Consumption of meat prepared by barbecuing is associated with risk of cancer due to formation of carcinogenic compounds including benzo[a]pyrene (BaP). Assessment of a population's risk of disease and people's individual probability of disease given specific consumer attributes may direct food safety strategies to where impact on public health is largest. The aim of this study was to propose a model that estimates the risk of cancer caused by exposure to BaP from barbecued meat in Denmark, and to estimate the probability of developing cancer in subgroups of the population given different barbecuing frequencies. We developed probabilistic models applying two dimensional Monte Carlo simulation to take into account the variation in exposure given age and sex and in the individuals' sensitivity to develop cancer after exposure to BaP, and the uncertainty in the dose response model. We used the Danish dietary consumption survey, monitoring data of chemical concentrations, data on consumer behavior of frequency of barbecuing, and animal dose response data. We estimated an average extra lifetime risk of cancer due to BaP from barbecued meat of 6.8 × 10^-5 (95% uncertainty interval 2.6 × 10^-7 - 7.0 × 10^-4) in the Danish population. This corresponds to approximately one to 4,074 extra cancer cases over a lifetime, reflecting wide uncertainty. The impact per barbecuing event on the risk of cancer for men and women of low body weight was higher compared to higher bodyweight. However, the difference due to sex and bodyweight between subgroups are dwarfed by the uncertainty. This study proposes a model that can be applied to other substances and routes of exposure, and allows for deriving the change in risk following a specific change in behaviour. The presented methodology can serve as a valuable tool for risk management, allowing for the formulation of behaviour advice targeted to specific sub-groups in the population.