Estimation of Economic Loss due to Food Poisoning Outbreaks

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Abstract Food poisoning outbreaks frequently occur in many countries resulting in economic loss. A formula for calculation of economic loss due to food poisoning outbreaks in Indonesia was developed. Estimation of the loss was developed based on experiences in several countries. Related data were also collected from local health facilities, food industry officials, and other sources to improve the accuracy of the formula. Calculation of the economic loss was performed based on cases of food poisoning outbreaks recorded in 2013. Economic loss was estimated based on direct health-care costs, direct non-health-care costs, and indirect non-health-care costs. The economic loss of food poisoning outbreaks in Indonesia in 2013 was approximately US\$ 78 million. The high-cost of economic loss due to food poisoning outbreaks suggests a need for additional and serious efforts for controlling all aspects of food safety.

Keywords: outbreak, estimate of economic losses, food poisoning, food safety, Indonesia

Introduction

Food poisoning occurs when someone suffers from illness with symptoms and signs after consuming food that is thought to be contaminated by biological or chemical agents. A food poisoning outbreak is an event when 2 or more persons suffer from illness with the same or similar symptoms after consuming food, and that food is proved to be a source of poisoning based on epidemiological analysis (1).

Safe food is the right of all people. Indonesian law assures the consumer right to safe consumer goods (2). A Bill of the Republic of Indonesia Number 18 of Year 2012 Concerning Food states that every person engaged in the food chain should control hazard risks for food, which may be sourced from raw materials, processing equipment, production facilities, or from personnel, to give assurance of food safety (3). A Government Regulation of the Republic of Indonesia Number 28 of Year 2004 on Food Safety, Quality, and Nutrition also states that every person who has responsibility for food chain related activities, which comprise production, storage, transportation, and distribution of food, is obligated to fulfill all sanitation requirements according to existing law (4).

However, many food poisoning outbreaks occur in Indonesia. One cause of this problem might be a low concern for food safety. Efforts of many parties are needed to assure the safety of foods and every food-related institution, including suppliers, distributors, and

retailers, should apply and improve good practices in food handling and processing. Application and improvement of good practices incurs a cost that could be a barrier to maximum effort.

Food poisoning outbreaks that occur every year result in economic loss experienced by many people, both directly and indirectly. Accurate estimation of economic loss caused by food poisoning outbreaks would be useful for decision makers and stakeholders involved in food poisoning outbreaks (5). Such information is important for decision makers to set priorities and for development of integrated policies in social and economic sectors. This study was aimed at development of a formula for calculation of economic loss related to food poisoning outbreaks in Indonesia.

Materials and Methods

Primary and secondary data collection Primary data were collected using letters, interviews, questionnaires, and focus group discussions with parties related to food poisoning outbreaks, including health facilities officers, regional health authorities, cemetery officers, and food industry officials. Data collected related to food poisoning outbreaks (6-8) from 3 hospitals, 4 regional health authorities, 3 food industries, and 1 tourism authority office. Secondary data regarding food poisoning outbreak cases in 2013 were collected from The National Agency for Drug and Food Control (NADFC) report (9).

Development of a formula for calculation of economic loss in food poisoning outbreaks A formula was developed based on formulas used in previous studies (6-8). The developed formula was adjusted to Indonesian conditions using collected data.

Calculation of economic loss in food poisoning outbreaks Calculation of economic loss from food poisoning outbreaks was based on a formula developed in this study, data from food poisoning outbreaks cases in 2013 (9), and survey data.

Results and Discussion

The 3 cost components related to food poisoning cases are 1) direct health-care costs (DHC), 2) direct non-health-care costs (DNHC), and 3) indirect non-health-care costs (INHC).

Direct health-care costs (DHC) Direct health-care costs are related to medication, including the cost for a first-time visit to a doctor, inpatient care, and laboratory testing. Based on interviews with a doctor and a nurse in a local hospital who treated food poisoning victims, the first treatment for every food poisoning victim will be performed in the emergency department. If the patient condition is severe, admission to inpatient care (hospitalization) follows. Based on survey data, most food poisoning victims were hospitalized for 2 days. Thus, food poisoning incidences are low in severity, in accordance with a previous study which reported that patients who suffer gastroenteritis as a result of food poisoning will be absent from work with a median duration of 2 days (8). The percentage of victims in every food poisoning outbreak who were hospitalized is approximately 55% of all victims. Laboratory testing may be used to support diagnosis of illness symptoms (7) assuming that testing was performed only for hospitalized victims. Treatment cost data were collected from local hospitals in Jakarta that treated food poisoning victims in 2012 and 2013. Costs were assumed to be standard (Table 1) based on the assumption that victims did not use health insurance and, therefore, treatment costs were paid by victims.

The DHC calculation can be improved using supporting data, such as patient age, which will affect the medication cost (6,10). In this study, categorization of patient age was not included in the calculation process, in accordance with Indonesian conditions.

Direct non-health-care costs (DNHC) Direct non-health-care costs are not related directly with medication, but are directly borne by households. In the formula, variables that were included in DNHC were travel costs for visiting a general practitioner (GP) or a hospital, and mortality cost. The travel cost was calculated based on the assumption that every food poisoning victim only visited a GP or hospital once, assumed to be a round trip. The travel cost calculation included the cost of fuel from the victim's house to the nearest doctor or hospital with a standard fuel usage of 6 km/L (7). The mean

Table 1. Hospital treatment minimal cost for food poisoning victims

Hospital treatment	Cost per person (US\$)		
	Outpatient	Inpatient	
Emergency department registration	2	✓	✓
Emergency department laboratory testing	2	✓	✓
Stool specimen laboratory testing	14		✓
Blood specimen laboratory testing	55		✓
Drugs	14		✓
Ward room (per day)	7		✓

distance from a victim's house to health facilities across Indonesia was unavailable. Therefore, this study used data from a study by the Bengkulu Province Agency for Health Research and Development (11) in which the distance from health care facilities to victim's houses was approximately 1.8 km.

Food poisoning causes illness and death for which the household cost is a mortality cost (6). Based on data collected from interviews with two cemetery offices, the cost of a funeral is regulated by the government in each province. Therefore, the mortality cost will vary. To simplify the calculation, the mortality cost used in this calculation was for the DKI Jakarta Province of approximately US\$ 7 (12). The mortality cost calculation only included cost for cemetery rent. In practice, funerals in Indonesia incur extra costs for a funeral ceremony that varies with tribe or religion. This includes, for example, the cost of food for ceremony attendees, cost of the *kafan* (the cloth used to wrap remains) for Muslims, the cost of a coffin for Christians, and the cost of animals sacrificed during funeral ceremonies of some tribes. Due to a high degree of variability, these costs are difficult to quantify. Therefore, the calculation performed in this study was a lower-bound for mortality cost.

Indirect non-health-care cost (INHC) Indirect non-health-care costs are not directly related to medication and are not borne directly by the victim. INHC components included in the formula were productivity loss, follow-up measure costs, loss of product or brand image, loss of consumer trust, and product recall costs. Cressey and Lake (7) calculated productivity loss based on the assumption that a victim could not go to work because of illness. Therefore, the loss suffered daily was equal to the daily wage. This approach was used because productivity in a day was assumed to be equal to the wage for the day. Daily wages are different for jobs and positions, so the wage used was the mean value of the regional minimum wage from every province in Indonesia. Based on data collected from The Ministry of Manpower of the Republic of Indonesia (13), the mean regional minimum wage in Indonesia is approximately US\$ 102 per month. Therefore, this approach was considered as a minimum loss calculation.

Calculation of productivity loss was divided into the 2 categories of victims who were in the productive age range of 15-65 years old, and victims who were in non-productive age ranges of <15 and > 65 years

old. For the non-productive age, no direct productivity loss was assumed. However, a caregiver productivity loss was used based on an assumption that victims needed a caregiver while sick (8). Food poisoning outbreaks that resulted in premature death cause productivity loss from human capital that could have contributed to economic activity (6). Death occurs year round. Therefore, in order to accommodate different conditions, a mean value 6 months was used for determination of productivity loss as months remaining after death.

Every food poisoning outbreak case requires follow-up measures by government, including laboratory testing, surveillance, and investigation (6). Surveillance costs consist of sampling, testing, and travel costs of as much as US\$ 172, US\$ 62, and US\$ 14, respectively. Food poisoning outbreaks can be categorized as caused by foods from food hawkers, processed foods, foods from restaurants, and homemade foods (9). Categorization of food poisoning outbreak cases is shown in Table 2. The number of cases caused by processed food was high at 7 cases. Food poisoning caused by foods processed in an industrial setting can result in larger societal impacts than homemade foods due to larger product quantities and a wider distribution. On the other hand, food poisoning outbreak cases related to food industry products were assumed to cause impacts on the industry due to product recall, resulting in loss to the manufacturer, loss of sales from recalled products, and loss of consumer trust, which will also cause a decline in sales. Based on interviews with food industry officials, every product causing food poisoning outbreaks will suffer a loss in sales of as much as 10% from pre-outbreak sales levels. Total sales amounts for products vary, relative to manufacturer and product. However, based on survey data, the mean value of total sales per product per year was approximately US\$ 827,586. Additionally, as an impact of declining consumer trust, a manufacturer incurs extra costs for promotion and advertising to rebuild the product image and repair consumer trust, estimated to be approximately US\$ 13,793 for every product.

For calculation of INHC, improvements can be made to achieve a

Table 2. Foods causing food poisoning outbreaks in 2013

Food category	Outbreak cases	Percentage (%)
Foods from food hawkers	8	17
Processed foods	7	14
Foods from restaurants	8	17
Homemade foods	23	48
Unidentified	2	4
Total	48	100

more accurate result, for example, in calculation of the loss of productivity due to illness and categorization of age for victims of food poisoning because loss is related to the number of victims in the productive age range of 15-65 years old, under the assumption that every victim in the productive age range had a job.

Calculation of economic loss due to food poisoning outbreaks (ELFPO) in Indonesia in 2013 The 3 cost components were built into a formula called Economic Loss of Food Poisoning Outbreaks (ELFPO):

$$\text{ELFPO} = P\{\text{UGD} + [X_r \times (\text{O} + (\text{txKM}))] + (X_r \times \text{US}) + (2 \times 1.8 \text{ km} \times \text{BB} / 6 \text{ km}) + (X_k \times \text{M}) + (\text{t} / 30 \times \text{UMR}) + (X_k \times \text{UMR} \times 6)\} + K\{T + (X_o \times \text{I}) + (X_o \times \text{HP} \times \text{J})\}$$

Description of formula components is presented in Table 3. There were 48 food poisoning cases recorded in 2013 causing 1,690 illness victims and 12 deaths (9). However, the number of cases recorded did not represent the actual number of cases (14). Therefore, the number of cases must be converted based on an assumption that there are 99 unreported cases for every reported case in developing countries (15). Based on this assumption, the number of food poisoning cases used in this calculation was 4,800 for food poisoning outbreaks, which caused 169,000 illness victims and 1,200 deaths.

Data for food poisoning cases in 2013 and other data used for calculation of economic loss of food poisoning outbreaks are presented in Table 4. The estimated economic loss from food poisoning

Table 3. Components of a formula for calculation of economic loss of food poisoning outbreaks in Indonesia

Calculation components	Calculation sub-components	Formula ¹⁾
Direct Health-care Costs (DHC)	First-time visit to doctor cost	PxUGD
	Inpatient care cost	$X_r \times P_x [\text{O} + (\text{txKM})]$
	Specimen testing cost	$X_r \times P_x \text{US}$
Direct Non-health-care Costs (DNHC)	Round trip to doctor or hospital	$2 \times P_x 1.8 \text{ km} \times \text{BB} / 6 \text{ km}$
	Mortality cost	$X_k \times P_x \text{M}$
Indirect Non-health-care Costs (INHC)	Loss from productivity loss due to illness	$P_{xt} / 30 \times \text{UMR}$
	Loss from productivity loss due to death	$X_k \times P_x \text{UMR} \times 6$
	Follow up measures cost	$K \times T$
	Loss from loss of image and consumer trust	$X_o \times K \times \text{I}$
	Loss from product recall	$X_o \times K \times \text{HP} \times \text{J}$

¹⁾P, number of food poisoning victims per year; UGD, emergency department treatment cost; X_r , percentage of hospitalized victims; O, medication cost; KM, ward room cost per day; US, specimen testing cost; BB, fuel cost (per liter); X_k , percentage of dead victims; M, mortality cost; t, mean duration of illness; UMR, mean regional minimum wage per month; K, number of annual food poisoning cases; T, cost of follow up measures per case; X_o , percentage of food poisoning outbreak cases caused by processed foods; I, promotion (advertisement) cost per product per year; HP, percentage of sales lost caused by product recall; J, mean of total sales per product per year.

Table 4. Data used for calculation of economic loss from food poisoning outbreaks using the ELFPO formula

Variable	Data used ¹⁾
P=number of food poisoning victims per year	169,000 persons ²⁾
UGD=emergency department treatment cost	US\$ 4
X _r =percentage of hospitalized victims	55% ²⁾
O=drugs cost	US\$ 14
t=mean duration of illness	2 days
KM=ward room cost per day	US\$ 7
US=specimen testing cost	US\$ 69
BB=fuel cost per liter	US\$ 0.4
X _k =percentage of dead victims	1% ²⁾
M=mortality cost	US\$ 7
UMR=mean regional minimum wage per month	US\$ 102
K=number of annual food poisoning cases	4,800 cases ²⁾
T=cost of follow up measures per case	US\$ 248
X _o =percentage of food poisoning outbreak cases caused by processed foods	14% ²⁾
I=promotion/advertisement cost per product per year	US\$ 13,793
HP=percentage of sales lost due to product recall	10%
J=mean of total sales per product per year	US\$ 827,586

¹⁾Data sourced from primary and secondary data collection²⁾Secondary data**Table 5.** Calculation of economic loss of food poisoning outbreak cases in Indonesia in 2013

Calculation sub-components	Formula ¹⁾	Calculation	Cost (US\$)
First-time visit to doctor cost	PxUGD	169,000xUS\$ 4	676,000
Inpatient care cost	X _r xPx[O+(txKM)]	55%x169,000x[US\$ 14+(2xUS\$ 7)]	2,602,600
Specimen testing cost	X _r xPxUS	55%x169,000xUS\$ 69	6,413,550
Round trip cost to doctor or hospital	2xPx1.8 kmxBB/6 km	2x169,000x1.8 kmxUS\$ 0.4/6 km	40,560
Mortality cost	X _k xPxM	1%x169,000xUS\$ 7	11,830
Loss from productivity due to illness	Pxt/30xUMR	169,000x2/30xUS\$ 102	1,149,200
Loss from productivity due to death	X _k xPxUMRx6	1%x169,000xUS\$ 102x6	1,034,280
Follow up measures cost	KxT	4,800xUS\$ 248	1,190,400
Loss from product image and consumer trust	X _o xKxI	14%x4,800xUS\$ 13,793	9,268,896
Loss from product recall	X _o xKxHPxJ	14%x4,800x10%xUS\$ 827,586	55,613,779
Total loss			78,001,095

¹⁾P, number of food poisoning victims per year; UGD, emergency department treatment cost; X_r, percentage of hospitalized victims; O, medication cost; KM, ward room cost per day; US, specimen testing cost; BB, fuel cost (per liter); X_k, percentage of dead victims; M, mortality cost; t, mean duration of illness; UMR, mean regional minimum wage per month; K, number of annual food poisoning cases; T, cost of follow up measures per case; X_o, percentage of food poisoning outbreak cases caused by processed foods; I, promotion (advertisement) cost per product per year; HP, percentage of sales lost caused by product recall; J, mean of total sales per product per year.

outbreak cases in Indonesia in 2013 was approximately US\$ 78 million, with a percentage of economic loss from INHC of 87.75% of total loss, followed by DHC and DNHC loss percentages of 12.17 and 0.08% of total loss, respectively. Calculation details are presented in Table 5. The calculated value was similar to the economic loss from food poisoning in the Netherlands of €77 million (approximately US\$ 86 million) (8) and in New Zealand of NZ\$ 86 million (approximately US\$ 56 million) (7). The economic loss from food poisoning in Australia reached AU\$ 1,249 million (approximately US\$ 885 million) (6). The large estimated loss in Australia was caused by several factors. First, calculation for Australia included a lifestyle pain and suffering cost (6). Additionally, there are more foodborne diseases considered in the calculation for Australia (8 kinds of disease), than in

the Netherlands (4 kinds of disease) and in New Zealand (7 kinds of disease) (6-8).

Concern from every related party is needed to assure the safety of foods so that numbers of food poisoning outbreaks can be reduced and loss minimized. Measures to be applied include upgrading of skills for health officers to improve epidemiology data of food-safety-related cases for better identification and use of effective strategies to control food safety (9,16). Education of people regarding steps to maintain food safety and choice of safe foods for consumption is also important.

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