Cancer Epidemiology 55 (2018) 1–7

Contents lists available at ScienceDirect

Cancer Epidemiology

journal homepage: www.elsevier.com/locate/canep

Avoidable colorectal cancer cases in Denmark – The impact of red and processed meat

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ARTICLE INFO

Keywords:
Colorectal cancer
Red meat
Processed meat
Prevention
Potential impact fraction
Population attributable fraction
Avoidable cancer

ABSTRACT

Background: High red and processed meat intakes are associated with increased colorectal cancer (CRC) risk. The effect of eliminating or reducing red and processed meat consumption on CRC burden was not previously quantified in Denmark. The aim of this study was to calculate the possible effects of reductions in red and processed meat consumption on future CRC incidence in the Danish adult population.

Methods: Under six scenarios of prevalence exposure (meat consumption) the number of CRC cases in Denmark for a 30-year period (2016-2045) was estimated and compared to the projected number of CRCs if the prevalence of meat consumption remains constant. Data was obtained from the NORDCAN register, Statistics Denmark, and from the Danish dietary survey data (DANSDA). Analyses were conducted using the Prevent model.

Results: During the 30-year period, a total of 36,767 (19.8%) CRC cases out of 185,937 expected could be avoided in Denmark by eliminating the consumption of both red and processed meat. For the same period, a modest reduction in both red and processed meat consumption could lead to the prevention of 16,964 (9.1%) CRC cases. The greatest reductions were seen among men, and the highest impact was estimated for the elimination or reduction of processed meat consumption.

Conclusion: Decreased red and processed meat consumption could reduce the burden of CRC markedly in Denmark. These results can assist public health planners and help highlight the important role of a modest but realistic reduction in meat consumption in the prevention of CRC.

1. Introduction

The pathogenesis of colorectal cancers (CRCs) is complex, with both genetic and lifestyle causes known to contribute to their development [1]. Food and nutrition play a major role both in the prevention and the causation of CRC, and there is evidence of a dose-response relationship between intake for both red and processed meat and the risk of developing CRC [2,3]. Red meat is defined as all mammalian muscle meat, and it includes beef, veal, pork, lamb, mutton, horse, and goat [3–5]. Processed meat is meat that has been modified through smoking, curing, salting, fermentation or other processes in order to improve its flavour or its preservation. Processed meat can include red meat but also other types of meat, like poultry, offal or meat by-products [3–5]. Both the World Cancer Research Fund (WCRF) and the International Agency for Research on Cancer (IARC) agree there is convincing evidence that a high intake of processed meat increases CRC risk, and that red meat is probably carcinogenic [2,3]. Mechanisms behind the carcinogenicity of red and processed meat are still unclear, but the most common hypotheses highlight the possible roles of heterocyclic amines (HCAs), polycyclic aromatic hydrocarbons (PAHs), heme-iron, and curing-agents nitrate and nitrite. These mechanisms are described elsewhere [6–9].

CRC is the third most common cancer type in Denmark, as well as worldwide [10], and the fourth most common cause of cancer death [11]. CRC accounts for 12.7% and 12.1%, respectively, of all cancer cases among Danish men and women [10].

Danish men have a total average intake of 1,134 g raw red and processed meat per week, whereas women's is about half, on average 644 g per week (calculated after [5]). Both the WCRF, the IARC, and the Danish Food and Veterinary Administration recommend a maximal intake of 500 g cooked red meat per week, and both the WCRF and the IARC further recommend avoidance of processed meat [12–14]. Meat intake among Danes thus exceeds recommendations.

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https://doi.org/10.1016/j.canep.2018.04.010
Received 18 December 2017; Received in revised form 17 April 2018; Accepted 22 April 2018
Available online 25 May 2018

Previous studies have focused on the population attributable fraction (PAF) due to red and processed meat intake [15–19], but not all studies have examined red and processed meat intake separately, and no analyses of this nature have been previously conducted in the Danish population. The aim of this study was to estimate the possible effects of reductions in the intake of red and processed meat on the incidence of CRC in the Danish adult population over a 30-year period.

2. Methods

We used the Prevent model as implemented in the EUROCADET Project [20] to estimate the number of CRC cases that can be prevented in the Danish adult population under different scenarios of changes in prevalence of red and processed meat intake. The Prevent model is described in detail elsewhere [21,22]. In brief, the model estimates the number of future cancer cases expected to occur based on current (and historical, when available) data on prevalence of a risk factor, and contrasts this with estimates based on an altered prevalence of the risk factor. The model requires data on disease incidence, demographic data, exposure prevalence, relative risk (RR) estimates, and the change in exposure prevalence under the selected scenarios.

2.1. CRC incidence

We used the ICD-10 codes C18-21 to define cases of CRC. Information on CRC incidence was obtained from the NORDCAN database [10,23] and collected for the Danish adult population aged 15 and above by gender and 5-year age groups (except 85+). We used the average incidence for the period 2009–2013 in order to reduce random variation in the data due to small numbers within a single year. We estimated the future number of CRC cases in Denmark for the period 2016–2045. We assumed that the incidence rates would stay constant at the levels observed in 2009–2013, except for changes associated with the hypothesized changes in prevalence of meat intake.

2.2. Demographic data

Gender-specific information on population size by single ages at baseline, and projection of population size by 5-year age categories for the whole 30-year period was obtained from the national statistical bureau Statistics Denmark [24].

2.3. Exposure prevalence

Information on red and processed meat intake was retrieved from DANSDA, a nationally representative survey of dietary habits and physical activity among 3946 Danes aged 4–75 years, conducted in 2011–2013 [5,25]. We used information on intake for age groups 15–75 years, assuming that it corresponds to intake in the adult population (age 15 and above). Intake of both red and processed meat were treated as continuous covariates. Mean intakes at baseline and under the scenarios of interest are presented in Table 1. Analyses presented in this study followed the lognormal distribution of intake in order to correct the possible negative meat intake allowed in the normal distribution.

2.4. Relative risk estimates

We used adjusted RRs from the meta-analyses presented in the WCRF's Continuous Update Project (CUP), in which RR for CRC is estimated to 1.16 (95% CI: 1.08-1.26) for each additional 50 g processed meat consumed daily, and 1.12 (95% CI: 1.00-1.25) for each additional 100 g red meat consumed daily [2]. In the Prevent model a "safe limit", indicating the level of exposure associated with no CRC risk, has to be included. No "safe limit" regarding meat consumption is known [4], and since it is not possible to include 0 g/d in the model, a mean of 1 g/d and a corresponding 0.5 SD were used.

Table 1
Mean intake (g/d) of raw red and processed meat at baseline and under different scenarios.

	Men Mean (SD)	Women Mean (SD)
Baseline		
Raw red meat	104 (63)	64 (43)
Processed meat	58 (46)	28 (24)
Scenarios A1-A3: elimination	1 (0.5)	1 (0.5)
Scenarios B1-B3: reduction		
Red meat	79 (48)	49 (33)
Processed meat	33 (26)	16 (14)

g/d: grams per day; SD: standard deviation.

2.5. Scenarios of interest

Six scenarios for the potential impact of changes in red and processed meat consumption on CRC burden were examined. The scenarios were categorized as follows:

A Elimination:
- A1. Elimination of red meat consumption (1 g/d).
- A2. Elimination of processed meat consumption (1 g/d).
- A3. Elimination of both red and processed meat consumption (1 g/d).

B Reduction:
- B1. Reduction of 25 g/d (24%) in red meat consumption among men.
- B2. Reduction of 25 g/d (43%) in processed meat consumption among men.
- B3. Reduction of 25 g/d in both red and processed meat consumption each, among men.

The same proportional reductions were applied to women's mean intake and to the standard deviations (Table 1).

These scenarios were assumed to begin in 2016, and we calculated the number of avoidable CRC cases for each scenario for the 30-year period 2016–2045. All scenarios model a decrease in exposure prevalence of red and/or processed meat consumption compared to the constant baseline exposure prevalence. Results from all analyses are presented for the entire adult population, as well as separately for each gender.

The Prevent model is able to handle a latency period, which is the time from when changes in exposure prevalence (reduced meat intake) reflect themselves in changes in the risk for cancer type (CRC), by computing LAT and LAG times. LAT is the number of years the risk of disease remains unchanged after a change in risk factor exposure, while LAG is the period of time from the moment the risk among previously exposed individuals starts to change until the risk among them is equivalent to the risk for unexposed individuals [26]. For this study, we chose a LAT of one year, and a LAG of nine years, assuming the risk decreases linearly during the LAG time. This is in concordance with Parkin et al., in which a latent period of 10 years was applied, even though it did not differentiate between LAT and LAG [16]. Sensitivity analyses with varying latency periods, and the inclusion of a trend in future CRC incidence, were performed (see Appendix A).

3. Results

The avoidable number of CRC cases, i.e. the difference between the expected number of cases between baseline and scenarios A3 and B3, is presented in Fig. 1. The effect of the two scenarios starts after a LAT time of one year, and increases during the following LAG time of nine years. Similar effects were found when looking at red and processed meat separately, and greater effects were seen for men (Figs. 2 and 3).