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Lean red meat consumption and lipid profiles in adolescent girls

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Abstract

Background—Epidemiologic studies of red meat consumption often fail to distinguish between leaner and fattier or processed cuts of meat. Red meat has also been frequently linked with less healthy diet patterns. Data exploring health effects of lean red meat in younger individuals, particularly in the context of a healthy diet, are sparse. This study examined the effects of lean red meat in combination with higher intakes of fruit/non-starchy vegetables on lipid profiles in older adolescent girls.

Methods—Data from 1,461 girls followed for 10 years starting at 9-10 years of age in the NHLBI Growth and Health Study were used. Diet was assessed using multiple sets of 3-day records collected over eight exam cycles. Outcome measures included fasting levels of low-density lipoprotein cholesterol (LDL-C), high-density lipoprotein cholesterol (HDL-C), non-high-density lipoprotein cholesterol and triglycerides at ages 18-20 years.

Results—After adjusting for age, race, SES, height, activity level, hours of television/day, and **intakes of whole grains and dairy foods** using multivariable modeling, girls consuming ≥6 oz lean red meat/wk combined with ≥2 servings of fruit/non-starchy vegetables/day had LDL levels about 6-7 mg/dL lower (p<0.05) than girls with lower intakes of lean red meat and fruit/non-starchy vegetables. In addition, girls with higher intakes of both were 33% less likely (OR=0.67, 95% CI: 0.48-0.94) to have an LDL-C ≥110 mg/dL and 41% less likely (OR=0.59, 95% CI: 0.42, 0.83) to have an elevated LDL:HDL ratio (≥2.2) at the end of adolescence.

Conclusion—These analyses suggest that lean red meat may be included in a healthy adolescent diet without unfavorable effects on lipid values.

Keywords

Lipids; adolescence; healthy eating; epidemiology; eating patterns

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Introduction

Sub-optimal lipid profiles characterized by higher low-density lipoprotein cholesterol (LDL-C) and triglyceride levels and lower high-density lipoprotein cholesterol (HDL-C) levels have long been associated with increased coronary heart disease (National Cholesterol Education Program, 2001). **In more recent years, non-high density lipoprotein (non-HDL-C) has emerged as a particularly useful predictor of cardiovascular disease risk** (Frontini et al., 2008; Blaha, Blumenthal, Brinton, & Jacobson, 2008). A number of epidemiologic studies have suggested that red meat consumption increases the risk of cardiovascular disease and diabetes (Hu et al., 2000; Fung, Schulze, Manson, Willett, & Hu, 2004). Avoidance of red meat as a component of the “Western dietary pattern” has become incorporated into dietary guidelines (Lichtenstein et al., 2006). **The potentially harmful effect of dietary fat and saturated fat in particular on LDL-C levels** has weighed strongly in nutritional policy in recent decades **although the possible role of selected saturated fatty acids in raising HDL-C has been recognized as well** (Astrup et al., 2011).

Data linking red meat consumption with cardiovascular risk are inconsistent, which may be due in part to methodological differences between studies (McAfee et al., 2010). Some studies, for instance, have failed to distinguish between the effects of meats with varying fat contents. Due to changes in food processing technologies and animal husbandry, various forms of lean red meat are far more available today than **a few decades ago when fat marbling in beef was considered desirable for taste enhancement** (McNeill, Harris, Field, & Van Elswyk, 2012). Given its significance as a rich source of protein and other essential nutrients such as iron, zinc, selenium and vitamin B12 (Cotton, Subar, Friday, & Cook, 2004), it is important to examine the differential health effects of red meat of dissimilar fat contents and when consumed as a part of diverse dietary patterns.

While some recent studies of adults have attempted to delineate the independent effects of different types of red meat on health outcomes as well as its effects in the context of a healthier dietary pattern (Li, Siriamornpun, Wahlqvist, Mann, & Sinclair, 2005; Luciano, 2009), few such data exist for children and adolescents. In the current study, daily intakes of fruit and non-starchy vegetables **(excluding, for example, French fries, potato chips and corn)** will be used as a marker of a healthier dietary pattern. Overall, these analyses focus on the effects of lean red meat consumed alone and in combination with higher amounts of fruit and non-starchy vegetables on lipid levels in older adolescent girls.

Materials and Methods

The current analyses were approved by the Boston University Institutional Review Board and used data from the National Heart, Lung and Blood Institute's Growth and Health Study (NGHS) a longitudinal study of bi-racial differences in the development of obesity and other cardiometabolic outcomes in girls initially 9-10 years of age. **2,379 girls were recruited by three clinical centers: University of California at Berkeley, University of Cincinnati/Cincinnati Children's Hospital Medical Center, and Westat, Inc./Group Health Association in Rockville, MD**.

Approximately equal numbers of black and white girls were enrolled in the study. Subjects were followed annually for 10 years and provided data through 19-20 years of age. Details of the study design and methods have been previously published (Obarzanek et al., 1994; NHLBI Growth and Health Study Research Group, 1992). For the current analyses, 1,461 girls with complete data over 10 years on diet, fasting lipid levels and all potential confounders of interest were included.

Dietary Intake

Dietary intake in NGHS was assessed using 3-day diet records (two weekdays, one week-end day) during eight of the 10 study years (exam years 1-5, 7, 8, and 10). A study nutritionist instructed all girls in the completion of the diet records including proper estimation of portion sizes and collection of information on recipes, brands and other details (from a parent or other caregiver). Standardized debriefing was carried out in person by a trained nutritionist. Dietary data were entered into the Nutrition Data System (NDS) nutrient analysis program using standardized entry protocols and stringent quality control measures (Schakel, Sievert, & Buzzard, 1988). Food Pyramid servings were calculated for the diet records by linking NDS food codes with those in the USDA's “Pyramid Serving Database for USDA Survey Food Codes, Version 2” (Cook & Friday, 2004).

Servings of food groups (as defined by the USDA Dietary Guidelines), including red meat and beef have been derived from these diet records by linking NDS output with USDA food composition data. All servings in the USDA meat group are expressed as one-ounce equivalents consumed per week. **Servings of lean (≥ 85% lean) red meat and beef represented the exposure variable in these analyses**.

Lipids

Mean values of serum lipid profile indices from exam year 10 served as the primary outcome measures for these analyses. Fasting blood specimens were collected in the morning and sent to a central lipid laboratory for analysis (Johns Hopkins Department of Lipid Research laboratory that is a part in the CDC's Lipid Standardization Program) (Myers, Cooper, Winn, & Smith, 1989). The Cholesterol CHOD-PAP method was used to determine Total Cholesterol (TC) and HDL-C (Boehringer-Mannheim Diagnostics); triglycerides were ascertained enzymatically (Abbott A-Gent Triglycerides Reagent Set). LDL-C was calculated using a modified Friedewald equation (Friedewald, Levy, & Fredrickson, 1972) based on Lipid Research Clinic data, as follows: [LDL-C] = [total cholesterol (TC)] – [HDL-C] – [triglycerides/6.5] (DeLong, DeLong, Wood, Lippel, & Rifkind, 1986). Non-HDL-C was estimated as the difference between TC and HDL-C. **Secondary outcomes for these analyses included the risk of “abnormal” lipid levels at exam year 10 (as described in the analysis section)**.

Potential Confounders

The following potential confounding factors were included in the final models: age at time of lipid measurement, race, socio-economic status (SES), mean height, mean physical activity level, hours of television/video watching per day, and markers of a healthy diet pattern (e.g., total dairy, fruit, vegetables, grains). Race was self-described as black or white;

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approximately equal numbers of each racial group were selected for enrollment. SES was classified as low, moderate or high based on data from household **annual** income and education level. High SES required an income of $40,000 or more and more than a high school education. The low SES category included all subjects with an income of < $10,000 (regardless of education) and those earning up to $20,000 but having high school education or less. All others fell into the moderate SES category.

Physical activity was assessed by using a Health Activity Questionnaire (HAQ), a validated instrument that was used to measure participation in structured games, sports and classes (except those performed in school-based physical education) (Kimm et al., 2000). Activity data were collected at visits 1, 3, 5 and 7-10. At the annual examination visit, girls were asked about weekly participation in each activity as well as the fraction of the year during which it was performed. The HAQ score was computed by multiplying an estimate of the metabolic equivalent (MET) levels **which measure the energy expenditure** for each activity by the frequency of participation (Ridley & Olds, 2008). Time spent watching television/videos was assessed by asking the usual number hours watched in a typical week.

Statistical Analysis

Mean dietary intake during early to mid-adolescence (ages 9-17 years) was used to estimate usual intake of lean red meat. **Two** categories of lean red meat intake were **used**: (1) ≥85% lean red meat (i.e., beef, lamb, pork, veal, or venison) and (2) ≥85% lean beef. **Both** red meat categor**ies were** then classified according to the amount consumed. **Multivariable modeling to adjust for possible confounding by the previously described factors was carried out using analysis of covariance**.

Consumption of lean red meat in the context of a healthy diet was defined based on the combined intakes of lean red meat (or beef) plus fruit and non-starchy vegetables. Each girl's eating pattern was classified as follows: (a) low intakes in both food groups (lean red meat / fruit and non-starchy vegetables), (b) high intakes in both food groups, or (c) high intakes in only one of the two food groups. **High vs. low intakes were defined as follows: lean red meat, ≥6 vs. <6 oz/wk; lean beef, ≥3 vs. <3 oz/wk; fruit & non-starchy vegetables, ≥ 2 vs. <2 servings day**. Adjusted means for each lipid outcome in the above categories of intake were estimated using **analysis of covariance modeling**.

In additional analyses, lipid levels at the end of follow up (18-20 years) were dichotomized using previously-identified or recommended cutpoints to classify girls as being at higher risk or not. Specifically, a LDL-C level ≥110 mg/dL were considered “high risk” based on the NCEP classification of “borderline high” levels for children and adolescents (1992). Our cutpoint of < 50 mg/dL for HDL-C in this all-female population was selected from the International Diabetes Federation guidelines for late adolescent girls (Zimmet et al., 2007). The cutpoint for the LDL-C:HDL-C ratio (≥2.2) was derived by dividing the cutpoint for high LDL-C by the cutpoint for low HDL-C. For non-HDL-C, we defined higher risk as ≥145 mg/dL since this level has been associated with higher risk of metabolic syndrome amongst adolescents (Li et al., 2011). Similarly, a cutpoint of ≥110 mg/dL for triglycerides has also been associated with metabolic syndrome in adolescents (Cook, Weitzman, Auinger, Nguyen, & Dietz, 2003). Multiple logistic regression analyses were used to estimate the adjusted relative risk (RR) of being in one of the “higher risk” lipid groups. All analyses were performed using SAS, version 9.2 (SAS Institute, Cary, NC, USA).

Results

Table 1 shows the characteristics of the girls according to their usual intake of lean red meat between 9 and 17 years of age. Girls who consumed more lean red meat per week also took in more total calories. Their diets were characterized not only by higher intakes of protein but also by higher intakes of dietary fats **and lower intakes total carbohydrates and fiber**.

In Table 2, girls were classified according to their combined intakes of lean red meat and fruits and non-starchy vegetables; characteristics of the girls in each of these intake groups are shown. **A greater proportion of girls with a diet pattern consisting of low intakes of red meat and high intakes of fruits and vegetables were white and had a higher SES level. This pattern was associated with higher intakes of carbohydrates and fiber as well as the lowest percent of calories from fat and saturated fat. These girls were also the most active, watched the fewest of hours of television per day, and had a lower BMI. However, the diet pattern consisting of higher intakes of both red meat and fruits and vegetables was also associated with a lower baseline BMI and higher activity levels. Both diet patterns with low fruit and vegetable intakes were linked with a higher baseline BMI, lower activity levels, more hours of television per day, lower intakes of fiber, higher intakes of fat and saturated fat, and a higher percent of calories from solid fat and added sugars**.

Table 3 examines the association between **the mean** consumption of lean red meat or lean beef **over ages 9-17** and mean levels of HDL, non-HDL cholesterol, LDL, the LDL:HDL ratio, and the log of serum triglycerides at the end of adolescence. While there is no suggestion of an adverse effect of lean red meat consumption on lipid outcomes, there is also no statistically-significant beneficial effect either.

Table 4 explores the combined effects of lean red meat intake in conjunction with fruit and non-starchy vegetable intakes. Girls consuming higher amounts of fruit and non-starchy vegetables had LDL (and non-HDL-C) levels that were 6-7 mg/dL lower than those of girls in the referent group (low red meat/low fruit and non-starchy vegetable intakes). Consuming higher amounts of lean red meat had no adverse effect on lipid levels, particularly when eaten as a part of a dietary pattern, characterized by higher intakes of fruits and non-starchy vegetables. Girls with higher intakes of both lean red meat and fruit/non-starchy vegetables had slightly higher HDL levels as well as the lowest LDL:HDL ratio. The results for ***higher*** combined intakes of lean beef and fruit/non-starchy vegetables ***on LDL, the LDL:HDL ratio, and serum triglycerides*** differed little from those for ***higher intakes of*** lean red meat ***alone***. Table 4 shows there was no positive or negative modification of the effects of fruit/non-starchy vegetables by lean red meat on lipid levels.

Table 5 shows the results of the multiple logistic regression analyses examining the effects of these eating patterns on the risk of “abnormal” lipid levels. After adjusting for age, race, SES, height, physical activity level, television viewing hours, and the intakes of dairy and whole grains as markers of a healthy diet, girls with higher intakes of fruit/non-starchy vegetables, **regardless of the level of intake of red meat**, had lower risks of a high LDL-C level (≥110 mg/dL). **There was no adverse effect of higher intakes of lean red meat on lipid levels and when the diet also included higher intakes of fruit and non-starchy vegetables, the risk of lipid abnormalities was even lower. Higher intakes of lean red meat and fruit and non-starchy vegetables were both associated with marked reductions in risk of elevated triglyceride levels.** ***There was no evidence of effect modification*****. This risk reduction was not affected by inclusion of carbohydrates (as a percent of calories) in the multivariable model (results not shown)**. Table 5 **also shows the results for dietary patterns including lean beef instead of red meat. These results in general were very similar although slightly attenuated in some cases and strengthened in others**.

Discussion

This study confirms that higher intakes of fruit and non-starchy vegetables are associated with a more favorable lipid profile than relatively lower intakes. In addition, **diets that included higher intakes of lean red meat in combination with higher intakes of** fruits and non-starchy vegetables were also associated with a more favorable lipid profile as well as a lower risk of having abnormal lipid levels by the end of adolescence. **Fruit and non-starchy vegetable consumption had a particularly beneficial effect on LDL-C while girls whose diets were higher in both red meat and fruits and non-starchy vegetables had higher HDL levels and a slightly lower risk of an abnormal LDL:HDL ratio. Finally, consumption of lean red meat was associated with lower triglyceride levels, regardless of fruit and vegetable intakes.** To the best of our knowledge, this is the first published study to specifically examine the effects of lean red meat consumption on lipid levels amongst adolescents.

In adults, several epidemiologic studies have found positive associations between red meat intake and cardiovascular disease. In the Nurses' Health Study, a prospective cohort study with 26 years of follow-up, higher red meat intakes were associated with increased rates of coronary heart disease (Bernstein et al., 2010). Similarly, data from the Physician's Health Study suggested that red meat consumption was associated with an increased risk of heart failure. Neither of these studies, however, were able to separate the effects of lean from non-lean cuts of meat and neither examined these effects in the context of the overall dietary pattern (e.g., fruit and vegetable intakes) (Ashaye, Gaziano, & Djousse, 2011). The time periods in which the data for these studies were collected makes it likely that the majority of red meat consumed was of a higher-fat type. Other studies have identified the importance of separating processed from non-processed meat. A recent review and meta-analysis, for example, concluded that intake of processed meat rather than red meat *per se* was associated with increased risks of CHD (Micha, Wallace, & Mozaffarian, 2010). In this study, we have focused on the effects of lean, non-processed red meat.

The majority of earlier studies examined the effects of red meat intake as a part of an overall dietary pattern. For example, cardiovascular risk factors such as body weight, blood pressure and lipid levels have been frequently found to be lower in vegetarians than meat eaters.

However, the term "vegetarian" is quite broad and, in addition, dietary factors other than meat avoidance (e.g., substitution of foods with health-promoting capacities) may underlie some of the apparent benefits of vegetarianism (Fraser, 2009). The effect of concomitant healthy lifestyle factors such as increased physical activity and decreased smoking must also be considered as potential explanations for these results.

Red meat is also often assessed as a part of a "Western pattern" of diet (typified by higher intakes of red meat, processed meat, refined grains, sweets, French fries, and high-fat dairy). Such a diet has been related to higher risk of CHD (Hu et al., 2000) and CVD (Panagiotakos et al., 2009) in adults. One comparable study amongst Australian adolescents found that a "Western" dietary pattern (as compared with a "Healthy" one) was associated with higher total cholesterol and BMI levels, particularly amongst girls (Ambrosini et al., 2010).

Clinical trial data on red meat consumption and lipid levels are limited to studies amongst hypercholesterolemic adults. These studies do provide some very indirect support for the current results in that they demonstrate that lean red meat consumption as a part of a heart healthy diet in hypercholesterolemic adults has benefits virtually identical to that of lean white meats (Davidson, Hunninghake, Maki, Kwiterovich, Jr., & Kafonek, 1999) and equivalent to consumption of both lean fish and poultry (Beauchesne-Rondeau, Gascon, Bergeron, & Jacques, 2003) . Evidence from the BOLD (Beef in an Optimal Lean Diet) study also showed that adding lean beef to a DASH dietary pattern (when the saturated fat content is held constant) had beneficial effects on lipoprotein risk factors that were comparable to the DASH diet without the addition of more lean beef (Roussell et al., 2012) .

No such clinical trials have been carried out amongst free-living adolescents. Further, there is very little direct evidence in adolescents of the effects of lean red meat in combination with a diet high in fruit and vegetable intakes on lipid levels. The current study emphasizes the limitations associated with drawing conclusions about the health effects of red meat *per se* from studies of a "Western" diet pattern. Such studies do, however, help to generate hypotheses for future studies.

An important strength of the current study is its prospective design and the precision of the estimates of dietary intake. Multiple sets of diet records were used to determine usual adolescent intake, thereby increasing our ability to identify true effects of eating patterns on lipid levels. On the other hand, this study is subject to at least one limitation that is common to epidemiological studies of dietary exposures. The dietary data on which the study is based were derived from self-report and are thus subject to error in terms of potential misreporting. Additionally, the study is limited by the fact that only one measure of lipids was available from the last three years of the study. Repeated measures in the final stages of the study might have enhanced the identification of those girls with high-risk lipid profiles.

Conclusions

Foods in the USDA "meat" group, including red meat, are important sources of protein and other essential nutrients for children and adolescents as well as adults. Concerns about harmful effects of red meat on lipid levels are cited by some as a reason to avoid its consumption. The results of this study suggest that lean red meat may be safely included as a part of a healthy diet during adolescence without fear of adverse effects on lipid levels.

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Table 1
Characteristics of girls according to servings of ≥ 85% lean red meat

	Weekly servings of ≥ 85% lean red meat*			
	<3 n=617	**3-<6 n=404**	**≥6 n=440**	**P value**
Baseline characteristics		*(mean ± s.d.)*		
Age (yrs)	10.0 ± 0.6	10.0 ± 0.5	10.0 ± 0.6	*0.3460*
Height (cm)	141.5 ± 7.9	141.3 ± 7.4	141.5 ± 8.2	*0.8867*
BMI (kg/m)^2	18.6 ± 4.0	18.6 ± 3.6	18.7 ± 4.0	*0.9361*
Activity Score (METS)*,†	20.3 ± 10.1	19.5 ± 10.0	19.2 ± 9.6	*0.1872*
TV/Video (hrs/day)*	4.4 ± 2.2	4.6 ± 2.0	4.9 ± 2.1	*0.0004*
Macronutrient intakes*				
Energy (kilocalories/day)	1830.5 ± 352.7	1870.3 ± 349.6	1989.3 ± 394.7	*<.0001*
% of calories from protein	13.5 ± 1.9	14.1 ± 1.6	14.9 ± 1.7	*<.0001*
% of calories from carb	52.9 ± 5.1	51.7 ± 4.5	50.0 ± 4.4	*<.0001*
% calories from fat	34.7 ± 4.2	35.2 ± 3.8	36.0 ± 3.7	*<.0001*
% calories from sat fat	12.7 ± 1.8	12.9 ± 1.6	13.1 ± 1.6	*0.0024*
Fiber/1000 kilocalories	6.3 ± 1.5	6.1 ± 1.2	6.0 ± 1.3	*0.0034*
Kcal from solid fat, added sugar	772.1 ± 210.7	782.5 ± 190.9	817.9 ± 200.2	*0.0011*
% of calories from solid fat, added sugar	41.9 ± 6.0	41.6 ± 4.7	41.0 ± 4.7	*0.0259*
Race		*(column percent)*		
White (%)	49.6%	48.8%	39.8%	*0.0037*
Black (%)	50.4%	51.2%	60.2%	
Socio-economic status				
Low (%)	19.6%	20.5%	25.9%	
Mid (%)	41.2%	45.8%	40.7%	*0.0088*
High (%)	39.2%	33.7%	33.4%	

Red meat includes beef, pork, lamb, veal, and venison.

*Mean values from ages 9-17 years

†METS = Metabolic Equivalent Score

Table 2

Characteristics of girls according to patterns of ≥ 85% lean red meat and fruits and non-starchy vegetable intake

	Combined intakes of ≥ 85% lean red meat and fruits and non-starchy vegetables				
	Low / Low n=469	**Low / High n=552**	**High / Low n=175**	**High / High n=265**	**P value**
Subject characteristics		*(mean ± s.d.)*			
Baseline age (yrs)	10.0 ± 0.5	10.0 ± 0.6	10.0 ± 0.6	10.1 ± 0.6	*0.2839*
Baseline height (cm)	141.3 ± 7.6	141.6 ± 7.7	141.0 ± 8.1	141.8 ± 8.2	*0.6862*
Baseline BMI (kg/m)^2	19.0 ± 4.0	18.3 ± 3.6	19.0 ± 3.9	18.5 ± 4.0	*0.0188*
Activity Score (METS)[*, †]	18.1 ± 9.1	21.5 ± 10.6	18.4 ± 9.3	19.7 ± 9.8	*<.0001*
TV/Video (hrs/day)[*]	5.0 ± 2.0	4.1 ± 2.2	5.1 ± 1.9	4.8 ± 2.1	*<.0001*
Macronutrient intakes[*]					
Energy (kilocalories/day)	1769.0 ± 333.8	1911.9 ± 353.7	1822.8 ± 347.1	2099.3 ± 386.3	*<.0001*
% of calories from protein	13.7 ± 1.9	13.8 ± 1.8	15.1 ± 1.6	14.8 ± 1.8	*<.0001*
% of calories from carb	50.9 ± 4.7	53.7 ± 4.7	48.8 ± 4.1	50.7 ± 4.5	*<.0001*
% calories from fat	36.2 ± 3.8	33.8 ± 4.0	36.8 ± 3.4	35.5 ± 3.8	*<.0001*
% calories from sat fat	13.4 ± 1.6	12.4 ± 1.7	13.5 ± 1.5	12.8 ± 1.6	*<.0001*
Fiber/1000 kilocalories	5.5 ± 1.0	6.8 ± 1.4	5.5 ± 1.1	6.3 ± 1.3	*<.0001*
Kcal from solid fat, added sugar	776.5 ± 188.9	775.9 ± 214.5	773.6 ± 175.4	847.2 ± 210.3	*<.0001*
% of calories from solid fat, added sugar	43.6 ± 4.8	40.2 ± 5.6	42.3 ± 4.2	40.1 ± 4.8	*<.0001*
Race		*(column percent)*			
White (%)	41.6%	55.8%	40.0%	39.6%	*<.0001*
Black (%)	58.4%	44.2%	60.0%	60.4%	
Socio-economic status					
Low (%)	30.3%	11.2%	29.1%	23.8%	
Mid (%)	45.0%	41.3%	46.3%	37.0%	*0.0289*
High (%)	24.7%	47.5%	24.6%	39.3%	

Red meat includes beef, pork, lamb, veal, and venison.

High vs low intakes: lean red meat, ≥6 vs <6 oz/wk; fruits & non-starchy vegetables, ≥ 2 vs <2 servings/day.

[*] Mean values from ages 9-17 years

†METS = Metabolic Equivalent Score

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Table 3

Lean red meat intakes and mean lipids levels at 18-20 years of age

Lean Red Meat (oz./wk, ages 9-17)	N	HDL(mg/dL)	Non-HDL (mg/dL)	LDL (mg/dL)	LDL/HDL	TG (log) (mg/dL)
			(adjusted means* ± s.e.)			
≥ 85% lean red meat						
<3	617	53.6 ± 0.48	111.3 ± 1.27	98.8 ± 1.18	1.95 ± 0.03	4.31 ± 0.02
3-<6	404	53.1 ± 0.59	110.9 ± 1.57	98.2 ± 1.45	1.96 ± 0.04	4.31 ± 0.02
≥6	440	54.2 ± 0.57	109.7 ± 1.51	97.7 ± 1.40	1.90 ± 0.04	4.26 ± 0.02
p for trend		*0.5039*	*0.4208*	*0.5371*	*0.4316*	*0.0813*
≥ 85% lean beef						
0-<0.5	475	54.1 ± 0.55	111.2 ± 1.46	98.8 ± 1.35	1.92 ± 0.04	4.30 ± 0.02
0.5-<3	565	53.1 ± 0.50	110.6 ± 1.33	98.1 ± 1.23	1.95 ± 0.03	4.30 ± 0.02
≥3	421	53.9 ± 0.58	110.3 ± 1.54	98.1 ± 1.43	1.93 ± 0.04	4.28 ± 0.02
p for trend		*0.7742*	*0.6920*	*0.7472*	*0.8591*	*0.3234*

*Adjusted for race, SES, age, height, activity score, TV/video watching, intake of dairy, fruits & non-starchy vegetables, and whole grains.

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Table 4

Mean lipid levels at 18-20 years of age associated with combined intakes of ≥ 85% lean red meat and fruits and non-starchy vegetables

		Lipid Levels at 18-20 Years of Age									
Eating Pattern (ages 9-17 yrs)	**N**	**HDL(mg/dL)**		**Non-HDL (mg/dL)**		**LDL (mg/dL)**		**LDL/HDL**		**TG (log) (mg/dL)**	
		(adj. means* ± s.e.)									
≥ 85% lean red meat / fruits & non-starchy vegetables											
			p-value		*p-value*		*p-value*		*p-value*		*p-value*
Low / Low	469	53.1 ± 0.6	-	115.0 ± 1.5	-	102.1 ± 1.4	-	2.03 ± 0.04	-	4.34 ± 0.02	-
Low / High	552	53.7 ± 0.5	*0.4481*	108.0 ± 1.4	*0.0007*	95.7 ± 1.3	*0.0009*	1.89 ± 0.03	*0.0068*	4.29 ± 0.02	*0.0874*
High / Low	175	53.6 ± 0.9	*0.6268*	111.0 ± 2.4	*0.1423*	98.9 ± 2.2	*0.2161*	1.97 ± 0.06	*0.4252*	4.25 ± 0.03	*0.0139*
High / High	265	54.6 ± 0.7	*0.1023*	108.5 ± 1.9	*0.0072*	96.4 ± 1.8	*0.0120*	1.85 ± 0.05	*0.0031*	4.27 ± 0.02	*0.0361*
≥ 85% lean beef / fruits & non-starchy vegetables											
			p-value		*p-value*		*p-value*		*p-value*		*p-value*
Low / Low	481	53.1 ± 0.6	-	115.0 ± 1.5	-	102.1 ± 1.4	-	2.02 ± 0.04	-	4.33 ± 0.02	-
Low / High	559	53.9 ± 0.5	*0.3264*	107.6 ± 1.4	*0.0003*	95.4 ± 1.3	*0.0004*	1.87 ± 0.03	*0.0021*	4.28 ± 0.02	*0.0590*
High / Low	163	53.5 ± 0.9	*0.7363*	110.8 ± 2.5	*0.1448*	98.9 ± 2.3	*0.2224*	1.98 ± 0.06	*0.5321*	4.26 ± 0.03	*0.0415*
High / High	258	54.2 ± 0.7	*0.2369*	109.5 ± 2.0	*0.0271*	97.2 ± 1.8	*0.0339*	1.89 ± 0.05	*0.0257*	4.29 ± 0.03	*0.1645*

High vs low intakes: lean red meat, ≥6 vs <6 oz/wk; lean beef, ≥3 vs <3 oz/wk; fruits & non-starchy vegetables, ≥ 2 vs <2 servings/day.

* Adjusted for race, SES, age, height, activity score, TV/video watching, and intake of dairy and whole grains.

Table 5

Effect of eating patterns on higher risk lipid levels in late adolescent girls

	Higher Risk Lipid Values at Ages 18-20 Years														
	HDL < 50			Non-HDL-C ≥ 145			LDL ≥ 110			LDL:HDL ≥ 2.2			Triglycerides ≥ 110		
Eating Pattern (9-17 yrs)	**Cases**	**RR***	**95% CI**	**Cases**	**RR***	**95% CI**	**Cases**	**RR***	**95% CI**	**Cases**	**RR***	**95% CI**	**Cases**	**RR***	**95% CI**
≥ 85% lean red meat / fruits & non-starchy vegetables															
Low / Low	203	1.00	-	77	1.00	-	172	1.00	-	167	1.00	-	98	1.00	-
Low / High	217	0.84	(0.65, 1.10)	64	0.62	(0.42, 0.90)	149	0.62	(0.47, 0.82)	150	0.64	(0.48, 0.84)	91	0.63	(0.45, 0.89)
High / Low	76	1.01	(0.71, 1.43)	23	0.78	(0.47, 1.30)	58	0.86	(0.60, 1.24)	62	1.00	(0.69, 1.44)	22	0.55	(0.33, 0.91)
High / High	88	0.67	(0.48, 0.92)	33	0.71	(0.45, 1.10)	76	0.67	(0.48, 0.94)	67	0.59	(0.42, 0.83)	43	0.76	(0.50, 1.14)
≥ 85% lean beef / fruits & non-starchy vegetables															
Low / Low	211	1.00	-	83	1.00	-	172	1.00	-	175	1.00	-	98	1.00	-
Low / High	212	0.77	(0.59, 1.00)	60	0.54	(0.37, 0.78)	148	0.63	(0.48, 0.83)	144	0.58	(0.44, 0.76)	86	0.61	(0.43, 0.86)
High / Low	68	0.90	(0.63, 1.30)	17	0.54	(0.31, 0.95)	58	0.99	(0.68, 1.43)	54	0.86	(0.59, 1.25)	22	0.54	(0.32, 0.91)
High / High	93	0.72	(0.53, 1.00)	37	0.75	(0.48, 1.15)	77	0.72	(0.52, 1.01)	73	0.65	(0.46, 0.91)	48	0.81	(0.54, 1.22)

High vs low intakes: lean red meat, ≥ 6 vs <6 oz/wk; lean beef, ≥3 vs <3 oz/wk; fruit & non-starchy vegetables, ≥ 2 vs <2 servings/day.

*Adjusted for race, SES, age, height, activity score, TV/video watching, and intake of dairy and whole grains.