Original Article

Total Energy Expenditure of 16 Chinese Young Men Measured by the Doubly Labeled Water Method*

ZHUO Qin[1,^], SUN Rui[1,2,^], GOU Ling Yan[3], PIAO Jian Hua[1], LIU Jian Min[3], TIAN Yuan[1], ZHANG Yu Hui[3,#], and YANG Xiao Guang[1,#]

1. Key Laboratory of Trace Element Nutrition MOH, National Institute of Nutrition and Food Safety, Chinese Center for Disease Control and Prevention, Beijing 100050, China; 2. Public Health Bureau in Xicheng District of Beijing, Beijing 110120, China; 3. Bethune Military Medical College, Shijiazhuang 050081, Hebei, China; 4. Hebei Medical University, Shijiazhuang 050017, Hebei, China

Abstract

Objective Doubly labeled water (DLW) method is the gold standard for measuring total energy expenditure (TEE). We used this method to measure TEE in Chinese young men.

Methods Sixteen healthy young men age 23±1 years with body mass index 22.0±1.4 kg/m^2 were recruited. TEE was measured by the DLW method, and basal energy expenditure (BEE) was determined by indirect calorimetry. We also conducted 24-h activity, energy balance and factorial approach to estimate energy requirements of the subjects.

Results TEE of subjects by DLW method was 9.45±0.57 MJ/day (2258±180 kcal/day). The 24-h activity was 10.80±0.33 MJ/day (2582±136 kcal/day). The energy requirement, derived from energy balance observations, was 9.93±1.32 MJ/day (2373±315 kcal/day). The BEE of 6.65±0.28 MJ/day (1589±67 kcal/day), calculated by the adjusted Schofield equation, was significantly higher (P<0.001) than that measured by indirect calorimetry, 5.99±0.66 MJ/day (1433±158 kcal/day). The TEE derived from the factorial approach was 10.31±0.43 MJ/day (2463±104 kcal/day).

Conclusion The TEE of Chinese young men measured by the DLW method was about 10% lower than the current recommended nutrient intake (RNI), suggesting that the RNI for Chinese men maybe overestimated. Further studies are warranted to determine the value of the estimated energy requirement.

Key words: Doubly labeled water; Total energy expenditure; Recommended nutrient intakes; Estimated energy requirement; Chinese young men

Biomed Environ Sci, 2013; 26(6):413-420 *doi: 10.3967/0895-3988.2013.06.001* *ISSN:0895-3988*

www.besjournal.com(full text) *CN: 11-2816/Q*

INTRODUCTION

Based on reports from the 2002 Chinese National Health and Nutrition Survey, the average dietary energy intake of the Chinese people was 9420.6 kJ/day (2250 kcal/day) which is about 8% lower than that in 1992 (9741.6 kJ/day) and 10% lower than that in 1982 (10 423.6 kJ/day)[1]. These data suggested that the energy intake of the Chinese decreased gradually.

*This work was supported by the projects of National Natural Science Foundation of China (No. 30771811) and the National Technology Research and Development Program in the Eleventh Five-Year Plan of China (No.2008BAI58B01).

#Correspondence should be addressed to YANG Xiao Guang, Tel: 86-10-83132798. Fax: 86-10-83132808. E-mail: xgyangcdc@vip.sina.com or ZHANG Yu Hui. Tel: 86-311-87977001. Fax: 86-311-87977029. E-mail: hbsjzzyh01@163.com

^The authors contributed equally to the article.

Biographical note of first authors: ZHUO Qin, female, born in 1969, professor, majoring in nutrition research; SUN Rui, male, born in 1974, ph. D, majoring in Nutrition and food hygiene.

Received: October 19, 2012; Accepted: March 30, 2013

Conversely, the prevalence of chronic diseases related to energy intake imbalance-e.g., overweight, obesity, lipid disorders, hypertension, diabetes, cardiovascular disease-increased rapidly during those years. For example, the prevalence of overweight and obesity in those >18 years old in 2002 were 17.6% and 5.6%, respectively—about 38.6% and 80.6% higher, respectively, than those in 1992[1]. Because of social and economic transformations, more Chinese tended to have more inactive lifestyles during these later years. It gives rise to a concern that the current diet energy-based recommended nutrient intake (RNI) (i.e., 2400 kcal/day for a man living at a light activity level) proposed by the Chinese Nutrition Society in 2000 may be overestimated[2].

To establish the recommended estimated energy requirement (EER), an accurate measurement of the TEE of individuals who maintain an energy balance should be applied. This means that they should have not only energy intake equal to expenditure but should maintain a stable body weight.

Currently, the adjusted Schofield equation[3] (5% lower than the original equation) is used to predict the basal energy expenditure (BEE), which depends on the physical activity level (PAL), to determine the energy requirement for the RNI for Chinese adults. The Schofield equation, however, was established using data that included values from a disproportionate number [3388/7173 (47%)] of Italian subjects. Many researchers pointed out that the Schofield equation might therefore overestimate the energy requirements for Chinese people by as much as 15%[4].

Few studies have measured TEE of Chinese adults, with only sparse data available using doubly labeled water (DLW) measurements. Therefore, we assessed TEE in 16 young Chinese men using the DLW method. We compared various methods, including a factorial approach and energy balance and physical records methods, with DLW measurements to estimate the energy requirement of the subjects. We believe that the results from our study can contribute to future revision of the Chinese RNI standards.

SUBJECTS AND METHODS

Subjects

A total of 300 male students attending Bethune Military Medical College (Hebei province, China) were screened through a questionnaire. Inclusion criteria stated that the subjects should be healthy with no history of diabetes, thyroid disorder, or other metabolic disorder. They had to have a normal body mass index (BMI 18.5-24.0 kg/m^2) and had maintained a stable weight for several months before the study. Subjects who had smoking, drinking, and/or bad eating habits, insomnia, and/or stress were excluded. After hematological and biochemistry examinations to rule out anemia, a thyroid disorder, and liver and kidney dysfunction, 16 eligible men, aged 20 to 26 years, were randomly selected.

The Ethical Review Committee of the National Institute for Nutrition and Food Safety, Chinese Center for Disease Control and Prevention approved this study. Written informed consent was obtained from all subjects.

The study was conducted for 16 days. During the study period, subjects were required to reside in a hotel at the college, and all food consumed by them was provided by the investigators. To maintain energy expenditure relatively constant throughout the study, subjects were required to follow their usual physical activities.

Total Energy Expenditure Measurements by DLW

For the first 2 days, the subjects moved into the hotel and got used to the environment and the foods. On the morning of the third day, immediately after collecting a predose urine sample, each subject was given a preweighed amount of DLW (Huayi Isotope, Changshu, China) that had been prepared and conditioned as a sterile solution in a sealed 125-mL plastic bottle. The bottles were weighed using an analytical balance to the nearest 0.1 mg (AX150; Mettler, Zurich, Switzerland) just before and after the DLW was consumed. The approximate doses were 160 mg $H_2{}^{18}O$ and 250 mg ^2H_2O/kg body weight. Postdose urine samples were collected at 2, 4, 6, and 8 h and then once a day during the subsequent 13 days. The tap water used for cooking was also collected. Urine samples and tap water samples were put in 100-mL containers with airtight screw tops and then transferred in 5.0-mL cryogenic vials with screw tops. These vials were stored at -20 °C until analyzed.

All urine samples, tap water, and diluted DLW samples (diluted about 1000 times by the tap water collected from the field site) were analyzed at the Laboratory for Stable Isotope Geochemistry (Geological and Geophysical Research Institute, Chinese Academy of Sciences) with MAT-252 and