적색육과 가공육 섭취와 대장암 간의 상관관계에 대한 젠더적 측면: 체계적 문헌고찰과 메타분석

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Gender Perspectives on the Relationship between Red and Processed Meat Intake and Colorectal Cancer: A Systematic Review and Meta-Analysis

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Background: Men and women choose different food items, and consume different amounts of food, due to biological, cultural, and social differences. However, when dietary assessment instruments are developed, gender differences in food selection and/or the portion sizes are often not considered.
Methods: Prospective cohort studies with men and women that examined the association between red or processed meat intake and colorectal cancer and published up to July 2017, were identified using PubMed. Studies were categorized as gender-specific (GS) group if the Food Frequency Questionnaire was developed using gender-specific data, and as not gender-specific (NGS) group if not gender-specific data were used.
Results: For cohort studies that reported combined intake estimates of men and women, a 100 g/day increment in red and processed meat intake was positively associated with a risk of colorectal or colon cancer in GS group (relative risk [RR], 1.23; 95% confidence interval [CI], 1.14-1.32) but not in NGS group (RR, 1.13; 95% CI, 0.90-1.35). For processed meat, the RR for 50 g/day increase was 1.28 (95% CI, 1.15-1.40) in GS group and 1.15 (95% CI, 1.03-1.27) in NGS group.
Conclusions: Gender differences need to be considered during development of dietary assessment tools because this may improve the quality of the findings of nutritional epidemiological studies.
Korean J Health Promot 2018;18(3):127-137

Keywords: Gender, Red meat, Processed meat, Colorectal neoplasms, Surveys and questionnaires

Introduction

According to the World Health Organization (WHO), gender refers to "the socially constructed roles, behaviours, activities and attributes that a given society considers appropriate for men and women".[1] Gender is a fundamental variable that should be considered in health-related research due to the importance of biological, physiological, and social

characteristics that can influence the identification of factors related to the development of diseases. Furthermore, gender differences in health-related research should merit serious consideration when determining risk factors for chronic diseases and planning public health interventions.

It has been suggested that 'Gendered Innovations' can promote excellence in science by incorporating gender into all stages of research;[2] in this regard, nutritional epidemiological research is not an exception. It has been shown that food choices,[3,4] compliance to dietary guidelines, food and nutrition knowledge, dietary beliefs, and food preferences[5] and taste preferences[6] differ according to gender. Similarly, biological and physiological gender differences in the digestion and metabolism of foods should be accounted for when conducting nutrition research.[7-9] In general, gender should be considered during all stages of research, from inception to application. Thus, the present review examines whether gender was considered during the development of dietary assessment tools, which is one of the initial steps of nutritional epidemiological research.[10]

Nutritional epidemiological studies investigating chronic diseases focus on long-term dietary intake because chronic diseases develop over a prolonged period of time. Food Frequency Questionnaires (FFQs) are often used to assess long-term exposure to foods and nutrients, both in individuals and in groups. FFQs are structured questionnaires with which to collect information regarding the estimated frequency of consumption of food items during a pre-specified period, as well as the quantity of intake on each occasion (i.e., portion size). Portion size information obtained with an FFQ can be combined with frequency information to calculate the usual consumption of a variety of foods and beverages. Because the food item list and portion size options are two key elements in an FFQ, it is necessary that these elements are based on a study of the target population. To qualify, a food item must be consumed regularly, substantially contribute to the key nutrients of interest, and explain between-person variation.[11] Given that the development of accurate measurements of habitual dietary intake is one of the most challenging aspects of nutritional epidemiological research, FFQs are of critical importance because well-designed food questionnaires can improve the validity and precision of dietary measurements. Although food preferences and portion sizes vary by gender, our previous study showed only 10.7% of FFQs in the literature consid-

ered gender during development process, and can be classified as gender-specific (GS) FFQs are often developed for use with both men and women, or are developed for one gender but applied to the other without any adjustments.[10] Analysis of validation studies of FFQs in the literature, GS FFQs seem to have less bias in estimation of dietary intakes of men and women compared to not gender-specific (NGS) FFQs.[10] However, it is not known whether gender consideration in FFQ development affect diet-disease associations.

Therefore, the present review explored whether previous studies conducted to determine the association between red and processed meat intake and colorectal cancer differed by using FFQs developed with or without gender considerations (GS FFQs or NGS FFQs). For this review, cohort studies in men and women that examined the association between red and processed meat intake and colorectal cancer risk, which is a widely accepted relationship,[12] were included. The results of these studies were assessed by meta-analysis in terms of any considerations made towards gender during the development of the FFQs.

Methods

1. Identification of studies

The PubMed database was searched to identify prospective cohort studies, published up until May 2018, using the following search terms: (((((colorectal OR colon OR rectal)) AND cancer) AND (cohort OR prospective)) AND (food OR diet OR meat)) AND (relative risk OR hazard ratio OR odds ratio). The search was limited to studies published in English; abstracts and unpublished results were not included, and the reference lists of all articles included in the present analysis were reviewed for additional relevant studies. Two researchers independently completed the same procedure using the Meta-Analysis of Observational Studies in Epidemiology (MOOSE) checklist.[13] Studies that met the following criteria were included in the analysis: 1) use of a cohort study design with men and women; 2) provision of relative risk (RR) estimates and 95% confidence intervals (CIs), allowing evaluation of the association between red or processed meat intake and colorectal cancer; and 3) outcomes of interest that included either the overall incidence rate of colorectal cancer or those of the two main anatomical subtypes, colon cancer and rectal cancer. Inclusion in the

dose-response meta-analysis required that the following information also be present: RRs, 95% CIs, category-specific numbers of cases, and category-specific person-years (or number of subjects). When there were duplicate publications from the same cohort, the publication that had a greater number of cases was included. Studies in which colorectal cancer mortality was the endpoint were excluded because mortality involves both incidence and survival; studies assessing colorectal adenoma or tumors other than cancer were also excluded.

The meta-analysis results for red meat and processed meat are presented both in combination and separately. Detailed descriptions of the meat items included in the articles were assessed; the foods were then reclassified because red meat items, including processed meat items classified as red meat, were observed in several of the studies. Thus, in the present analysis, red meat items, including processed meat items, were regrouped as 'red and processed meat'.

2. Definition of gender-specificity during FFQ development

Gender-specificity in the cohort studies was defined using the following procedure: 1) the developmental phase of each FFQ was examined; 2) the FFQs were classified as GS if gender was considered during the selection of food items, portion sizes, or both; all remaining FFQs were defined as NGS; and 3) the studies were classified as GS if a GS FFQ was used to collect food intake data, and as NGS studies if an NGS FFQ was used; only one GS study determined portion sizes for each food item using dietary records collected separately for men and women.[14]

3. Data extraction

The following information was extracted from each study: the first author's surname, publication year, study period, participants' age and sex, endpoint, RRs, exposure assessment (where available), number of cases, person-years for each category of red meat or processed meat intake, and covariates adjusted for in the analysis. When several estimates were reported, those adjusted for by the greatest number of covariates were used. Any disagreements were resolved through consensus.

4. Statistical analysis

Study-specific multivariate RRs and 95% CI were combined to compare the highest and lowest categories of red and processed meat intake, using a random-effects model that considered both within- and between-study variation.[15] Heterogeneity among the studies was evaluated using Q and I2 statistics and a weight was allotted to each study based on the inverse variance. The pooled RRs were calculated for men and women combined, and for men and women separately. For the estimates of men and women combined, the reported RRs were used when a study reported results for men and women combined; the pooled RRs were derived with a fixed-effects model when a study reported the results according to gender.

In the dose-response meta-analyses, the RR estimates were pooled, or computed from the categorical data using a generalized least-squares for trend estimation.[16] When intake was reported in terms of the "serving" or "time", the values were converted into grams (g) using 120 g as a standard portion size for red meat and 50 g as a standard portion size for processed meat. The RRs from the dose-response analysis are presented by increments of intake; i.e., 100 g/day for red and processed meat and red meat and 50 g/day for processed meat. In the dose-response analysis, the means or medians of the intake categories, if reported, were used; otherwise, the midpoints were used. Zero consumption was used as a boundary when the lowest category was open-ended, while the range of the lower nearest category was used when the highest category was open-ended. For any study presenting intakes as g/1,000 kcal/day, the intake in g/day was estimated using the average energy intake reported in that study. When a study provided results for both distal and proximal colon cancer, the estimates were pooled using a fixed-effects model and then the pooled value was included in the meta-analysis.

All analyses were performed using Stata software (ver. 10.1; StataCorp., College Station, TX, USA) and P values <0.05 were considered to indicate statistical significance.
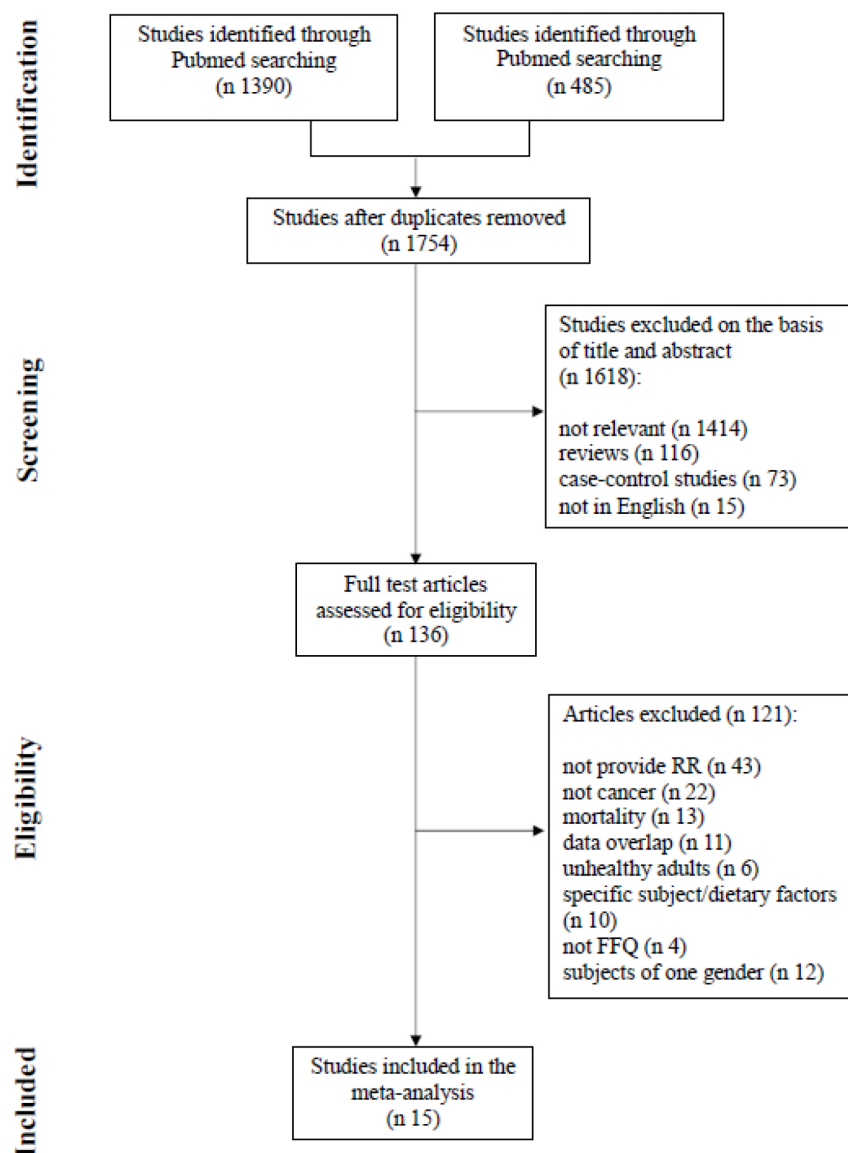
Results

In total, 1,390 articles meeting the study criteria and published up to May 2018 were identified by searching PubMed; an additional 485 articles were retrieved from

other sources (Figure 1). After removing duplicates, 1,618 articles were excluded based on the title and abstract. Of the remaining 136 articles that examined red or processed meat intake and colorectal cancer risk, 121 were excluded for the following reasons: did not provide RRs (n=43), outcome other than cancer (n=22), mortality (n=13), data overlap (n=11), inclusion of unhealthy adults (n=6), overly specific subjects or dietary factors (n=10), dietary assessment done using an instrument other than an FFQ (n=4), and included subjects of one gender only (n=12). Ultimately,

15 articles based on 14 cohort studies were included in the meta-analysis.

The study characteristics, including cohort name, ethnicity, baseline population, age, study period, number of cases, and meat categories, are presented in Table 1. All studies used an FFQ, diet questionnaire, or structured questionnaire to measure meat intake. A total of six articles based on six different prospective studies were included in the GS group, and nine articles based on eight different prospective studies were included in the NGS group. Four of

Figure 1. Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flowchart. Screening and selection of studies analysing the association between meat (red and processed/red/processed) intake and Colorectal cancer risk.

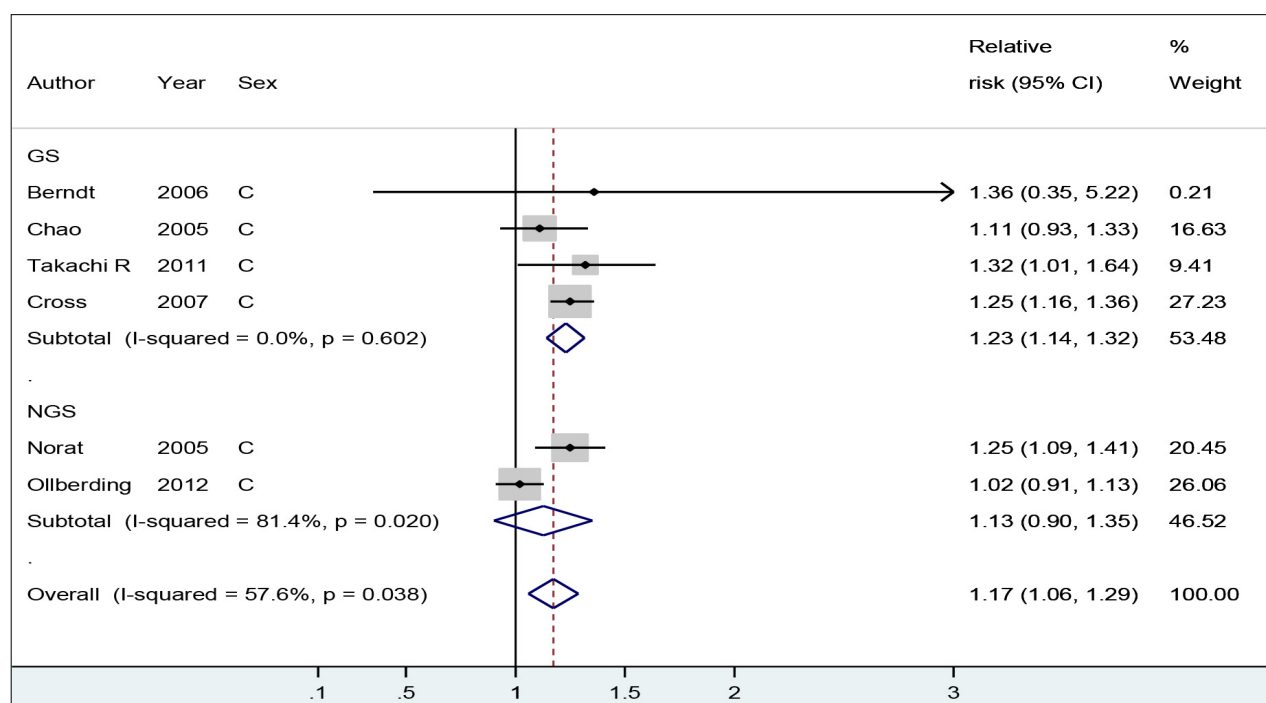Abbreviations: RR, relative risk; FFQ, Food Frequency Questionnaire.

Table 1. Characteristics of cohort studies included in the meta-analysis

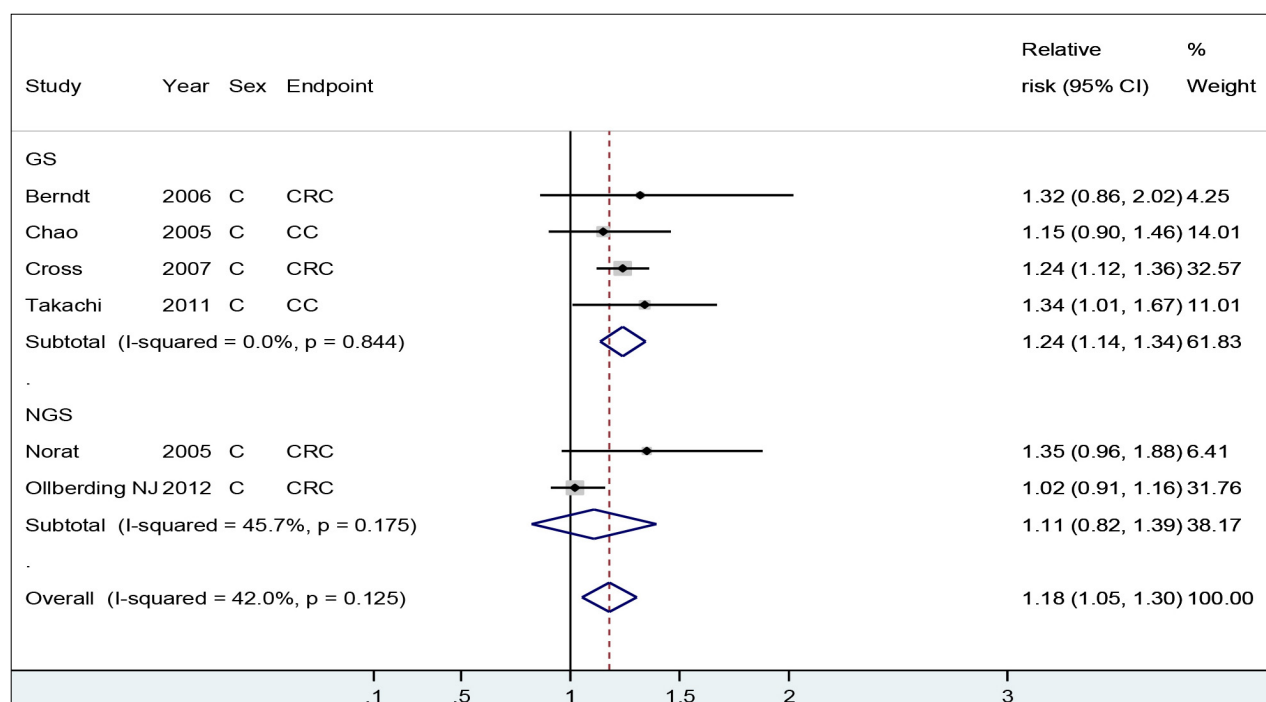| Study	Cohort	Ethnicity (% of subjects)	Baseline population	No. of cases	Age at baseline	Study period (follow-up years)	Meat category (intake in quantiles)
GS Group							
Berndt et al[22] (2006)	CLUE II	Caucasian (98.3%)	Men: 932, Women: 1,292	CRC: 202	>35 (mean 48.5)	1996-2003 (mean 13.5)	Red and processed meat (T1: <44.0 g, T3: ≥86.3 g)
Chao et al[23] (2005)	CPS II	Caucasian (98.0%)	Men: 69,664, Women: 78,946	CC: 1,197, RC: 470	50-74 (median 63)	1992-2001	Red and processed meat (median) (men Q1: 14.3 g, Q5: 142.7 g; women Q1: 6.1 g, Q5: 101.7 g) Processed meat (median) (men Q1: 1.4 g, Q5: 40.4 g; women Q1: 0 g, Q5: 20.7 g)
Takachi et al[24] (2011)	JPHC	Asian	Men: 38,462, Women: 42,196	CRC: 1,145, CC: 788	45-74 (mean 56.6)	1995,1999-2006	Red and processed meat (median) (men Q1: 20 g, Q5: 117 g; women Q1: 18 g, Q5: 107 g) Red meat (median) (men Q1: 15 g, Q5: 102 g; women Q1: 14 g, Q5: 93 g) Processed meat (median) (men Q1: 0.2 g, Q5: 16 g; women Q1: 0.4 g, Q5: 15 g)
English et al[25] (2004)	MCCS	Caucasian	Men: 14,643, Women: 22,469	CRC: 451, CC: 283, RC: 169	27-75	1990,1994-2002 (average 9)	Red meat (Q1: <51.4 g, Q4: ≥111.4 g) Processed meat (Q1: 10.7 g, Q4: 28.6 g)
Sato et al[14] (2006)	Miyagi cohort	Asian	Men: 20,174, Women: 21,661	CRC: 474, CC: 280, RC: 198	40-64 (mean 52)	1990-2001 (11)	Processed meat (median) (Q1: 0 g, Q4: 15.8 g)
Cross et al[26] (2007)	NIH-AARP	Caucasian (92.6%)	Men: 294,724, Women: 199,312	CRC: 5,107	50-71 (mean 62)	1996-2003 (mean 6.8)	Red and processed meat (median) (Q1: 9.8 g/1,000 kcal, Q5: 62.7 g/1,000 kcal)
NGS Group							
Singh and Fraser[27] (1998)	AHS	Caucasian (100.0%)	Men and women: 32,051	CC: 135, RC: 22	≥25	1977-1982 (6)	Red meat (T1: 0 g, T3: 17.1 g)
Norat et al[28] (2005)	EPIC	Caucasian (>97.0%)	Men: 141,987, Women: 336,052	CRC: 1,329, CC: 855, RC: 474	35-70 (mean 51.2)	1992-1998 (mean 4.8)	Red and processed meat (Q1: <10 g, Q5: ≥160 g) Red meat (Q1: <10 g, Q5: ≥160 g) Processed meat (Q1: <10 g, Q5: ≥80 g)
Järvinen et al[29] (2001)	FMCHES	Caucasian (100.0%)	Men and women: 9,959	CRC: 109, CC: 63, RC: 46	≥15 (mean 39.1)	1967-1999 (max 32)	Red meat (men Q1: <94 g, Q4: >206 g; women Q1: <61 g, Q4: >134 g)

Table 1. Continued

Study	Cohort	Ethnicity (% of subjects)	Baseline population	No. of cases	Age at baseline	Study period (follow-up years)	Meat category (intake in quantiles)
Knekt et al[30] (1999)	FMCHES	Caucasian (100.0%)	Men: 5,274 Women: 4,711	CRC: 73	≥15	1967-1990 (max 24)	Meat and meat products
Iso et al[31] (2007)	JACC	Asian	Men: 44,647 Women:60,992	CC: 354 RC: 211	40-79	1988-2003	Processed meat (men T1: <7.1 g, T3: ≥21.4 g)
Ollberding et al[32] (2012)	MEC	Mixed	Men: 76,893 Women: 88,824	CRC: 3,404	45-75 (mean 59.9)	1993-2007 (median 13.6)	Red and processed meat (g/1,000 kcal) (Q1: median 7.4 g, Q5: median 48.0 g) Red meat (g/1,000 kcal) (Q1: median 4.6 g, Q5: median 34.9 g) Processed meat (g/1,000 kcal) (Q1: median 1.7 g, Q5: median 18.0 g)
Chen et al[33] (1998)	SCHS	Asian	Men and women: 61,321	CRC: 961 CC: 591 RC: 370	45-74	1993-2005 (average 9.8)	Red meat (median intake) (case: 24 g, noncase: 25 g) Processed meat (median intake) (case: 1.2 g, noncase: 1.3 g)
Balder et al[34] (2006)	NLCS	Caucasian	Men: 58,279 Women: 62,573	CRC: 1,535	55-69	1986-(9.3)	Processed meat (Q1: 0 g, Q5: ≥20 g [median 32 g])
Wada et al[35] (2017)	Takayama cohort	Asian	Men: 13,957 Women: 16,374	CRC: 709 CC: 222 RC: 236	≥35 (mean 55.7)	1992-2008	Red meat (median intake) (men Q1: 19 g, Q4: 64 g; women Q1: 12 g, Q4: 49 g) Processed meat (median intake) (men Q1: 4 g, Q4: 23 g; women Q1: 3 g, Q4: 19 g)

Abbreviations: GS, gender-specific; CLUE II, 'give us a clue to cancer' study; CRC, colorectal cancer; CC, colon cancer; RC, rectal cancer; JPHC, Japan Public Health Center-based Prospective Study; MCCS, Melbourne Collaborative Cohort Study; NIH-AARP, American Association of Retired Persons' Diet and Health Study; NGS, not gender-specific; AHS, Adventist Health Study; EPIC, European Prospective Investigation into Cancer and Nutrition; FMCHES, Finnish Mobile Clinic Health Examination Survey; JACC, Japan Collaborative Cohort Study; MEC, multiethnic cohort study; SCHS, Singapore Chinese Health Study; NLCS, Netherlands Cohort Study.

Figure 2. Dose-response meta-analysis between red and processed meat and colorectal or colon cancer in male and female combined cohort studies (P for difference=0.340).

Author	Year	Sex	Relative risk (95% CI)	% Weight
GS				
Berndt	2006	C	1.36 (0.35, 5.22)	0.21
Chao	2005	C	1.11 (0.93, 1.33)	16.63
Takachi R	2011	C	1.32 (1.01, 1.64)	9.41
Cross	2007	C	1.25 (1.16, 1.36)	27.23
Subtotal (I-squared = 0.0%, p = 0.602)			1.23 (1.14, 1.32)	53.48
NGS				
Norat	2005	C	1.25 (1.09, 1.41)	20.45
Ollberding	2012	C	1.02 (0.91, 1.13)	26.06
Subtotal (I-squared = 81.4%, p = 0.020)			1.13 (0.90, 1.35)	46.52
Overall (I-squared = 57.6%, p = 0.038)			1.17 (1.06, 1.29)	100.00

(x-axis: .1 .5 1 1.5 2 3)

Abbreviations: CI, confidence interval; GS, gender-specific; C, combined men and women; NGS, not gender-specific.

Figure 3. Highest vs. lowest meta-analysis between red and processed meat and colorectal or colon cancer in male and female combined cohort studies (P for difference=0.022).

Study	Year	Sex	Endpoint	Relative risk (95% CI)	% Weight
GS					
Berndt	2006	C	CRC	1.32 (0.86, 2.02)	4.25
Chao	2005	C	CC	1.15 (0.90, 1.46)	14.01
Cross	2007	C	CRC	1.24 (1.12, 1.36)	32.57
Takachi	2011	C	CC	1.34 (1.01, 1.67)	11.01
Subtotal (I-squared = 0.0%, p = 0.844)				1.24 (1.14, 1.34)	61.83
NGS					
Norat	2005	C	CRC	1.35 (0.96, 1.88)	6.41
Ollberding NJ	2012	C	CRC	1.02 (0.91, 1.16)	31.76
Subtotal (I-squared = 45.7%, p = 0.175)				1.11 (0.82, 1.39)	38.17
Overall (I-squared = 42.0%, p = 0.125)				1.18 (1.05, 1.30)	100.00

(x-axis: .1 .5 1 1.5 2 3)

Abbreviations: CI, confidence intervals; GS, gender-specific; C, combined men and women; CRC, colorectal cancer; CC, colon cancer; NGS, not gender-specific.

six cohort studies in the GS group, and five of nine cohort studies in the NGS group, were conducted in Caucasians. Two of six cohort studies in GS group and four of the nine cohort studies were conducted in Asians. One study includes population of mixed ethic groups. The average number of subjects was larger in the GS group (n=134,076) than the NGS group (n=112,655).

In the present review, meta-analysis of six cohort studies assessing red and processed meat intake in men and women combined revealed that a 100 g/day increase in red and processed meat intake was significantly associated with colorectal or colon cancer risk in the GS group (RR, 1.23; 95% CI, 1.14-1.32), but not in the NGS group (RR, 1.13; 95% CI, 0.90-1.35; Figure 2).

A comparison between the highest and lowest categories revealed the following summary RRs, 1.24; 95% CI, 1.14-1.34 in the GS group and RRs,1.11; 95% CI, 0.82-1.39 in the NGS group (Figure 3). When the outcomes were limited to colorectal cancer, similar results were observed (data not shown).

The summary estimates of the meta-analysis according to group (GS vs. NGS) are presented in Table 2. For processed meat, there were significant associations between intake and colorectal or colon cancer risk in both the GS group (RR,

1.28; 95% CI, 1.15-1.40 for a 50 g/day increase) and the NGS group (RR, 1.16; 95% CI, 1.04-1.28 for a 50 g/day increase).

Discussion

In the present study, there was a stronger association between red and processed meat intake and the risk of colorectal or colon cancer when the estimates of prospective cohort studies that used FFQs developed in a gender-specific manner were combined than when those from cohort studies that did not consider gender were combined. In the meta-analysis of studies that included both men and women, a 100 g/day increase in red and processed meat intake was associated with a 1.23-fold higher risk of colorectal or colon cancer in the GS group. However, the summary estimate of both the GS and NGS groups reduced this estimate to an RR of 1.17. For processed meat, the summary RRs of the GS and NGS groups were 1.28 and 1.16, respectively, which although similar were significantly different.

The relationship between a higher intake of red and processed meat and an increased risk of colorectal cancer has been established by several studies. A previous meta-analysis of 10 cohort studies reported a 22% higher risk of colorectal

Table 2. Summary of the estimated RRs and 95% CIs for colorectal or colon cancer risk

			Dose-response[a]					Highest vs. lowest		
	N	RR	95% CI	*P* for differences	Ref.[b]	N	RR	95% CI	*P* for differences	Ref.[b]
Red and processed meat				0.340					0.022	
GS	4	1.23	1.14, 1.32		22,23,24,26)	4	1.24	1.14, 1.34		22,23,24,26)
NGS	2	1.13	0.90, 1.35		28,35)	2	1.11	0.82, 1.39		28,35)
Total	6	1.17	1.06, 1.29			6	1.18	1.05, 1.30		
Red meat			NA[c]					NA[c]		
GS	1				25)	1				25)
NGS	5				27,28,29,32,35)	5				28,29,32,33,35)
Total	6					6				
Processed meat				0.168					0.409	
GS	5	1.28	1.15, 1.40		14,23,24,25,26)	5	1.18	1.07, 1.28		14,23,24,25,26)
NGS	3	1.16	1.04, 1.28		28,34,35)	7	1.12	1.03, 1.21		28,30,31,32, 33,34,35)
Total	8	1.21	1.13, 1.30			12	1.15	1.08, 1.21		

Abbreviations: RR, relative risk; CI, confidence intervals; Ref., reference; GS, gender-specific; NGS, not gender-specific; NA, not available.
[a]Dose-response analysis: RR of 100 g/day increase in red and processed meat or red meat and RR of 50 g/day increase in processed meat.
[b]List of reference number included in summary of RR.
[c]Summary estimates were not calculated if number of studies was 1 or less in either GS or NGS group.

cancer in those who had a high red and processed meat intake compared to those with a low intake.[17] The present study also found that a high intake of red and processed meat was associated with an increased risk of colorectal or colon cancer when all studies were combined; however, the magnitude of the association differed according to whether gender was considered during FFQ development. Epidemiological studies commonly use FFQs to estimate typical dietary intakes and identify relationships between diet and disease. Although FFQs are cost-effective and time-saving, and therefore suitable for large-scale epidemiological studies, the development of an FFQ is a long and exhaustive process. To accurately determine habitual dietary intakes using FFQs, the selection of food items and portion size options requires a careful exploration of the participant characteristics, because the information obtained from the FFQ should explain the contributions of the nutrients of interest, as well as between-person variation. Gender may be particularly important to consider, given that commonly consumed foods and typical portion sizes differ between men and women.[10] Our recent study shows that men and women who chose the same portion size category tend to eat different amount in actual consumption examined by 3-day 24 hour dietary recalls.[18]

Marks et al.[19] reported the effects of selected demographic, anthropometric, and social characteristics on the validity of a 129-item FFQ and revealed that gender was significantly related to differences between FFQ values and weighted food records for nine of 21 nutrients. A validation study of an FFQ completed by Australian adults, which used multivariate modeling within the limits of an agreement analysis, showed that gender was an important explanatory variable with respect to variation in the differences between the FFQ results and those of a reference method.[20] Cade et al.[21] suggested that using gender-specific portion is appropriate; their review of validation studies that assessed FFQs showed differences in preferred portion sizes between men and women. In a previous systematic review done by our research group, only 10.7% of FFQ development studies accounted for gender during food item selection or portion size determination.[10] Moreover, the differences observed in the ratios of the FFQ intake data relative to those of the reference method were greater for women compared to men.

To the best of our knowledge, this is the first meta-analysis of prospective cohort studies investigating the association between red and processed meat intake and colorectal cancer risk to summarize the results based on how the FFQ, which is the most commonly used dietary assessment tool in such studies, was developed. There was a difference in summary estimates between the GS and NGS groups. However, this finding might not definitively show that consideration of gender during the development of an FFQ results in total accuracy in dietary measurement studies, because a variety of factors influence the accuracy and precision of nutritional epidemiological studies. For example, factors related to red and processed meat, the study population, adjustment for confounding factors, the number of cases, and the duration of the follow-up periods could modify any observed associations.

However, the present findings suggest that gender differences in responses to questionnaire items related to portion sizes, food choices, and food preferences, as well as social and cultural characteristics associated with dietary behaviours, should be taken into consideration in the initial study design, especially during FFQ development. Measuring dietary intake remains challenging, and the development of an FFQ requires considerable effort; gender-specific FFQs could significantly improve the success of epidemiological studies. Thus, special attention should be paid to gender differences during the collection of dietary information, analysis of food-related data, and formulation of FFQs.

The present study had several limitations that should be noted. First, the prospective studies included in the meta-analysis were categorized into two groups (GS and NGS) according to whether gender-specific FFQs were used to collect the dietary intake data. To assess gender-specificity, our procedure to evaluate FFQ development was based on the descriptions provided in each study. Although the absence of a description does not necessarily imply that gender was not considered during FFQ development, it is likely that some authors did not describe how they considered gender, because factors related to gender were not a priority. Therefore, more studies on gender differences in dietary intakes as well as associations between dieraty factors and disease risks are needed. Additionally, there are several versions of many FFQs because researchers employ modified FFQs during the follow-up period. Because few of the studies assessed in this review presented results according to gender, it was not possible to compare results between the GS and NGS groups in terms of their male and female populations.

In conclusion, the present review suggests that gender should be considered from the initial stages of study design onwards, particularly during the development of dietary assessment tools, to enhance the accuracy of nutritional epidemiological studies. Further investigation is required regarding the degree to which exposure to the foods and nutrients assessed by gender-specific FFQs predict the risk of chronic diseases versus those assessed by gender-combined FFQs within the same populations.

요   약

연구배경: 남성과 여성의 섭취 음식과 섭취 분량에 차이가 있음에도 불구하고, 식이섭취 조사도구를 개발할 때 대부분 이러한 차이를 고려하지 않고 있다. 본 연구는 영양역학연구에서 주로 사용되는 식이섭취빈도조사지(FFQs)를 개발할 때 젠더 차이를 고려하는 것이 식이섭취와 질병 간의 상관관계를 측정하는 정확도에 영향을 미치는 지 알아보고자 하였다.

방법: 적색육 혹은 가공육 섭취와 대장암 발생 위험 간의 상관관계를 조사한 논문을 체계적 문헌고찰 방법으로 검색하였다. 남성과 여성을 모두 포함한 코호트 연구에서 각 논문별로 사용한 식이섭취빈도조사지가 젠더 차이를 고려하였는지 여부에 따라 젠더 특이적 그룹과 그렇지 않은 그룹으로 분류하였고, 논문별 연구 결과를 메타분석으로 통합하여 두 그룹 간 비교 분석하였다.

결과: 남성과 여성 모두 포함된 코호트 연구에서 젠더 특이적 그룹에서는 적색육 및 가공육 섭취가 1일 당 100 g씩 늘어날수록 대장암 발생 위험이 1.23배 유의적으로 증가하였지만(RR, 1.23; CI, 1.14-1.32), 젠더 특이적이지 않은 그룹에서는 유의적인 상관관계를 보이지 않았다(RR, 1.13; CI, 0.90-1.35). 가공육 섭취가 1일 당 50 g씩 늘어날수록 젠더 특이적 그룹에서는 대장암 발생 위험이 28% 증가하였고(RR, 1.28; CI, 1.15-1.40), 젠더 특이적이지 않은 그룹에서는 15% 증가하였다(RR, 1.15; CI, 1.03-1.27).

결론: 젠더 차이를 고려하여 식이섭취 조사도구를 개발하는 것이 영양역학 연구의 정확성을 향상시킬 수 있다.

중심 단어: 젠더, 육류 섭취, 대장암, 식이섭취빈도조사지

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