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Ethnic differences in attitudes, beliefs, and patterns of meat consumption among American young women meat eaters

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Conflict of Interest
The authors declare no potential conflicts of interests.

ABSTRACT

BACKGROUND/OBJECTIVES: Meat eaters face conflicts over meat consumption due to recent increasing demands for reduced-meat diets to promote human and environmental health. Attitudes toward consuming meat have been shown to be culture-specific. Thus, this study was performed to examine cultural differences in attitudes, beliefs, and patterns of meat consumption among meat eaters in a group homogeneous in terms of age and sex but with diverse ethnicities.

SUBJECTS/METHODS: In this cross-sectional study conducted in New York City in 2014, 520 female meat eaters (Whites = 25%; Blacks = 20%; East Asians = 35%; Hispanics = 20%) aged 20–29 completed a questionnaire consisting of a series of questions on meat consumption behaviors, which addressed amounts of consumption, cooking methods, past and future changes in meat consumption, and attitudes and beliefs regarding relationships between health and meat consumption. Logistic and multiple regression analyses were used to assess the effects of variables on meat consumption.

RESULTS: Blacks had the highest annual total meat consumption (64.2 kg), followed by East Asians (53.6 kg), Whites (46.9 kg), and Hispanics (35.8 kg). Blacks ate significantly more chicken than the other ethnic groups ($P < 0.001$), and East Asians ate significantly more pork and processed meat ($P < 0.001$). Regardless of ethnicity, grilling/roasting/broiling were the preferred cooking methods, and vegetables were most consumed as a side dish. More than half of the participants expressed an intention to decrease future meat consumption. East Asians more strongly perceived meat as a festive food ($P < 0.001$) and were less guilty about the slaughtering animals ($P = 0.11$) than other groups. No differences were found between the ethnic groups regarding negative attitudes to meat consumption.

CONCLUSIONS: The results show that ethnicities differ in terms of attitudes, beliefs, and patterns of meat consumption. Irrespective of ethnicity, the meat-eating participants almost unanimously demonstrated a willingness to reduce future meat consumption. It is hoped these findings aid the formulation of culturally-tailored interventions that effectively reduce meat consumption.

Keywords: Meat; consumption; women; ethnicity; attitude

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Author Contributions

Conceptualization: Choi SE, Lee KJ; Formal analysis: Choi SE; Investigation: Choi SE, Lee KJ; Methodology: Choi SE, Lee KJ; Supervision: Choi SE; Validation: Choi SE; Writing - original draft: Choi SE; Writing - review & editing: Choi SE, Lee KJ.

INTRODUCTION

Throughout human history, in both nomadic and agricultural societies, meat has been considered the most highly prized and sacred food in both Western and Eastern food cultures [1-3]. However, in recent times, many meat eaters have experienced pressure to reduce meat consumption [4,5] due to health, social, environmental, and economic consequences of meat overconsumption [6]. Health is the most influential reason for reducing meat consumption because excessive consumption, particularly of red and processed meat, has been associated with increased risks of diet-related non-communicable diseases such as obesity, type 2 diabetes, heart disease, and cancer [7]. In addition to the health effect, the ethicality of eating meat has presented meat eaters with a paradox [8]; that is, the psychological conflict of enjoying eating meat and revulsion of animal slaughter. Thus, vegan lifestyles have become popular [9,10].

Despite the increasing global effort to popularize reduced meat diets, global meat consumption continues to increase. According to OECD-FAO data in 2021, annual per capita meat consumption is projected to increase worldwide from 42.4 kilograms in 2021 to 43.7 kilograms in 2030 [11]. A lack of culturally tailored approaches is a potential reason for the ineffectiveness of attempts to reduce meat consumption. The literature shows that culture is one of the most influential factors determining meat consumption [12]. Furthermore, cultural membership is defined by ethnicity [13]. According to a study by Andrew *et al.* [14] on the theoretical basis for transcultural care, ethnicity is a social identity affiliated with shared behavioral patterns, which include food habits. Sheikh and Thomas [15] reported a relationship between food habits and ethnicity among Asian and English teenagers. Devine *et al.*, [16] in a study on ethnically diverse adults in a US city, also demonstrated that ethnic identity has a major influence on food consumption (Black, Latino, White). The authors suggested that the conceptualization of ethnic influences on food choices can enhance the outcomes of nutrition education in multicultural societies [16]. Additionally, Dindyal and Dindyal [17] provided examples that demonstrated ethnicity is a major factor of food choice and found that Africans and Afro-Caribbeans tend to consume various meats, wheat, and rice, while people from the East and Far East tend to consume foods containing various herbs and spices.

Culturally-based food habits are the last practices people change because eating is usually done in the privacy of homes [13]. Furthermore, given the influence culture has on food habits, interventions aimed at reducing meat consumption should be tailored for specific cultural groups. Many studies have reported that Westerners tend to experience more mental discomfort over-consuming meat than Easterners [18,19]. Tian *et al.* [20] investigated Chinese and French individuals and found that they used different strategies to resolve cognitive dissonance resulting from the meat paradox. In this study, the authors explained that French people might deal with cognitive dissonance by focusing more on the pleasure of eating. In contrast, Chinese individuals might resolve any cognitive dilemma using familiarity to de-dramatize the phenomenon of slaughter, presumably because they were more familiar with killing food animals because many grew up in rural areas.

Among the factors that affect meat consumption, gender is a key variable that determines beliefs, attitudes, and behaviors toward meat consumption, especially vegetarianism. In most cultures, eating meat is usually presented as a masculine activity, while vegetarianism is consistently associated with feminine qualities. However, although most studies have reported that men eat more meat than women [21,22], some have reported gender is not a

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significant moderator of value-attitude-meat consumption behavioral interventions [23] and that gender is not associated with an explicit attitude toward meat [24].

Studies about meat consumption attitudes, perceptions, and behaviors are important because they suggest how we should approach designing dietary interventions in response to requirements for reduced meat consumption and alternative meat production. However, most studies on the topic have compared these factors in meat eaters and non-meat eaters, and few have investigated ethnic differences regarding the meat paradox among meat eaters.

Studies on cultural factors that influence meat consumption can contribute to the design of culturally appropriate intervention strategies for meat eaters. In this sense, we aimed to identify cultural differences in meat consumption among different ethnic groups in a relatively homogeneous pool in terms of age, sex, and diet. Therefore, the objective of this study was to analyze ethnic differences in (1) meat consumption behaviors, (2) past and future changes in meat consumption, and (3) attitudes and beliefs regarding meat consumption and health among young American women meat eaters from ethnically diverse populations.

SUBJECTS AND METHODS

Study design and participants

This study was conducted using a cross-sectional design. A convenience sample of 572 women was initially recruited via snowball sampling through word-of-mouth and flyers that were posted on a college campus in the New York City area. Since the college campus is located in the most ethnically diverse county [25] and the college has students from more than 150 nations [26], nearly equal numbers of participants were assigned to four ethnic groups, viz. Black, East Asian, White, and Hispanic groups. No financial incentive was offered to participants, but refreshments were provided as tokens of appreciation. Eligibility criteria included female meat eaters aged 20–29 yrs, a non-multiracial ethnicity, and a non-nutrition major. Fifty-two candidates who did not complete the survey or identified themselves as non-meat eaters, multiracial, or a nutrition major were excluded. The remaining 520 participants completed the self-report survey between March and June 2014. The protocol was approved by the Institutional Review Board of Queens College, the City University of New York (#11-06-087-4578). All participants provided written informed consent.

Questionnaire development and contents

Initially, a questionnaire was drafted based on previous studies about; frequencies of eating home-cooked meals [27], diet questionnaire design [28], meat consumption rationale [29], and motivations of young meat eaters toward a reduced meat diet [30]. The preliminary survey was conducted on 30 female meat eaters aged 20–29 yrs old in January 2014, and based on the results obtained, a questionnaire was finalized by revising and selecting survey items. The final survey consisted of 36 questions that represented demographic traits, meat consumption behavior, past and future changes in meat consumption, and attitudes and beliefs toward health and meat consumption.

The sociodemographic traits and other characteristics analyzed were age, race/ethnicity (non-Hispanic Whites; non-Hispanic Blacks; East Asians; Hispanics), religion (Christianity; Roman Catholicism, Judaism; Islamism; Hinduism; no religion; other), marital status (single; married/live-in partner; other), annual household income level (lower than $25,000;

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$25,000–$49,999; $50,000–$74,999; $75,000 or higher), weight, height, and chronic disease (Yes/No) (questions #1-8). Self-reported weights and heights were used to calculate body mass index (BMI, kg/m^2). In this study, overweight was defined as a BMI of 25.0–29.9 kg/m^2, and obesity as a BMI ≥ 30 kg/m^2. In a large population-based cohort study, Mills *et al.* [27] reported that eating home-cooked meals more frequently was associated with better dietary quality. Based on this result, the weekly frequency of home cooking (#9) was included as an indicator of healthy food behavior. To examine the influence of family members on meat consumption, we included the question "Who are the vegetarians in your family?" (#10). The choices included none, spouse, father, mother, siblings, and other(s). If the respondents chose "other(s)", they were asked to write down their answer on a blank line alongside the "other(s)" option.

Participants were asked about their meat consumption amount during the previous yrs (#11, 12). Meat choices included beef, lamb, pork, chicken, turkey, duck, processed meat (e.g., ham, sausage, bacon), and others (e.g., bison, ostrich, deer). For each type of meat, participants were asked for average serving size (small, medium, and large) (#11) and frequency (#12). The frequency questionnaire was adapted from the Food Frequency Questionnaire developed by Block *et al.* [28]. The responses were used to calculate annual meat consumption in kilograms.

To examine ethnic differences in meat consumption behaviors in detail, participants were also asked to rank their preferred meat cooking methods in descending order (#13). The options provided were roasting, boiling, stir-frying, deep-frying, and stewing. Participants were requested to give their preferred method a ranking of 1 and the least preferred method a ranking of 5. Additionally, questions about the frequency and type of side dishes eaten with meat followed (#14, 15). The options provided for side dish frequency were 1 = never, 2 = rarely, 3 = sometimes, 4 = often, and 5 = always, and for types of side dishes were starch, vegetable, or other (the participants were asked to provide written answers). Responses to these questions were used to gain insight into culturally appropriate nutritional interventions.

Participants were also asked about changes in red meat, poultry, and processed meat consumption during the previous six months (#16-18). The options provided were 1 = decrease, 2 = no change, and 3 = increase. Three questions addressed willingness to change red meat, poultry, and processed meat consumption (#19-21). The options provided were 1 = "I will stop eating someday," 2 = "I will reduce consumption," 3 = "I will maintain the same level of consumption," and 4 = "I will increase my consumption."

Finally, the participants were presented with a series of statements regarding attitudes and beliefs toward health and meat consumption and asked to rate levels of agreement using a 5-point Likert scale (1 = strongly disagree, 2 = somewhat disagree, 3 = neither agree nor disagree, 4 = somewhat agree, and 5 = strongly agree). The first three statements that probed attitude toward health (#22-24) were: "I am interested in new information about my health"; "I eat healthy food consistently"; and "I try to maintain a healthy weight." Participants then responded to 12 statements about attitudes and beliefs regarding meat consumption (#25-36). Eight of the statements were constructed based on the meat consumption rationalization theory and addressed positive attitudes toward meat consumption [29]. Specifically, the 4 Ns were used: natural (#25, "It is difficult for adults to get sufficient energy by only eating vegetables"), necessary (#26, 27, "Eating meat is necessary for children"; "Eating meat is necessary for the old and weak"), normal (#28, "Meat is considered part of everyday meals"),

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and nice (#29-32, "I am satisfied when I have a meal that includes meat"; "Good meat is the symbol of a good meal"; "You should eat meat when you go out to restaurants"; "Meat is eaten on holidays or at parties"). The other four statements expressed negative attitudes about meat consumption, viz. specific health concerns (#33-35, "I believe eating a lot of meat increases the risk of getting cancer"; "The more I increase my meat consumption, the worse it is for my health"; "I am worried that animal health will affect human health") and guilt about slaughtering animals (#36, "Slaughtering animals for meat makes me feel guilty").

The internal reliability of the composite measure was assessed using Cronbach's α; all measures had good internal reliability (measures of health attitudes, $\alpha = 0.77$; measures of positive attitudes toward meat consumption, $\alpha = 0.77$; measures of negative attitudes, $\alpha = 0.61$).

Statistical analysis

Descriptive statistics were calculated for all variables. The χ^2 test was used to evaluate associations between outcomes of interest for categorical variables. The one sample *t*-test was conducted to compare annual meat consumption data determined in the present study with US and OECD data. To test for significant differences, we used the one sample *t*-test and US and OECD data as reference values. For nonparametric ordinal variables, the Kruskal-Wallis and post hoc Mann-Whitney U tests were used to determine the significances of differences between pairs of ethnic groups. For parametric continuous variables, one-way ANOVA and Tukey's Honest Significant Difference (HSD) post hoc tests were used to determine the significances of differences between ethnic groups.

Logistic regression models were fitted for each meat consumption outcome (Low consumption vs. High consumption). For logistic regression analysis, participants were categorized as low meat consumers (< 36.5 kg/yrs) and high meat consumers (≥ 36.5 kg/yrs) for each type of meat. The models included predictor indicators for each category of the following variables: ethnicity (White, Black, East Asian, and Hispanic), annual household income (lower than $25,000, $25,000-$49,999, $50,000-$74,999, $75,000 and higher), and BMI (kg/m^2, continuous variable). For lamb consumption, the regression model was inadequate due to an imbalanced classification (logistic regression data was not provided).

Principal axis factor analysis with varimax rotation was performed to assess the underlying structure of the fifteen attitudinal variables about health and meat consumption (positive and negative). The statistical assumptions of normality and linear relationships between pairs of variables were checked and met. Five factors were used to index five constructs: health-related attitude, any three combinations of 4 Ns (Natural, Necessary, Normal, and Nice), and positive and negative attitude toward meat consumption. After rotation, the first factor accounted for 11.5% of the variance, and the five factors accounted for half (51.9%). **Table 1** displays the items and factor loadings for the rotated factors. As a result of factor analysis, the attitudinal variables were reduced to five: Health-related attitude (survey items #22-24); Positive – Natural / Necessary (items #25-27); Positive – Normal (items #28-30); Positive – Nice attitude toward meat consumption (items #31, 32); Negative attitude toward meat consumption (items #33-36).

According to the factor analysis result, these five-dimension attitudinal variables were created by averaging items loaded on each dimension. The five variables were treated as independent variables for predicting each dependent variable by multiple regression analyses. To predict total meat consumption, a multiple linear regression model was used to fit with the

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Table 1. Factor loadings for the rotated factors on attitudinal variables

Attitudinal variable	Factor loading					Communality
	1	2	3	4	5	
Health						
I am interested in new information about health.			0.80			0.45
I eat healthy food consistently.			0.70			0.40
I try to maintain a healthy weight.			0.65			0.34
Meat Consumption						
Positive–natural/necessary						
Eating meat is necessary for children.		0.86				0.55
Eating meat is necessary for the old and weak.		0.79				0.53
It is difficult for adults to get sufficient energy by only eating vegetables.		0.44				0.24
Positive–normal						
I am satisfied when I have a meal including meat.	0.70					0.45
Good meat is the symbol of a "good meal".	0.77					0.45
Meat is considered part of an everyday meal.	0.66					0.42
Positive–nice						
You should eat meat when you go out to restaurants.				0.87		0.52
Meat is eaten on holidays or at parties.				0.72		0.50
Negative						
The more I increase my meat consumption, the worse it is for my health.					0.80	0.39
I believe eating a lot of meat increases the risk of getting cancer.					0.53	0.29
I am worried that the animal's health will affect human health by eating meat.					0.47	0.21
Slaughtering animals for eating meat makes me feel guilty.					0.31	0.17
Eigen values	1.72	1.67	1.64	1.43	1.34	
% of variance	11.46	11.14	10.90	9.51	8.91	

Only those items with a loading ≥|0.30| are presented.

covariates age, ethnicity, marital status, annual household income, and attitudinal variables of health and meat consumption. Assumptions of linearity and normality were checked and met. Residuals and expected values were plotted linearly, which suggested agreement with normality. Also, the result of collinearity analysis confirmed the absence of multicollinearity among the independent variables in the regression model. The analysis was conducted using SPSS for Windows (version 25.0, 2017, IBM Inc., Armonk, NY, USA), and statistical significance was accepted for *P*-values < 0.05.

RESULTS

Demographic traits and other characteristics

Participant characteristics are presented in **Table 2** and **Fig. 1**. The four ethnic groups were evenly distributed in the sample (Whites = 25%; Blacks = 20%; East Asians = 35%; Hispanics = 20%). Tukey's HSD results show that the Hispanic and Black groups were significantly older than the White and East Asian groups ($P < 0.001$, **Fig. 1**). All participants had at least some college education.

As regards religions, 35% of the participants reported no religion, and this was followed in decreasing order by Christianity, Roman Catholicism, and 'others.' In White and East Asian groups, "no religion" was highest, followed by Christianity (**Table 2**). Among Blacks, Christianity was highest, followed by Roman Catholicism. Among Hispanics, Roman Catholicism was highest, followed by 'other' (**Table 2**).

The total sample consisted of primarily single participants (89.2%) (**Table 2**). In particular, single individuals constituted 99.5% of East Asians, followed by Whites (90.8%), Blacks (84.3%),

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Table 2. Characteristics and demographics of 520 young female participants

Participant characteristic	Total (n = 520)	Non-Hispanic Whites (n = 130)	Non-Hispanic Blacks (n = 102)	East Asians (n = 182)	Hispanics (n = 106)
Religion					
No religion	182 (35.0)	47 (36.2)	20 (19.6)	108 (59.3)	7 (6.6)
Christianity	125 (24.0)	35 (26.9)	39 (38.2)	39 (21.4)	12 (11.3)
Roman Catholicism	85 (16.3)	23 (17.7)	22 (21.6)	17 (9.3)	32 (30.2)
Judaism	48 (9.2)	20 (15.4)	5 (4.9)	0 (0.0)	20 (18.9)
Islamism	17 (3.3)	2 (1.5)	7 (6.9)	0 (0.0)	8 (7.5)
Hinduism	7 (1.3)	0 (0.0)	3 (2.0)	0 (0.0)	4 (3.8)
Others	56 (10.8)	3 (2.3)	6 (5.9)	18 (9.9)	23 (21.7)
Marital status					
Single	464 (89.2)	118 (90.8)	86 (84.3)	181 (99.5)	79 (74.5)
Married/Live with partner	48 (9.3)	9 (7.0)	15 (14.7)	1 (0.5)	23 (21.7)
Others[1)]	8 (1.6)	3 (2.3)	1 (1.0)	0 (0.0)	4 (3.7)
Annual household income					
Lower than $25,000	145 (27.9)	40 (30.8)	38 (37.3)	39 (21.4)	28 (26.4)
$25,000–$49,999	136 (26.2)	28 (21.5)	23 (22.5)	61 (33.5)	24 (22.6)
$50,000–$74,999	124 (23.8)	34 (26.2)	19 (18.6)	52 (28.6)	19 (17.9)
$75,000 and higher	115 (22.1)	28 (21.5)	22 (21.6)	30 (16.5)	35 (33.0)
Chronic disease					
Yes	59 (11.3)	17 (13.1)	16 (15.7)	9 (4.9)	17 (16.0)
No	461 (88.7)	113 (86.9)	86 (84.3)	173 (95.1)	89 (84.0)
Vegetarians in the family					
None	471 (90.6)	115 (88.5)	93 (91.2)	172 (94.5)	91 (85.8)
Spouse	13 (2.5)	0 (0.0)	0 (0.0)	0 (0.0)	13 (12.3)
Father	5 (1.0)	2 (1.5)	2 (2.0)	1 (0.5)	0 (0.0)
Mother	16 (3.1)	6 (4.6)	3 (2.9)	6 (3.3)	1 (0.9)
Siblings	8 (1.5)	5 (3.8)	1 (1.0)	2 (1.1)	0 (0.0)
Others	6 (1.2)	2 (1.5)	3 (1.2)	0 (2.1)	1 (0.9)

Values are presented as number (%).
[1)]'Others' includes divorced, separated, and widowed.

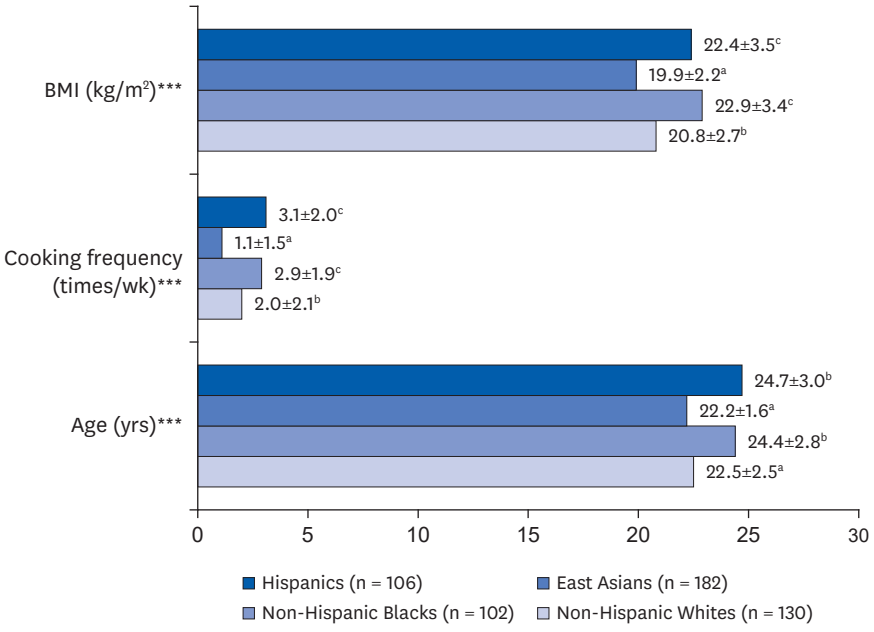

Fig. 1. Age, weekly cooking frequency, and BMI (kg/m²) values (mean ± SD) of 520 participants by ethnic group. Tukey's Honest Significant Difference post hoc test was used for significance testing ($P < 0.05$). [a-c]Between ethnic groups, means with a common superscript indicate no statistical significance.
BMI, body mass index.
***$P < 0.001$.

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and Hispanics (74.5%). For annual household income, the highest percentage of Whites and Blacks had an income of "lower than $25,000," while the highest percentage of Hispanics had an income of "$75,000 and higher." The highest percentage of East Asians had an income of "$25,000–$49.999" (**Table 2**). Of the 520 participants, 11.3% had a chronic disease. The most frequently reported disease was diabetes, and Hispanics had the highest rate (**Table 2**).

For the item related to vegetarian family members, 90.6% of all participants reported that they had no vegetarian family member. Hispanics had the most vegetarian family members. Among vegetarian family members, mothers had the highest vegetarian rate, followed by spouses, brothers/sisters, and other(s) (**Table 2**). Weekly cooking frequency results showed Hispanics and Blacks cooked significantly more than Whites and East Asians. Thus, the cooking frequency pattern across ethnic groups was similar to age and marital status patterns (Tukey's HSD test, $P < 0.001$) (**Fig. 1**). Mean BMI for all participants was 21.2 ± 3.1 kg/m^2 (range 15.6–33.8 kg/m^2) (**Fig. 1**). Only 11.7% of the participants were obese or overweight (data not shown); most participants had a healthy weight. Blacks and Hispanics had significantly higher BMIs than Whites and East Asians (Tukey's HSD test, $P < 0.001$).

Meat consumption behavior

Tukey's HSD post hoc test showed annual consumptions of lamb, pork, chicken, turkey, processed meat, and total meat were significantly different in the four ethnic groups ($P < 0.05$, **Fig. 2**). Hispanics ate significantly less pork and meat (overall) than other ethnic groups, Blacks ate significantly higher amounts of chicken and turkey, and East Asians ate significantly more processed meat (**Fig. 2**).

Binary logistic regression was used to determine whether the three predictors, ethnicity, annual household income, and BMI significantly predicted high meat consumption for each type of meat. Odds ratios (ORs) calculated by logistic regression analyses are presented in **Table 3**. The White ethnic group and the 'Lower than $25,000' income group' were used as reference groups (OR = 1) for OR calculations for each categorical variable. When all three predictors are considered together, they significantly predict being a high chicken-eater ($\chi^2 = 22.38$, df = 7, n = 520, $P = 0.002$) and a high total meat-eater ($\chi^2 = 24.26$, df = 7, n =520, $P = 0.001$). The calculated ORs in **Table 3** show that East Asian and Black women were more likely (ORs > 1.0) than White women to be high consumers of total meat, chicken, and processed meat, but that Hispanic women were more likely than White women to be high consumers of beef and chicken. Participants with a higher household income were less likely (ORs < 1.0) to be high consumers of beef, lamb, pork, turkey, or processed meat than those in the lowest income group, and the odds of being a high meat consumer for all types of meat increased with BMI. In particular, the odds of East Asians being high meat consumers of total and processed meat were 2.1 and 6.3 times, respectively, that of Whites (**Table 3**).

When asked about cooking methods, participants in all ethnic groups preferred grilling/roasting/broiling (**Table 4**). However, second most preferred cooking methods differed, viz, deep frying ranked second in Whites and Blacks, boiling and deep-frying in among East Asians, and stir-frying among Hispanics.

Regarding side dish consumption, most Whites and Blacks reported that they always had a side dish when they ate meat, but most East Asians and Hispanics report that they never eat side dishes with meat. When side dish consumption frequencies were compared using the Mann-Whitney U test (**Table 4**), Blacks consumed side dishes significantly more often than

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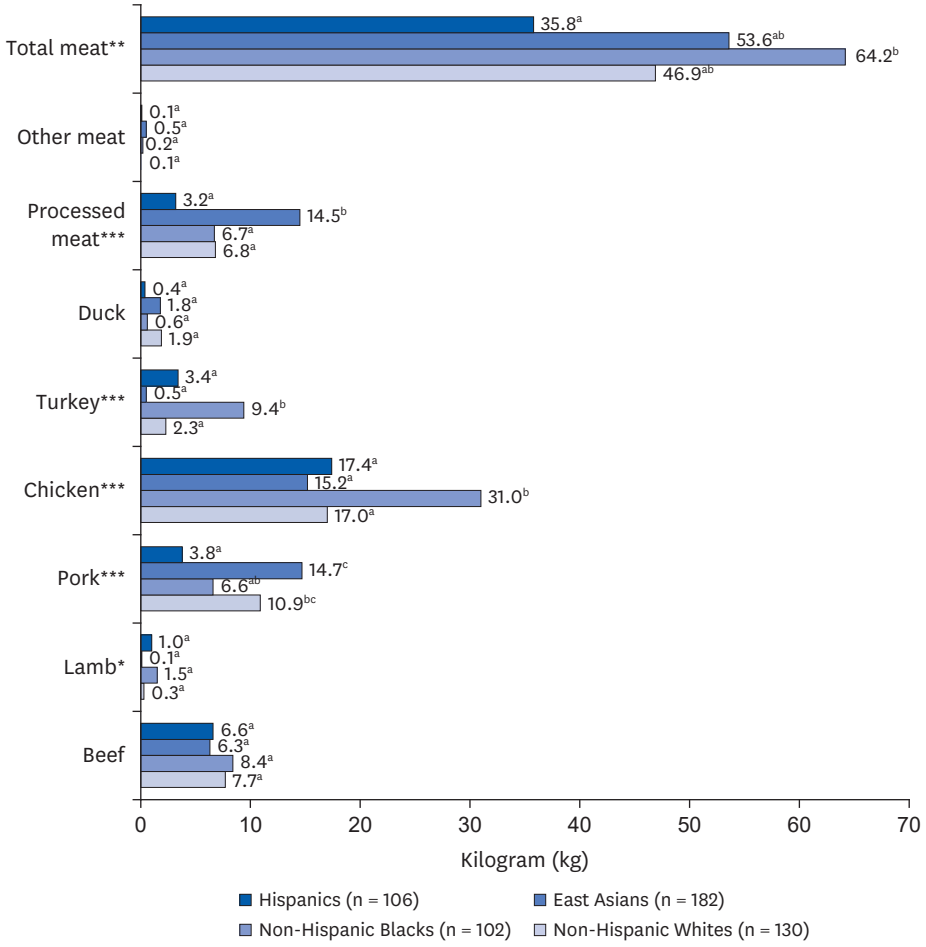

Fig. 2. Estimated annual meat consumption mean values of the 520 participants by ethnic group. Tukey's Honest Significant Difference post hoc test was used for significance testing ($P < 0.05$). [a-c]Between ethnic groups, means with a common superscript indicate no statistical significance.
*$P < 0.05$; **$P < 0.01$; ***$P < 0.001$.

any other ethnic group, and Hispanics and East Asians consumed side dishes significantly less than Blacks and Whites. Regardless of ethnic group, vegetable side dishes were consumed most, followed by starch and others (**Table 4**).

Table 3. Logistic regression results for the predicting of meat consumption with respect to independent variables (ethnicity, annual household income, and BMI)

Variable	Beef	Pork	Chicken**	Processed meat***	Total meat***
Ethnicity					
Non-Hispanic Whites	Ref[1)]	Ref[1)]	Ref[1)]	Ref[1)]	Ref[1)]
Non-Hispanic Blacks	0.6 (0.1–2.9)	0.3 (0.1–1.4)	2.1 (1.0–4.7)	1.2 (0.2–6.3)	1.9* (1.1–3.3)
East Asians	0.5 (0.1–2.0)	1.2 (0.5–3.1)	1.2 (0.6–2.6)	6.3** (1.8–22.1)	2.1** (1.3–3.3)
Hispanics	1.3 (0.4–4.5)	0.2 (0.1–1.2)	2.4* (1.1–5.1)	0.4 (0.04–3.5)	0.7 (0.4–1.3)
Annual Household Income					
Lower than $25,000	Ref[1)]	Ref[1)]	Ref[1)]	Ref[1)]	Ref[1)]
$25,000–$49,999	0.5 (0.1–2.3)	0.3 (0.1–1.2)	0.7 (0.3–1.3)	0.6 (0.2–1.8)	0.7 (0.4–1.1)
$50,000–$74,999	0.7 (0.1–2.0)	0.7 (0.2–2.1)	0.7 (0.3–1.4)	0.2* (0.1–0.8)	0.8 (0.5–1.3)
$75,000 and higher	1.5 (0.4–5.2)	0.9 (0.3–2.5)	0.5 (0.2–1.1)	0.7 (0.3–2.0)	0.8 (0.5–1.4)
BMI (kg/m^2)	1.1 (1.0–1.3)	1.1 (0.9–1.2)	1.1 (1.0–1.2)	1.0 (0.9–1.2)	1.1 (1.0–1.1)

Values are presented as odds ratio (95% confidence interval).
BMI, body mass index; OR, odds ratio; CI, confidence interval.
[1)]Reference group for categorical variables, odds ratio = 1.0.
*$P < 0.05$; **$P < 0.01$; ***$P < 0.001$.

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Table 4. Meat consumption behaviors by ethnic group

Meat consumption behavior attribute	Total (n = 520)	Non-Hispanic Whites (n = 130)	Non-Hispanic Blacks (n = 102)	East Asians (n = 182)	Hispanics (n = 106)	*P*-value
Frequency of the most preferred choice for meat cooking method[1)]						
Grilling/Roasting/Broiling	379 (72.9)	109 (83.8)	69 (67.6)	130 (71.4)	71 (67.0)	0.001[5)]
Stir frying	42 (8.1)	3 (2.3)	8 (7.8)	14 (7.7)	17 (9.6)	< 0.001[5)]
Boiling	35 (6.7)	6 (4.6)	5 (4.9)	15 (8.2)	9 (8.5)	< 0.001[5)]
Deep frying	40 (7.7)	7 (5.4)	13 (12.7)	15 (8.2)	5 (4.7)	< 0.001[5)]
Stewing/Soup	18 (3.5)	4 (3.1)	7 (6.9)	3 (1.6)	4 (3.8)	< 0.001[5)]
Braising/Others	6 (1.1)	1 (0.8)	0 (0.0)	5 (2.1)	0 (0.0)	< 0.001[5)]
Side dish consumption frequency[2)]	2.7 ± 1.5	3.1 ± 1.6[b]	4.4 ± 0.8[c]	1.8 ± 0.9[a]	2.0 ± 1.4[a]	< 0.001[6)]
Type of side dish						
Starch	130 (25.0)	25 (19.2)	71 (69.6)	9 (4.9)	25 (23.6)	< 0.001[5)]
Vegetable	417 (80.2)	119 (91.5)	91 (89.2)	169 (92.9)	38 (35.8)	< 0.001[5)]
Others	60 (11.5)	30 (23.1)	22 (21.6)	4 (2.2)	4 (3.8)	< 0.001[5)]
Changes in meat consumption in the Past 6 months[3)]						
Red meat	2.2 ± 0.8	2.1 ± 0.8[b]	1.7 ± 0.5[a]	2.5 ± 0.8[c]	2.4 ± 0.7[c]	< 0.001[6)]
Poultry	2.3 ± 0.8	2.2 ± 0.7[a]	2.1 ± 0.6[a]	2.4 ± 0.8[b]	2.5 ± 0.8[b]	< 0.001[6)]
Processed meat	2.2 ± 0.7	2.1 ± 0.8[b]	1.7 ± 0.5[a]	2.3 ± 0.7[c]	2.4 ± 0.7[c]	< 0.001[6)]
Plans of change in future meat consumption[4)]						
Red meat	2.4 ± 0.6	2.4 ± 0.6[a]	2.4 ± 0.7[a]	2.3 ± 0.6[a]	2.5 ± 0.7[a]	< 0.001[6)]
Poultry	2.4 ± 0.6	2.5 ± 0.6[b]	2.9 ± 0.6[c]	2.3 ± 0.6[a]	2.2 ± 0.6[a]	< 0.001[6)]
Processed meat	2.6 ± 0.8	2.5 ± 0.7[b]	2.1 ± 0.7[a]	2.8 ± 0.7[c]	2.7 ± 0.8[bc]	< 0.001[6)]

Values are presented as number (% within ethnic groups) or mean ± SD.
[1)]Participants were asked the question: Rank the following meat cooking methods in descending order of preference. The most preferred method should be ranked #1.
[2)]Participants were asked: Generally, how often do you eat side dishes when you eat meat? 1 = never; 2 = rarely; 3 = sometimes; 4 = often; 5 = always.
[3)]Participants were asked: Has your meat consumption changed in the last 6 months? 1 = decrease; 2 = no change; 3 = increase.
[4)]Participants were asked: Will you change your amount of meat consumption in the future? 1 = I will stop eating meat someday; 2 = I will decrease meat consumption; 3 = I will maintain the same meat consumption; 4 = I will increase the meat consumption.
[5)]*P*-values were determined using χ^2 test for categorical variables.
[6)]*P*-values were determined using Kruskal-Wallis test and significant differences between pairs of ethnic groups were determined using the Mann-Whitney *U* test for ordinal variables. [a-c]Within a row, means with a common superscript indicate no statistical significance.

To summarize, healthy meat cooking methods such as steaming were preferred more by East Asians, and ethnic groups equally preferred deep-frying. Healthy side dishes, like vegetables, were consumed more frequently by Blacks.

Past and future changes in meat consumption

When asked about changes in meat consumption over the previous six months, nearly half of the participants reported their intakes of red meat and poultry had increased and that processed meat consumption had not changed. However, Mann-Whitney U post hoc testing showed some significant differences between ethnic groups. Blacks reported significantly more than the other ethnic groups that red meat, poultry, and processed meat consumptions had either reduced or were unchanged, while East Asians and Hispanics reported significantly more than Whites and Blacks that their consumptions of red meat, poultry, and processed meat had increased (**Table 4**).

As for plans regarding changing red meat consumption, no significant difference was found between ethnic groups by post hoc Mann-Whitney U testing (**Table 4**). Regarding poultry consumption, Blacks reported they were planning to maintain consumption, whereas the other ethnic groups reported they intended to reduce consumption (**Table 4**). Furthermore, East Asians planned to consume significantly more processed meat than Whites and Blacks (**Table 4**). Despite ethnic differences, more than half of the participants reported they were planning to decrease their consumptions of red meat and poultry. A small number of participants said they would "stop eating meat someday" (**Table 4**).

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Attitudes and beliefs toward health and meat consumption

Blacks and Hispanics had significantly higher positive attitudes toward health than Whites and East Asians ($P < 0.001$, **Table 5**), which resembled age distributions across ethnic groups. The mean ages of Blacks and Hispanics were significantly greater than those of Whites and East Asians ($P < 0.001$, **Fig. 1**).

Regarding positive attitudes toward meat consumption, significant differences were observed between ethnic groups, except for two statements, "Eating meat is necessary for children" ($P = 0.562$) and "Eating meat is necessary for the old and weak" ($P = 0.905$). On the other hand, as regards negative attitudes toward meat consumption, no significant difference was found among the four ethnic groups ($P > 0.05$) (**Table 5**).

Predictions of meat consumptions and BMI

Table 6 presents multiple linear regression results of regression models that significantly predicted total meat consumption ($P < 0.001$). In regression analysis, the combination of the independent variables age, ethnicity, marital status, annual household income, and 5 attitudinal dimensions (health, positive 3 combinations of 4Ns, and negative attitudes) significantly predicted annual total meat consumption (**Table 6**). Household income, health-related attitude, and "Normal" attitude significantly contributed to the prediction of total meat consumption. The significant β weights ($P < 0.05$) presented in **Table 6** suggest that having a higher score for "Normal" attribute contributed more to predicting higher total meat consumption and that a higher household income and that a lower health-related attitude score also contributed to the prediction of higher total meat consumption.

Table 5. Attitudes and beliefs toward health and meat consumption by ethnic group: Mean ratings (SD)

Attitude and belief attribute	Total (n = 520)	Non-Hispanic Whites (n = 130)	Non-Hispanic Blacks (n = 102)	East Asians (n = 182)	Hispanics (n = 106)	*P*-value
Health						
I am interested in new information about health.	4.0 (1.1)	3.9 (1.2)^{a}	4.3 (1.2)^{b}	3.6 (1.0)^{a}	4.4 (1.1)^{b}	< 0.001
I eat healthy food consistently.	3.3 (1.2)	3.3 (1.3)^{b}	3.7 (1.0)^{c}	2.8 (1.2)^{a}	3.8 (1.1)^{c}	< 0.001
I try to maintain a healthy weight.	3.7 (1.2)	3.7 (1.2)^{ab}	4.0 (1.1)^{b}	3.5 (1.1)^{a}	3.9 (1.3)^{b}	0.001
Meat Consumption						
Positive–natural/necessary						
It is difficult for adults to get sufficient energy by only eating vegetables.	3.6 (1.2)	3.6 (1.1)^{ab}	3.4 (1.3)^{ab}	3.8 (1.1)^{b}	3.3 (1.3)^{a}	0.004
Eating meat is necessary for children.	3.9 (1.0)	3.9 (1.0)^{a}	3.8 (1.1)^{a}	3.9 (1.0)^{a}	3.8 (1.1)^{a}	0.562
Eating meat is necessary for the old and weak.	3.6 (1.0)	3.6 (1.0)^{a}	3.5 (1.1)^{a}	3.6 (1.0)^{a}	3.5 (1.2)^{a}	0.905
Positive–normal						
Meat is considered part of an everyday meal.	3.0 (1.1)	3.0 (1.1)^{ab}	3.3 (1.2)^{b}	2.7 (0.9)^{a}	3.3 (1.3)^{b}	< 0.001
I am satisfied when I have a meal including meat.	3.7 (1.1)	3.8 (1.1)^{b}	3.9 (1.1)^{b}	3.4 (1.1)^{a}	4.1 (1.1)^{b}	< 0.001
Good meat is the symbol of a "good meal".	3.0 (1.2)	3.0 (1.1)^{b}	3.4 (1.2)^{b}	2.6 (1.0)^{a}	3.2 (1.3)^{b}	< 0.001
Positive–nice						
You should eat meat when you go out to restaurants.	3.3 (1.1)	3.4 (1.1)^{bc}	2.9 (1.2)^{a}	3.6 (1.0)^{c}	3.1 (1.3)^{ab}	< 0.001
Meat is eaten on holidays or at parties.	3.6 (1.1)	3.6 (1.1)^{ab}	3.3 (1.3)^{a}	3.9 (0.9)^{b}	3.4 (1.2)^{a}	< 0.001
Negative						
I believe eating a lot of meat increases the risk of getting cancer.	3.4 (1.0)	3.4 (0.9)^{a}	3.4 (1.1)^{a}	3.5 (1.0)^{a}	3.3 (1.1)^{a}	0.566
The more I increase my meat consumption, the worse it is for my health.	3.3 (1.1)	3.3 (1.0)^{a}	3.3 (1.1)^{a}	3.4 (1.0)^{a}	3.2 (1.4)^{a}	0.633
I am worried that the animal's health will affect human health by eating meat.	3.5 (1.1)	3.4 (1.0)^{a}	3.6 (1.1)^{a}	3.4 (1.0)^{a}	3.6 (1.2)^{a}	0.103
Slaughtering animals for eating meat makes me feel guilty.	2.8 (1.1)	2.8 (1.2)^{a}	3.0 (1.2)^{a}	2.6 (1.0)^{a}	2.8 (1.3)^{a}	0.108

Ratings were made using a 5-point Likert scale (1 = strongly disagree to 5 = strongly agree). Tukey's Honest Significant Difference post hoc test was used for significance testing ($P < 0.05$). $^{a-c}$Within a row, means with a common superscript indicate no statistical significance.

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Table 6. Simultaneous multiple regression analysis results for independent variables predicting annual meat consumption and body mass index (BMI) (dependent variable: total meat consumption: kg)

Variable	Unstandardized coefficients	Standardized coefficients	*P*-value
	B ± SE	ß	
Age	−60.17 ± 37.90	−0.08	0.113
Ethnicity	−106.73 ± 82.48	−0.06	0.196
Marital status	67.24 ± 167.04	0.02	0.687
Annual household income***	288.57 ± 79.80	0.15	< 0.001
BMI (kg/m^2)	53.95 ± 30.52	0.08	0.078
Health related attitude**	−270.12 ± 96.26	−0.13	0.005
Positive–natural/necessary	3.15 ± 110.61	0.001	0.977
Positive–normal***	575.82 ± 106.38	0.27	< 0.001
Positive–nice	62.26 ± 94.44	0.03	0.510
Negative	41.45 ± 125.20	0.02	0.741
R^2 = 0.12 (Adjusted R^2 = 0.10), F (10,509) = 6.82, P < 0.001			

Independent variables included: age (yrs); ethnicity (1: Whites; 2: Blacks; 3: East Asians; 4: Hispanics); marital status (1: single; 2: Married/live with partner; 3: Others); annual household income (1: lower than $25,000; 2: $25,000–$49,999; 3: $50,000–$74,999; 4: $75,000 and higher); attitudinal variable dimension mean score (5-point Likert scale, 1 = strongly disagree to 5 = strongly agree).
**P < 0.01; ***P < 0.001.

DISCUSSION

Previous studies have reported that the religions that affect meat consumption are Islamism, Judaism, and Hinduism [13,31]. In the present study, distributions of these three religions were similar across ethnic groups (**Table 2**), and our results indicate that religious affiliations might not influence ethnic differences in meat consumption behaviors.

The BMI results obtained in the present study (**Fig. 1**) accord well with national prevalences of overweightedness and obesity data for adults (2017–2018) published in the United States [32] and that non-Hispanic Black adults (49.6%) have the highest age-adjusted prevalence of obesity, followed by Hispanic adults (44.8%), non-Hispanic White adults (42.2%) and non-Hispanic Asian adults (17.4%). As compared with the prevalence of overweightedness and obesity data among adults aged 20–49 reported in 2017–2018 in the United States (42.5%), the prevalence in the present study (11.7%) was much lower.

According to OECD statistics for 2021 [33], the world average annual per capita consumption of beef, lamb, pork, and poultry is 6.4, 1.8, 10.7, and 14.9 kg, whereas in the present study, these were 7.1, 0.6, 9.9, and 23.8 (chicken + turkey + duck) kg, respectively. Average annual consumptions of beef, lamb, pork, and poultry in OECD countries were 14.4, 1.3, 22.9, and 31.7 kg, respectively, whereas in the US corresponding values for 2021 were 26.1, 0.4, 23.9, and 50.8, respectively. One sample *t*-test showed that beef and poultry consumption data obtained in the present study are significantly lower than those reported in the US (P < 0.001) and OECD (P < 0.001) but higher than world averages with a significant difference for poultry (P < 0.001; beef P = 0.17). For lamb consumption, the value obtained in the present study tended to be higher than that reported in the US (P = 0.24) but was significantly lower than the world (P < 0.001) and OECD (P < 0.001) consumptions. Pork was eaten significantly less by our participants than in the US (P < 0.001) or OECD countries (P < 0.001), but average pork consumption by our participants tended to be less than the world average (P = 0.43). Additionally, in line with the present study, OECD statistics for 2021 show that the inhabitants of countries in East and South Asia consume more pork than those of other nations [33].

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The Food and Agriculture Organization (FAO) of the United Nations found US per capita annual meat consumption was 124 kg in 2017 [34], whereas average total meat consumption for all participants (n = 520) in the present study (50.4 kg) was less than half of this figure. The female make-up of our study cohort seems to be the main reason for this lower meat consumption. Women generally consume less meat than men in Europe, Asia, Africa, and the Americas [35], and women are twice as likely as men to be vegetarian or vegan in Western societies [6,36,37]. In Finland and the Baltic countries, women eat less meat and more fruits and vegetables than men [22], whereas in England, more women than men avoid meats, except for fish [38]. Furthermore, according to Hopwood *et al.* [39], men have significantly stronger reasons to eat meat than women.

In a study by de Boer *et al.* [30], in which the method used to estimate average meat intake was similar to ours, meat-eaters were allocated to low (< 50 g/day), medium (50–99 g/day), or high meat-eater groups (100 g/day and more). Applying this meat-eating group categorization to our results, Whites, Blacks, and East Asians were high meat-eaters and Hispanics were medium meat-eaters. In a study by de Boer *et al.* [30], poultry was the most popular type of meat among low and medium meat-eaters. However, in the present study, poultry was the most popular meat in all ethnic groups, although most of the participants were high meat-eaters. Stegelin [40] reported that expenditures on ground beef and chicken were least responsive to changes in total household income. It would appear that economical reasons seem to be associated with the popularity of chicken across ethnic groups.

In agreement with the results of non-Hispanic Blacks shown in **Table 3**, the Economic Service/USDA report [41] showed that non-Hispanic Black Americans consumed significantly larger amounts of chicken and turkey (at least 38% more) than any other ethnic group between 1994–2008, and in the same report Hispanic Americans were reported to consume more beef than other ethnic groups [41]. Stegelin reported that Hispanic households spent the highest proportion of meat expenditure on beef (24%), while non-Hispanic white (26%) and African-American (31%) households spent the highest proportion on pork [40]. These findings contrast with our observation that beef consumption by Hispanics was third among the four ethnic groups (**Fig. 2**). On the other hand, Guenther *et al.* [42] reported that chicken consumption was associated with a higher income and pork consumption with a lower income. In the present study, the Hispanic group, which contained the highest percentage of individuals in the highest income group (**Table 2**), also tended to eat more chicken and less pork.

The high intakes of all meats and processed meat by East Asians observed in the current study concur with that reported in an online article by Hill [43]. This higher meat consumption by East Asians may be due to increasing meat consumption in China. According to a report issued by the Foreign Agricultural Services/United States Department of Agriculture (USDA) [44], China is the world's largest consumer of meat, and pork consumption in China is set to be more than double that of all European Union countries in 2020. Pork is the most consumed meat in China, but consumptions of beef and chicken are expected to be greater than for any other country, except the United States [44].

Considering the health risks associated with the excessive consumption of processed meat reported by the World Health Organization (WHO)'s International Agency for Research on Cancer (IARC) [45], nutritional intervention is required to reduce processed meat consumption by East Asians, who are predicted to consume 6.3 times more processed meat than Whites (**Table 3**).

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Consistent with our results about preferred meat cooking methods and side dishes, Kim *et al.* [46], in a study of 301 Korean adults, reported that the most preferred cooking method was roasting/grilling/broiling (91% of all respondents), followed by steaming (19.3%) and deep-frying (18.9%). The primary reason given for this preference was taste (88% of all respondents). A similar outcome was reported by Bai and Hwang [47] who found the most preferred meat cooking method among Koreans eating out was roasting/grilling/broiling. Those results accord well with the conclusions of Lee and Cho [48] in their book on the cultural history of Korean grilled meat. These authors concluded that Korean's preferred meat cooking method in 1975 was changing from stewing to grilling/broiling at a time when meat consumption increased dramatically in Korea in parallel with gross national income, which surpassed $500/annum. Our side dish consumption frequency results (**Table 4**) are also consistent with the finding of Yoon and Woo [49], that is, that vegetable side dishes are preferred by Koreans.

While the opinion that red meat is necessary for personal health is widely held [21,50], reduced meat diets are now widely accepted because the overconsumption of meat is known to have negative impacts on environmental and human health [6,51,52]. The flexitarian diet, a semi-vegetarian style of eating that encourages less meat and more plant-based food, is an example of a reduced-meat diet. This diet is listed on US News best diet rankings as the second-best diet after the Mediterranean diet [53]. In addition to the reduced-meat diet, a pescatarian diet, which is essentially a vegetarian diet with fish and shellfish, is becoming more popular due to the unique health benefits derived from seafood [54]. Given the combination of popular belief and diet trends, responses to future meat consumption items in our questionnaire (**Table 4**) can be ascribed to the influence of current diet trends.

Regarding health-related attitudes, East Asians, the youngest ethnic group in our study, had the lowest agreement score for a positive healthy attitude, while Hispanics, the oldest group with a higher percentage of non-single participants, had the best health-related attitude (**Fig. 1** and **Table 5**). These results indicate older Blacks and Hispanics pay more attention to health-related issues. Diehl *et al.* [55] and Labouvie-Vief *et al.* [56] found that older adults have more impulse control than young adults, probably because they have devised more effective coping strategies. Steinberg *et al.* [57] also reported significant differences in psychosocial maturity between 16- to 17-yr-olds and those 22 yrs and older, and between 18- to 21-yr-olds and those 26 and older. These results suggest age-related maturity increases positive health attitudes.

Natural, normal, and necessary were suggested by Joy [58] as the "Three Ns that justify meat consumption". Responses to the two statements in the "Necessary" category revealed no significant difference between ethnic groups ($P = 0.56$ and 0.91) (**Table 5**), indicating no difference between the degree of agreement on "Necessary" justification for meat consumption among the four ethnic groups. Furthermore, average responses of all participants were higher for these two "Necessary" statements than other positive beliefs.

Major ethnic differences in attitudes and beliefs regarding meat consumption were found between East Asians and the other groups. East Asians agreed significantly more with the statements "It is difficult for adults to get sufficient energy by only eating vegetables," "Meat is eaten on holidays or at parties," and "You should eat meat when you go out to restaurants," but agreed significantly less with "Meat is considered part of everyday meals" and "Good meat is the symbol of a good meal" than other ethnic groups. These results may reflect

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cultural differences and provide clues how East Asians' beliefs differ from those of other ethnic groups. It appears that East Asians consider meats to be something eaten on holidays or at parties rather than a daily activity. Smil reported meat was not eaten frequently and that relatively large amounts of meat were consumed as roasts and stews only during festive occasions in traditional agricultural societies [12]. Smil also provided Chinese and Japanese examples of infrequent meat consumption behavior in traditional agricultural societies. Thus, it appears East Asian respondents' have stronger perceptions of meat as a festive food that may have originated from an agricultural societal culture toward meat consumption [13].

As for negative attitudes toward meat consumption, no significant difference was found among the four ethnic groups ($P > 0.05$). Nevertheless, East Asians displayed less guilt about slaughtering animals, which is consistent with the results of a previous study that compared attitudes to the meat paradox in French and Chinese participants [20]. In this study, French participants experienced a stronger meat paradox than Chinese participants. The authors explained that this difference may have resulted from feelings of familiarity with animal slaughter, as Chinese participants may have been more familiar with killing animals for food than French participants, who may experience more cognitive dissonance due to a lack of direct experience of slaughter.

The main strength of this work is the inclusion of a fairly large cohort of young female meat eaters. The participants in the four ethnic groups had similar ages and marital and health statuses, which strengthened the validities of our comparisons. In addition, the study measures used allowed us to examine the effects of ethnic differences on various outcome variables related to meat consumption behaviors, such as cooking methods and side dish consumptions. However, this study also has several limitations. First, participants were recruited from a single geographic location, and the sample was homogeneous in terms of education level, as all participants had received at least some college education. Additionally, although questions were asked about typical average meat consumption behavior, no specific timeframe was mentioned, and data were collected during the spring and summer. These shortcomings might reduce the generalizability of our findings to other populations. Second, the study was conducted using self-reported behavioral data, which are subject to misreporting (e.g., misremembering and under/overestimating) and human errors. Third, lack of control of independent variables precludes our making causal inferences.

In conclusion, our findings suggest that cultural differences can significantly impact meat consumption behaviors. Based on the ethnic differences in meat consumption identified in this study, further research is needed to identify culture-competent nutrition programs that effectively improve healthy eating behaviors. Furthermore, improved understanding of the myriad factors that influence food choices would provide insight of practical interventions that alter meat consumption behaviors in ethnically diverse societies. Given growing concerns about the overconsumption of meat, culturally tailored, sustainable interventions that promote reduced-meat diets are required to benefit people and the planet.

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