Cancer Risk and Barbeque Trend in Indonesia: Efforts to Reduce Cancer Burden

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Introduction

In the last decades, concerns have been raised about the shift in the dietary patterns towards a high energy dense diet, mainly higher red meat consumption. The amount of meat consumption per person has almost doubled between 1961 and 2013 from 23 kilograms to 43 kilograms per year worldwide.[1] Meat consumption generally increases in line with economic development, as happened in Indonesia as one of the developing countries, which an increase in beef consumption per capita by 12.50 percent from 2016 (0.417 kg) to 2017 (0.469 kg) had been seen.[2] Also influenced by culture assimilation - Korean lifestyle through Korean drama series and K-pop bands, many all-you-can-eat (buffet), especially Korean barbeque restaurants, have been established in Indonesia.

Meanwhile, cancer remains one of the leading causes of death worldwide. Based on data from the International Agency for Research on Cancer (IARC)-GLOBOCAN in 2018, there were 18.1 million new cases with 9.6 million deaths worldwide, while in Indonesia, there were 348,809 new cases of cancer and 207,210 deaths due to cancer. The most prominent causes of cancer deaths each year are breast cancer, cervical cancer, lung cancer, colorectal cancer, and liver cancer.[3]

Link Between Meat Consumption and Cancer

Meat is an important source of nutrition regarding protein, iron, zinc, and vitamin B12, yet the genuine concern about the shift in the dietary patterns towards a high energy dense diet is the increased cancer risk that lies behind it. World Health Organization (WHO) has officially pronounced red meat as a 'probable' cause of cancer (Group 2a carcinogen) and processed meat as a 'definite' cause of cancer (group 1 carcinogen) - which smoking and alcohol included.[4] The term 'red meat' includes beef, veal, pork, lamb, and goat, while 'processed meat' refers to meat that has gone through salting, preserving, fermenting, fumigating, or other processes that aim to improve taste or improve durability.[5]

There is now clear body evidence that red meat consumption increases colorectal cancer risk, while there are limited but suggestive

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increase risks in nasopharynx, esophagus, lung, stomach, and pancreatic cancer.[4] Meta-analysis of studies in Korea showed a 25% increase in colorectal cancer risk associated with red meat intake (OR 1,25, 95% CI 1,15 to 1,36, I^2 26%),[6] while one of the largest dose-response meta-analysis by World Cancer Research Fund showed a probable increased risk per 100 grams red meat consumption/day (RR 1.12; 95% 1.00-1.25; I^2 0.00%).[4]

Although the red meat itself can increase the risk of cancer due to its heme content, the cooking method rather than the type of meat cooked may be more critical. The red color in the meat is a result of a high concentration of myoglobin, which transforms into reddish oxymyoglobin when in contact with oxygen. As a component of myoglobin, heme iron releases ferrous iron, a strong pro-oxidant that can produce reactive oxygen species (ROS) from phospholipids and triglycerides, which play an essential role in cancer.[7] Heme iron is 10 fold higher concentrations in red meat than in white meat. Low levels of ROS can be beneficial, but excessive accumulation can promote cancer by modulating various cell signaling pathways (primarily mediated through the transcription factors NF-êB and STAT3, hypoxia-inducible factor-1á, kinases, growth factors, cytokines and other proteins, and enzymes) linked to cellular transformation, inflammation, and proliferation of cells.[8]

The practice of cooking meat at high temperatures increases the production of carcinogen chemical compounds, namely heterocyclic amines (HCAs) and polycyclic aromatic hydrocarbons (PAHs). HCA is a combination of creatinine, amino acids, and sugar through the Maillard reaction and more than 25 HCAs have been identified. More HCA will be formed at temperatures higher than 220°C, which generally occurs in the process of frying or roasting meat, even though HCA is also formed on low-temperature roasting but for an extended period. Studies have revealed that oil waste and meats left after the frying pan was hot contains a high concentration of HCA.[4]

When fat or meat-juice is exposed to open fire, PAHs are formed in the smoke, drips onto the hot coals, wood, or other materials, and then adhere to the surface of the meat. Fuel used in the barbeque process also contributes to PAH concentration, which is the highest in charcoal and woods compared to in gas or electric flame. Seventeen PAHs are genotoxic/mutagenic with benzo[a]pyrene (BaP) being the most studied PAH. PAH content in food does not stand one by one but is a combination of various PAHs, making it difficult to determine the impact of each type of PAH. Bodyweight might contribute to BaP simulated exposure per barbeque event, with low body weight (below 33rd quantiles of the subjects body-weight) gets higher exposure (9,1 to 21,6%) per event than those in medium and high bodyweight classes.[9] Another metabolism factor also affects how we respond to PAH. CYP1A1, one type of Cytochrome P450s, plays an essential role in oral PAH detoxification, which is shown in animal models. The absence of CYP1A1 in the GI tract of CYP1a1 absence mice results in negligible detoxication and a 25-fold higher blood BaP level than in the wild-type mice.[10]

In some cases, nitrite is used as an additive to preserve meat because it can prevent the growth of pathogenic bacteria, such as Clostridium botulinum. This process involves the chemical reduction of nitrite to nitric oxide (NO) and the formation of nitrosyl-heme, marked in pink color. Later on, nitrite reduced to a series of nitrogen oxides (NO), which can react with secondary amines to produce N-nitroso compounds (NOC), another genotoxic compound. Nitrosamine, the most carcinogenic agent (cancer-causing) in cigarette smoke, was also found to increase in red meat that was burned directly.[11]

Another pathway links to cancer is consuming meat at high levels has been shown to increase weight gain due to its high energy density and/or fat content,[12] which is correlated to an increased prevalence of obesity.[13] There is a strong evidence that being overweight or obese throughout adulthood increases the risk of various cancers, such as colorectal, liver, prostate, stomach, and pancreatic cancer.[14]

Further Recommendations

World Cancer Research Fund recommends the consumption of red meat should be no more than three servings per week (~350 to 500 grams of heavy-cooked red meat or 500-750 grams of raw meat) and the consumption of processed meat is limited to a minimum.[4]

Other alternatives to reduce carcinogen production are avoiding direct-fire and prolonged cooking, minimizing direct-fire exposure to food can be done by wrapping food with leaves or other materials, changing cooking methods from grill and fry to baked, boiled, or sautéed; throwing away charred (blacken, overcooked) part of food, maintaining the frying pan or grill clean from the black part (oil or fat may burns or stick on its), flipping meats often,

and marinating meat which are proven to reduce HCA level.[15]

The government and health workers should take preventive measures by educating people about the potential hazard caused by this lifestyle, in order to reduce the prevalence and disease burden of cancer. Also, there has not been any specific limit to the consumption of red meat in Indonesia, suggesting a need for specific recommendations by government or professional organizations.

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