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Meat consumption and breast cancer: A case–control study in women

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ABSTRACT

Background: The relationship between meat intake and breast cancer has been inconsistent .
Objective: The aim of this work was to evaluate the association between meat intake and breast cancer, in women.
Design: A case–control study with 250 consecutive, newly diagnosed breast-cancer-female-patients (56 ± 12 years) and 250, one-to-one age-matched controls was conducted. A standardized, validated questionnaire assessing various socio-demographic, clinical, lifestyle and dietary characteristics was applied through face-to-face interviews. Data on consumption of red, white, processed and grilled meat were also recorded. Overall dietary habits were assessed through the level of adherence to the Mediterranean diet using the MedDietScore (theoretical range 0–55).
Results: Processed meat intake, even for 1–2 times/week, was associated with a 2.7-fold (OR = 2.65, 95% CI 1.36, 5.14) ($p = 0.004$) higher likelihood of having breast cancer, while daily intake increased the likelihood by a 2.8-fold (OR = 2.81, 95% CI 1.13, 6.96) ($p = 0.026$), after various adjustments made. Red, white and grilled meat intake was not significantly associated with the outcome when the same adjustments were made.
Conclusions: This study suggested that only daily processed-meat intake was consistently associated with increased odds of breast-cancer.

1. Introduction

Meat consumption has long been associated with human health, due to its nutritional composition. It contains 20–35% protein, providing all essential amino acids, as well as relatively high levels of B vitamins (particularly B6 and B12) and vitamin D (Biesalski, 2005; Williamson, Foster, Stanner, & Butriss, 2005). It also provides readily absorbable zinc, selenium and iron, a mineral necessary for growth, development, normal cellular functioning and synthesis of some hormone and connective tissue. Meat total iron (TFe) concentration depends on the type as well as the cut of meat, while usually heme iron (HeFe) comprises the vast majority of TFe (Valenzuela, De Romana, Olivares, Morales, & Pizzaro, 2009; Valenzuela et al., 2011). Along with these important nutrients, meat is a primary source of fat which facilitates the absorption of fat-soluble vitamins including A, D, E and K. Between 30% and 40% of the fat is composed of monounsaturated fatty acids (MUFAs), with the principal MUFA being oleic acid. It also contains predominantly linoleic (*n*-6) and *a*-linolenic acid (*n*-3) from poly-unsaturated fatty acids (PUFAs), as well as long-chain *n*-3 PUFAs eicosapentaenoic acid (EPA), docosapentaenoic acid (DPA) and docosahexaenoic acid (DHA). The main saturated fatty acids (SFAs) present in red meat are palmitic acid and stearic acid, while meat from ruminant animals is also a source of conjugated linoleic acid (CLA) (Biesalski, 2005; Williamson et al., 2005). Meat fatty acid composition can be changed via the diet (e.g., the feeding regime of the animal), affecting meat quality and producing different flavors in cooked meat due to the different oxidative changes occurring during storage and cooking (Calabro et al., 2014; Cutrignelli et al., 2008; Wood & Enser, 1997). Finally, L-Carnitine which plays an important role in fatty acid metabolism is also provided by meat, having the opportunity not to be modified during domestic cooking (Rigault, Mazue, Bernard, Demarquoy, & Le Borgne, 2008). Since meat is a good source of many valuable nutrients and especially high quality protein, its consumption could reveal its beneficial effects on cardiovascular health (Giordano et al., 2010; McNeill, 2014) and overweight (McNeill, 2014). Nevertheless, during the past decades, several studies have associated red and processed meat intake with increased all-cause mortality (Larsson & Orsini, 2014), increased risk of type 2 diabetes (Aune, Ursin, & Veierod, 2009) and stroke (Chen, Lv, Pang, & Liu, 2013), with higher odds of having acute coronary events (Kontogianni, Panagiotakos, Pitsavos, Chrysohoou, & Stefanadis, 2008) as well as increase in the risk of some types of cancer, specifically

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pancreatic (Larsson & Wolk, 2012) and colorectal cancer (WCRF/AICR, 2007).

Cancer is a chronic disease and among its various types breast cancer is the most frequently diagnosed cancer and the leading cause of cancer death in females, worldwide (Jemal et al., 2011). However, the relationship between meat consumption and breast cancer remains not well understood and appreciated, since the current data lack definitive evidence. In a recent large cohort study investigating diet and cancer in women in the United Kingdom (UK Women's Cohort Study), increased consumption of total and non-processed meat was associated with significant increased risk of premenopausal breast cancer incidence and positive associations between postmenopausal breast cancer and total, processed and red meat consumption were found, as well (Taylor, Burley, Greenwood, & Cade, 2007). In contrast, in a recent meta-analysis of red and processed meat consumption and breast cancer where the researchers were able to meta-analyze data on over 25,000 cases of breast cancer, overall observed weak positive summary associations, with the majority being non-statistically significant (Alexander, Morimoto, Mink, & Cushing, 2010). The above conflicting results regarding the effect of meat consumption on breast cancer risk may be owing to differences in definitions of total meat, red and processed meats, in the derivation of the meat content of meat dishes, the homogeneity of diet within individual population groups as well as the lack of investigations of potential effect modifiers such as analyses by hormone receptor status.

Thus, the aim of this work was to evaluate the association between meat intake (red, white, processed and grilled meat) and breast cancer development, after various adjustments were made.

2. Material and methods

2.1. Study's design and sample

This is a case–control study, with face-to-face interviews with the participants. Between November 1, 2010 and July 31, 2012, 250 consecutive, newly (within 6 months) diagnosed breast cancer female patients (defined by physical examination and biopsy) that visited pathology-oncology clinics of five major general hospitals in Athens, Greece (i.e., "Alexandra" General Hospital, "Elena Venizelos" Maternity-General Hospital, "Agioi Anargyroi" General Oncological Hospital of Kifissia, "Saint Savvas" Cancer Hospital and "I. Metaxa" Special Cancer Hospital) were contacted to participate in the study. Patients with diagnosis older than 6 months (in order to avoid changes in their dietary habits or other behaviors), were not included. In the same period, 250 female subjects (controls) without any clinical symptoms, signs or suspicion of any type of cancer in their medical history, were selected on a volunteer basis. Control subjects were age-matched (± 3 years) with the cancer patients, population-based and selected from the same catchment area (i.e., Athens metropolitan area, i.e., 76% or other areas) of the patients (i.e., controls were selected from the same city or town patients were living or working; there were no substantial differences between living and working areas of the participants). The participation rate of the patients was 82% and of the controls was 88%. To reduce selection bias a random selection of the controls was performed, when it was possible (i.e., in 60% of the controls), e.g., through the employee listings of the companies that were visited by the study's investigators or the apartments of the building. The rest 40% of the controls were selected on a feasibility basis, and were colleagues, friends, or relatives of the study's field investigators that fulfilled the aforementioned criteria.

The number of the enrolled subjects ($n = 500$) was decided through power analysis, in order to evaluate (two sided) odds ratio equal to 1.10 (95% CI 1.05, 1.15), achieving statistical power greater than 0.80 at 0.05 probability level (p-value).

The design of the study and the full methods followed have been already described elsewhere (Mourouti et al., 2013).

2.2. Bioethics

The study has been approved by the Ethics Committee of "Alexandra" General Hospital (No. 4/10.3.2010), "I. Metaxa" Special Cancer Hospital (No. 40/8.12.2011) and "Saint Savvas" Cancer Hospital (No. 448/2.3.2012) and was carried out in accordance to the Declaration of Helsinki (1989) of the World Medical Association. Prior to the collection of any information, participants were informed about the aims and procedures of the study and provided their signed consent.

2.3. Dietary assessment

A validated, semi-quantitative food frequency questionnaire (FFQ) was used during the interviews to collect dietary information from the participants (Mourouti et al., 2013). In brief, the FFQ included 86 questions regarding the frequency of consumption of all main food groups and beverages usually consumed. In this work the interest was focused on specific food groups, like the consumption of red meat (including beef, lamb, veal and pork), white meat (including chicken, game and turkey), processed meat (including cured and smoked meats; ham, bacon, sausages and salami) as well as grilled meat. Thus, specifically for meat consumption, data on regular consumption of red meat (i.e., ≤1 time/week, 2–3 times/week, 4–5 times/week, 6–7 times/week, 8–10 times/week, >10 times/week), white meat (i.e.,≤3 times/week, 4–5 times/week, 5–6 times/week, 7–8 times/week, 9–10 times/week, >10 times/week) and of processed and grilled meat (i.e., never, <1 time/month, 2–3 times/month, 1–2 times/week, 3–4 times/week, daily), were recorded for the last year prior to diagnosis. To account for overall dietary habits, adherence to the Mediterranean dietary pattern was assessed using the MedDietScore, an 11-item composite dietary index, with large scale scoring that ensures better predictive accuracy (Panagiotakos, Pitsavos, & Stefanadis, 2006). It contains the 11 main food components of the Mediterranean diet: nonrefined cereals, fruits, vegetables, potatoes, legumes, olive oil, fish, red meat, poultry, full fat dairy products and alcohol, and its theoretical range is between 0 and 55. Higher values of this score indicate greater adherence to the Mediterranean diet. The validation properties of the MedDietScore have been presented elsewhere in the literature (Panagiotakos, Pitsavos, Arvaniti, & Stefanadis, 2007; Panagiotakos et al., 2006, 2009). The evaluation of overall dietary habits was considered essential in the present analysis, in order to account for the potential confounding effect of a healthy dietary pattern in the evaluation of the main research hypothesis (i.e., the association between meat consumption and breast cancer).

2.4. Other measurements

Age of the participants was recorded, as well as their place of living (i.e., living in the city of Athens or out of town), educational level and financial status. Weight and height were measured using standardized procedures, and body mass index was calculated as weight in kilograms divided by height in meters squared. Physical activity was assessed using the International Physical Activity Questionnaire (IPAQ) index (Craig et al., 2003) that has been validated for the Greek population (Papathanasiou et al., 2009). Subjects were asked to recall the number of days and hours or minutes they engaged in physical activity of different intensities for at least 10 minutes, vigorous intensity and moderate intensity, walking and time spent sitting. According to their physical activity levels participants were classified as inactive, minimally active or health enhancing physical activity (HEPA) active. Smoking habits (i.e., current and former smoking, total years of smoking and number of cigarettes smoked per day) were also recorded. Family history of breast cancer, gynecological medical history (i.e., existence or not of menstruation, age of menarche, age of menopause and use of hormone