



Network Representation of Disease Risk from Foods

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Introduction

The food supply in the United Kingdom is changing and the identification of disease risks from foods is important for guiding prevention efforts and for assessing the effectiveness of food safety regulations. Surveillance data from foodborne disease outbreaks, where a single vehicle of infection is identified through epidemiologic or microbiologic investigations, is an important piece of information for estimating these risks.

Epidemiology

Surveillance of foodborne disease provides a snapshot of disease risks from foods. This information in the UK is captured by the Health Protection Agency and includes the National Surveillance Database for General Outbreaks of Infectious Disease (GSURV). Partitioning disease outbreaks across all food groups and across causative agents results in a two dimensional (2D) table. This table (Table 1) represents an association between food and disease. The probability that a food group is the vehicle of an infection, given a diagnosis of a foodborne disease, can be estimated from the proportion of cases where an individual food group has been identified as the vehicle of infection in outbreak scenarios. This information is, however, only relevant for the population suffering from foodborne illness

Combining diet and foodborne disease

The consumption pattern of the United Kingdom population also contributes to estimates of disease risks from foods (Table 2). Information on the diet of the UK population is available from the National Diet and Nutritional Survey (NDNS). This survey program is the result of collaboration between the Food Standards Agency and the Department of Health, who jointly funded the collection of the survey data, with the Office for National Statistics and the Medical Research Council Human Nutrition Research.

The 2D table, which encapsulates the outbreak data, can be combined with the NDNS data to give a probabilistic representation of the risk of foodborne illness arising from a food consumption event. We can build this probabilistic representation by introducing a variable A to represent the distribution of foodborne disease in the population and a variable F to represent a rationalised food group (vehicle) across the two tables. The combined table is then a representation of the conditional probability $p(F|A)$.

Belief network

The probabilistic representation linking diet and disease can be captured graphically using a belief network. Belief networks combine probability theory and graph theory and represent the joint probability in a domain. For this domain, the belief network (Figure 1) shows, intuitively, the association between diet and disease. The network can be implemented in software and the software facilitates the inversion of the conditional probability $p(F|A)$. This inverse conditional probability, $p(A|F)$, also known as Bayesian inference can be used to access the risks of foodborne disease arising from consuming certain food groups.

References

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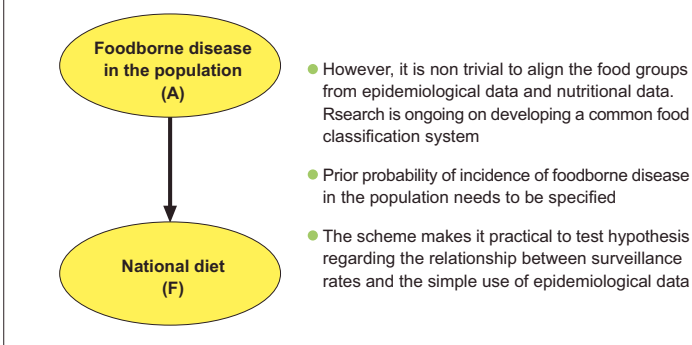
Table 1: A subset of general outbreaks of infectious intestinal disease, involving 1 food vehicle, in England and Wales from 1996-2000 (Adak *et al.* 2005)

Food group	All salmonellae (%)	Campylobacter (%)
Poultry	108 (0.23)	15 (0.56)
Red meat	51 (0.11)	0
Eggs	69 (0.15)	0
Seafood	19 (0.04)	1 (0.04)
Milk	8 (0.02)	6 (0.22)
Other dairy products	4 (0.01)	0
Vegetables/fruit	10 (0.02)	1 (0.04)
Rice	4 (0.01)	0
Complex foods	202 (0.43)	4 (0.15)
Total	475 (1)	27 (1)

Table 2: A subset of National Diet and Nutritional Survey (NDNS) of total quantities (grams) of food consumed in seven days by age of respondent: men (Henderson *et al.* 2002)

Food category	Men aged (years)	
	19-24	25-35
	g	g
Eggs & egg dishes	129	153
Meat, meat dishes & meat products	1438	1462
Fish & fish dishes	130	159
Vegetables & vegetable dishes (excluding potatoes)	665	854
Pasta, rice & other miscellaneous cereals	767	743

Figure 1: Belief net representation of the association between diet and foodborne disease



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