Urinary 1-Methylhistidine Is a Marker of Meat Consumption in Black and in White California Seventh-day Adventists

Tun Myint, Gary E. Fraser, Kristian D. Lindsted, Synnøve F. Knutsen, Richard W. Hubbard, and Hannelore W. Bennett

Meat consumption predicts risk of several chronic diseases. The authors validate the accuracy of meat consumption reported by food frequency questionnaires and the mean of eight 24-hour recalls, using urinary methylhistidine excretion, in 55 Black and 71 White Adventist subjects in Los Angeles and San Diego, California, in 1994–1997. 1-Methylhistidine excretion predicts vegetarian status in Black (p = 0.02) and in White (p = 0.005) subjects. Spearman’s correlation coefficients between 1-methylhistidine and estimated meat consumption were usually between 0.4 and 0.6 for both food frequency questionnaires and 24-hour recall data. This is despite the chance collection of dietary recalls and urines from omnivores on meatless days. Am J Epidemiol 2000;152:752–5.

Blacks; diet; methylhistidines; vegetarianism; Whites

Several studies have demonstrated that estimates of urinary 1- and 3-methylhistidine can predict the consumption of meat in the diet and that 1-methylhistidine is probably superior in this regard (1–9). Urinary 1-methylhistidine results from the metabolism of the dipeptide anserine found in meats. Previous reports were usually from a small number of individuals, often in a metabolic ward setting. However, McKeown-Eyssen et al. (10) studied 44 free-living individuals and found a correlation coefficient of 0.77 between urinary 3-methylhistidine and meat consumption 1 year previously.

The purpose of this paper is to validate vegetarian status as measured by food frequency questionnaires (FFQ) and 24-hour recall data, using urinary amino acid excretion in Black and in White free-living California Seventh-day Adventists, some of whom are vegetarians.

MATERIALS AND METHODS

Study population

Subjects were randomly selected from the directories of Adventist churches in Los Angeles and San Diego, California. Of those who initially agreed to participate, 73 percent of Black and 94 percent of White subjects completed the study. All subjects provided an overnight urine sample in a plastic container containing 5 ml of 6.0 molar hydrochloric acid. Thus, we received 55 urine samples from Black and 71 samples from White subjects, although two of the latter were lost due to laboratory error. The mean age of the Black subjects was 47.0 years, and that of the White subjects 54.4 years.

Dietary information

All subjects completed an FFQ and eight telephone 24-hour recalls on random days. Two weekday plus a Saturday and Sunday recall, with appropriate weightings, were used to estimate food consumption for the week. This cycle was duplicated for a total of eight recalls, and all of these were completed within 10 months for each subject. The 24-hour recalls were obtained by using the interactive Nutrition Data System (11) software version 2.5, that has also been used by others for telephone recalls (12).

The FFQ, completed by mail and timed to be collected between the first and last sets of four 24-hour recalls, contained 200 food items and 11 vitamin questions. The selection of either a standard portion size or a smaller or larger size than standard was required. Subjects selected from nine different frequency options ranging from “never or rarely” to “6+ per day.” Vegetarians were defined as those who ate flesh foods once per month or less, using the FFQ data.

Data analysis

Urinary amino acids were analyzed at Loma Linda University Medical Center clinical laboratory by using ion exchange chromatography with a Beckman 7300 amino acid analyzer (Beckman Instruments, Fullerton, CA) (13, 14).
Values were standardized to µmol/g of urinary creatinine excretion. Logistic regression was used to regress the vegetarian status of the subject (vegetarian or omnivore) on urinary amino acid excretion. Spearman’s correlation coefficients were used to correlate the frequency of meat consumption against urinary amino acid excretion. Analyses were conducted with SAS statistical software (SAS/STAT Version 6.12, SAS Institute, Cary, North Carolina) (15).

Results are reported separately for Black subjects and White subjects or for all subjects combined, but then adjusted for race. This is because we plan to study two cohorts of Adventists, one of Black and the other of White subjects, and we wish to establish the validity of our questionnaire with regard to meat consumption in both ethnic groups.

RESULTS

Twenty percent of Black and 38 percent of the White subjects were vegetarian (table 1). While Black male omnivores ate more chicken than beef, others ate roughly equal quantities of chicken and beef. The results from food frequency data (servings per day) and repeated 24-hour recall data (grams per day) are fairly consistent in these respects.

Within subgroups defined by gender and race (table 2), the urinary excretion of 1-methylhistidine was much greater in the omnivores than in the vegetarians and was statistically significant except in Black females. Omnivores also excreted more 3-methylhistidine, although the magnitude of the difference was much less. The analysis is extended from a comparison of mean values in vegetarians and omnivores to a comparison of the rankings of meat intake to urinary methylhistidine excretion, using Spearman’s correlation coefficients, adjusted for age, sex, and race (as necessary).

As shown in table 3, these have values of between 0.37 and 0.61 for 1-methylhistidine and are usually statistically significant. Coefficients are a little higher for poultry than for red meat in Black subjects, but this is true for FFQ data only in White subjects. Coefficients tend to be about 0.1 unit higher for most variables in White compared with Black subjects.
In certain epidemiologic analyses, it is useful to be able to distinguish between vegetarians and omnivores by using available dietary data. We have used the excretion of 1- and 3-methylhistidine to validate vegetarian status as measured by our FFQ. The results of logistic regression analyses in table 4 show statistically significant beta coefficients describing this association, such that a 50 µmol/g creatinine increment of 1-methylhistidine predicts a decrease in the odds ratio of vegetarian status by a factor of 0.14 (p < 0.001) in California†. Although there is little difference between results for 1- and 3-methylhistidine in this table, perhaps suggesting the previous superior results for 1-methylhistidine depend on its absence in vegetarians.

Finally, we conducted correlational analyses only within the omnivore subjects to determine whether higher frequency meat consumption could be distinguished from lower frequency consumption by amino acid excretion. Table 5 shows that the correlation coefficients are of lower magnitude than before, no doubt reflecting in part the lower range of values, but are still statistically significant when both ethnic groups are combined. There is little difference between results for 1- and 3-methylhistidine in this table, perhaps suggesting the previous superior results for 1-methylhistidine depend on its absence in vegetarians.
specimens from nonvegetarians on days during which they ate no meat.

Sjölin et al. (7) have demonstrated that urinary excretion of 1- and 3-methylhistidine is increased by the addition of beef or chicken to the diet. Urinary 1-methylhistidine seems more responsive, and other studies show that the excretion of this amino acid is particularly sensitive to the intake of chicken (1, 16). In the absence of meat or fish in the diet, the endogenous production of 1-methylhistidine is minimal (1, 16). It is present in meat as part of the dipeptide anserine (7, 16), which appears to be specifically associated with neuromuscular activity in animal tissues.

In contrast to 3-methylhistidine, 1-methylhistidine is not a marker of muscle catabolism, and urinary excretion is not increased in the traumatized patient (16). However, excretion of 3-methylhistidine is proportional to muscle mass regardless of dietary intake (6, 7, 16–19). Although 3-methylhistidine also responds to meat intake (3, 18), the excretion of 1-methylhistidine is a more specific marker of meat consumption. The consumption of other animal products, such as milk and eggs, that may be consumed in a lacto-ovo-vegetarian diets, does not influence excretion of these urinary amino acids (7).

Excretion half-lives of 11.7 and 12.6 hours, respectively, for 1- and 3-methylhistidine have been reported (7). Jacobson et al. (5) showed that the timing of the last meal and the previous urine void could influence the excretion of 3-methylhistidine in an early morning urine sample. This was partially corrected by adjusting for creatinine excretion, and the authors concluded that creatinine-standardized early morning urine provided a useful measure of methylhistidine excretion. Thus, our use of an overnight urinary collection for convenience is supported.

In summary, our studies show that 1-methylhistidine excretion differed greatly and significantly between vegetarians and omnivores and is thus a good indicator of vegetarian status in both Black and White Adventists. Excretion of these amino acids can also distinguish between high and low meat consumption, but with less precision. These results serve to validate the dietary data provided by this population in a FFQ.

We conclude that if it is practical to collect overnight urine specimens from all members of some cohorts, this should provide a useful measure of meat consumption. Alternatively, if such measurements are available for a validation or calibration substudy, this should give useful information regarding the dietary assessment instrument and possibly improve estimates of the relative risk of disease.

ACKNOWLEDGMENTS

Supported by National Institutes of Health grant 2R01-CA14703-15A1 from the National Cancer Institute.

The authors thank David Shavlik for his help in data management.

REFERENCES