated mass spectrometric analysis.T.C. Shriver, ... W.A. Coward, in the Encyclopedia of Human Nutrition (third edition), 2013Body body tissues in terms of the percentage of fat in relation to fat-free mass (usually excluding bones). Double-labeled water (DLW)A combination of two stable isotopes, usually deuterium and oxygen-18, used as a tracker in the water. Indirect calorimetry Measurement of a chemical produced during fuel oxidation in the body versus direct measurement of heat released during this oxidation. Respiratory exchange ratio (RER)Ratio of CO2 output to O2 intake occurring during breathing. Total energy consumptionSam resting metabolism, thermal effect of meals and energy consumption of physical activity.D.A. Schoeller, ... A. Raman, in the Encyclopedia of Human Nutrition (Third Edition), 2013This is an isotope dilution technique, detailed in the following article, where deuterium and heavy oxygen-labeled water (DLW) are given to individuals and collected time-lapse urine samples to measure the elimination rate of 2H and 18O in urine. 2H label from DLW is mixed with body water and eliminated as water in the urine. Similarly, the 18O mark from the DLW is eliminated as water, but it is also used in bicarbonate synthesis and is therefore also eliminated on breath as CO2. The difference in isotope 2H-H and 18O water turnover rates is proportional to CO2 production. DLW is technically a method of indirect calorimetry although no measurements of air gas exchange across the lungs are made. Energy consumption, oxygen consumption, water intake and metabolic water production can be calculated using standard indirect calorimetry equations with estimated RER. Unlike most other methods, the DLW method provides a measure of the average energy consumed over a period of 3-21 days, which provides a better estimate of normal free-living energy consumption.S.A. Unger, in the Encyclopedia of Human Nutrition (Third Edition), 2013Antioxidants. Appetite | Physiological and neurobiological aspects; Appetite | Psychobiological and behavioral aspects. Breastfeeding. Cancer | Lung cancer epidemiology. Cystic fibrosis. Early origin of the disease | Fetal; Early origin of the disease | Non-fetal. Power consumption | Double-labeled water; Power consumption | Indirect calorimetry. Allergies to | Diagnosis and management. Food intolerance. Infection | Nutrition management in adults. Low birth weight and premature baby | Causes, prevalence and prevention; Low birth weight and premature baby | Nutrition management. Dissatisfied | Secondary, diagnosis and management. Nutrition and susceptibility to tuberculosis. Nutritional supports | Adults, Enteral; Nutritional supports | In the starting lineup; Nutritional supports | Infants and children, Parenteral. Obesity | Complications. Older people | Nutritional needs; Older people | Physiological changes. Parenteral nutrition. Salt | Epidemiology. Selenium. Sodium | Physiology. | Developed countries; Supplemental | Developing countries; Supplemental | Dietary supplements; Supplemental | Program questions. Tuberculosis | Nutrition management. Vitamin A | Lack and intervention; Vitamin A | Physiology, nutritional sources and requirements. Vitamin D | Physiology, nutritional sources and requirements. Vitamin E | Metabolism and requirements; Vitamin E | Physiology and health effects. Vitamin KG.R. Goldberg, in the Encyclopedia of Nutritional Sciences and Nutrition (Second Edition), 2003Degrade in the early 1980s double-labeled water techniques (DLW) to measure energy consumption in free-lived people also provided external validation of energy intake measurements. On a group basis, it can be assumed that energy intake is equal to energy consumption. The data from the DLW measurements therefore not only provided information on energy consumption and energy needs (see below) in many physiological, behavioral and experimentally imposed conditions, but also provided important insights into the validity and interpretation of energy input measurements. Of particular concern is that most dietary research is significantly biased towards underestimating energy intake. Invalid dietary data have serious implications for interpreting the results. Obvious underestimations of intake will falsely inflate the prevalence of inadequate nutrient intake, and differences between objects in qualitative or quantitative reporting create a bias that distorts real associations between diet and health. It is neither feasible nor necessary to carry out contest DLW measurements of energy consumption when the main interest of the study is to measure energy intake. However, a large number of DLW data from many studies conducted over the past 20 years, together with statistical considerations, which take into account the number of subjects, duration of measurements and variability in energy intake and expenditure, can be used as independent reference points for assessing energy intake measurements. Robert D. Baker, Susan S. Baker, in Pediatric Gastrointestinal and Hepatic Diseases (4th Edition), 2011Energy needs are variable in young children, as well as for other age groups, and depend on the basal metabolic rate, growth rate, physical activity and body size. Energy requirements also depend on whether the child is overweight or unsaid. The reader focuses on the latest dietary reference inputs (DRI) for a thorough discussion of various factors affecting energy needs.6,90-94 Energy needs can be determined experimentally in a number of ways: indirect calorimetry, double-labeled water, and factor method. Of these, double-labelled water, the most accurate method, takes the advantage of measuring energy consumption in free-living people for a longer period of time Time. Its disadvantages are the cost and lack of availability. Indirect calorimetry determines the oxygen consumed and carbon dioxide produced by carefully measuring inspired and expired gases. Accurate measurements are severe in the age range of the child. The factor method compresses the contributions of basal metabolic rates, physical activity, thermal effect of food, growth and all known losses. The factor method is the least accurate, but it is the method most commonly used in the past. It is now generally believed that previous estimates of young children's energy needs were wrongly high. The 10th edition of recommended dietary supplements (RDA) set the energy needs of children 1 to 3 years old at 103 kcal per kg of body weight per day.94Prentice et al.,95 using double-labeled water, determined the energy consumption of children aged 12, 24 and 36 months at 83, 84, and 85 kcal per kilogram per day, respectively. The latest DRIs, depending on double-labeled water measurements, set the estimated energy need for 12-month-old boys at 844 kcal/day for 12-month-old girls at 768 kcal/day. The estimated energy requirements of boys aged 24 months are 1050 kcal/day and those for girls 997 kcal/day. For boys aged 35 months, the estimated energy need is 1184 kcal/day and for girls it is 1139 kcal/day. Assuming weight at 50.percentile for age, these numbers translate into 81.2 kcal/kg per day for 12-month-old boys and 80.6 kcal/kg per day for girls, and 82.7 and 83.1 kcal/kg per day for 24-month-old boys and girls, respectively. For boys aged 35 months, the estimated energy need is 84.0 kcal/kg per day for girls 83.8 kcal/kg per day. The new DRI's are in line with prentice and Dr. 95 measurements and are significantly lower than previous RDAs. The RDAS.

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