FOOD POISONING OUTBREAK CASES AMONG SCHOOL CHILDREN IN TERENGGANU YEAR 2016 AND ITS ASSOCIATED FACTORS

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LIST OF ABBREVIATIONS

CCP	Critical Control Point
CDC	Communicable Disease Centre
CI	Confidence Interval
HACCP	Hazard Analysis and Critical Control Points
MOE	Ministry of Education
MOH	Ministry of Health
MREC	Medical Research Ethics Committee
NHMS	National Health and Morbidity Survey
NMRR	National Medical Research Registry
ROC	Receiver Operating Characteristics
WHO	World Health Organization

LIST OF SYMBOLS

>	More than
<	Less than
=	Equal to
≥	More than and equal to
≤	Less than and equal to
α	Alpha
β	Beta
%	Percentage
Δ	Precision/ Delta
°C	Degree Celsius

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ABSTRAK

KES WABAK KERACUNAN MAKANAN DI KALANGAN PELAJAR SEKOLAH DI TERENGGANU PADA TAHUN 2016 DAN FAKTOR-FAKTOR PENYUMBANG

Latar belakang: Keracunan makanan adalah salah satu masalah kesihatan awam di Malaysia dan merupakan antara lima penyakit berjangkit tertinggi di Malaysia. Negeri Terengganu juga menunjukkan peningkatan kes wabak keracunan makanan yang melibatkan pelajar sekolah.

Objektif: Kajian ini bertujuan untuk menentukan peratus kes wabak keracunan makanan yang melibatkan pelajar sekolah di Terengganu pada tahun 2016. Ia juga untuk menerangkan dan menentukan faktor-faktor yang berkaitan dengan wabak keracunan makanan yang melibatkan pelajar sekolah di Terengganu pada tahun 2016.

Metodologi: Kajian ini menggunakan kaedah hirisan lintang yang dijalankan menggunakan data sekunder mengenai kejadian wabak keracunan makanan yang melibatkan pelajar sekolah di Terengganu pada tahun 2016. Data diperolehi dari Borang Siasatan Keracunan Makanan (FWBD / KRM / BG 001) Pindaan 2008 dan laporan wabak akhir dari sistem eWabak.

Keputusan: Kadar kejadian wabak keracunan makanan yang melibatkan pelajar sekolah di Terengganu tahun 2016 adalah 63.6%. Sekolah di bawah kelolaan Kementerian Pelajaran Malaysia menyumbang kepada 95.3% kes keracunan makanan. Sekolah menengah telah menyumbang kepada 81% kes keracunan makanan. Kebanyakan wabak keracunan makanan (57.1%) berlaku di sekolah yang terletak di daerah pedalaman. Ayam adalah jenis makanan yang paling tinggi berkaitan dengan wabak keracunan makanan di sekolah dengan menyumbang sebanyak 61.9%. Agen etiologi mikrob yang paling biasa dijumpai adalah *Salmonella spp.* (52.4%) dan 57.1% daripada titik kawalan kritikal yang terlibat adalah memakan makanan yang kurang masak dan proses pemanasan makanan yang tidak sempurna. Sekolah yang terletak di daerah pedalaman (aOR=1.668; 95% CI: 1.355,2.055; p<0.001) dan sekolah bukan daripada kelolaan Kementerian Pelajaran Malaysia (aOR = 3.621; 95% CI: 2.368, 5.537; p<0/001) mempunyai risiko lebih tinggi untuk mengalami wabak keracunan makanan di sekolah. Selain daripada itu, bagi jenis makanan, ayam (aOR= 0.384; 95% CI: 0.180,0.819; p=0.013), daging merah (aOR=0.327; 95% CI: 0.181,0.589; p<0.001), nasi / bijirin (aOR= 0.216; 95% CI: 0.083,0.563; p= 0.002) adalah mempunyai risiko yang rendah dalam menyebabkan wabak keracunan makanan di sekolah jika dibandingkan dengan telur. Tiada penemuan yang signifikan dalam faktor titik kawalan kritikal semasa penyediaan makanan dalam kajian ini.

Kesimpulan: Keracunan makanan dalam kalangan murid sekolah di Terengganu adalah berkait dengan faktor yang tidak boleh diubah seperti kategori sekolah (Sekolah kelolaan Kementerian Pelajaran Malaysia dan sekolah bukan kelolaan Kementerian

Pelajaran Malaysia) dan dearah terletaknya sekolah tersebut. Faktor yang boleh diubah adalah jenis makanan, titik kawalan kritikal dalam penyediaan makanan. Untuk mencegah keracunan makanan di sekolah, pendidikan kesihatan perlu diperkukuhkan dengan keselamatan makanan, pengendalian makanan yang betul, amalan kebersihan yang ketat, dan persekitaran kantin bersih semasa persediaan makanan.

Kata kunci: Keracunan makanan, wabak, sekolah, penyakit bawaan makanan.

ABSTRACT

FOOD POISONING OUTBREAK CASES AMONG SCHOOL CHILDREN IN TERENGGANU YEAR 2016 AND ITS ASSOCIATED FACTORS

Background: Food poisoning is a public health problem in Malaysia and is in the top five communicable diseases in Malaysia. Terengganu had also shown increasing trend of food poisoning involving school children.

Objective: This study aimed to determine the proportion of food poisoning cases involving school children in Terengganu in year 2016 and to determine the associated factors of food poisoning outbreak involving school children in Terengganu in year 2016.

Methodology: This was a cross–sectional study using secondary data of 21 food poisoning outbreaks collected among school children in Terengganu that involved in food poisoning outbreak at school in year 2016. The data were obtained from Borang Siasatan Keracunan Makanan' (FWBD/KRM/BG 001) Pindaan 2008 and final outbreak report from eWabak system.

Result: The proportion of food poisoning outbreak involving school children in Terengganu in year 2016 was 63.6%. Ministry of Education schools had contributed to 95.3% of food poisoning outbreak cases and 81% occurred at secondary schools. Most of the food poisoning outbreak (57.1%) occurred at schools located in rural

district. Poultry was the most food vehicle related to school food poisoning outbreak with the proportion of 61.9%. The commonest microbial etiological agent was *Salmonella spp.* (52.4%) and 57.1% of critical control point involved was inadequate cooking and reheating. Schools that were located in rural district (aOR=1.668; 95% CI: 1.355,2.055; p<0.001), non-MOE school (aOR = 3.621; 95% CI: 2.368, 5.537; p<0/001), were the factors at higher risk to involve in school food poisoning outbreak. Meanwhile, for food vehicle,poultry (aOR= 0.384; 95% CI: 0.180,0.819; p=0.013), red meat (aOR=0.327; 95% CI: 0.181,0.589; p<0.001) and rice/grain (aOR= 0.216; 95% CI: 0.083,0.563; p= 0.002) are more protective than eggs that were associated with the occurrence school food poisoning outbreak in Terengganu year 2016. The CCP factors were all not significant in our studies.

Conclusion: Food poisoning among school children in Terengganu had been associated with non-modifiable factors such as school category (MOE & non-MOE school) and school district location and modifiable factors such as food vehicles and critical control points involved. In preventing food poisoning in school, health education need to be strengthened on food safety, proper food handling, strict hygiene practice, and clean canteen environment during food preparations.

Keyword: food poisoning, outbreak, school, food borne disease.

CHAPTER 1

INTRODUCTION

1.1 Overview of food poisoning

Food poisoning is the rapid onset of symptoms (typically nausea, vomiting, abdominal pain and diarrhoea) after ingestion of contaminated food (Eley,1992). Foodborne disease outbreak is defined as the occurrence of two or more cases of similar illness resulting from the ingestion of common food (Olsen *et al*., 2000).

WHO in 2014 had shown that 3% of mortality and two million deaths each year including many children were contributed by diarrheal disease (WHO, 2015). In Indonesia, the prevalence of diarrhoea was 42.2% which ranked the 5th highest among school children (5-14 years) after the age groups of infant, toddler and the elderly (Syahrul, 2017). In Japan, there were 11,824 cases of food poisoning and 12 deaths resulting from infection with *E. coli* O157:H7 between May to December 1996. The major sources of infection are from school lunch served at elementary and nursery schools (Michino and Otsuki, 2000).

In Malaysia, food poisoning is still a public health problem evidenced with the incidence rate of food poisoning 44.18 per 100,000 populations in 2010, 50.42 per100,00 populations in 2014 and 47.2 per100,000 populations in 2016. Food

poisoning is the top five communicable disease in Malaysia (MOH, 2015) and mortality caused by food poisoning was 0.041 per100,000 population in year 2016 (MOH, 2016). The percentage of school affected with food poisoning appeared similar in year 2013 (49.2%) and 2014 (49.1%) (MOH, 2014).

Statistics in Malaysia showed increasing in trend of food poisoning in year 1996 to 1997, and 66.5% of outbreak took place in primary and secondary schools. Other educational institutions like universities, colleges and training centres contributed to the second highest cases and only 0.4% originated from contaminated food sold at various public food courts (Meftahuddin, 2012). These numbers showed that school children were among the most affected victims of food poisoning in Malaysia. Food poisoning cases usually reported among school students that involved in school canteens, hostel kitchens and food prepared under the Supplementary Food Programme.

In Terengganu, the incidence rate of food poisoning had increased from 54 per/100,000 population in 2013 to 77 per100,000 population in 2014. Cases had increased from 502 in 2013 to 907 cases in 2016. It was documented by Communicable Disease unit of Terengganu State Health Department that food poisoning outbreak episodes involving schools had increased from 15 outbreak episodes in 2015 to 23 episodes in year 2016.

1.2 Problem statement and study rationale

Terengganu had shown an increasing trend of food poisoning outbreak in schools from year 2102 to 2016. Previously, there were few studies done on food poisoning cases at schools in Terengganu that described its contributing factors. There is also lack of evidence in determining the most important aetiological agents, the critical control point (CCP) and the food vehicles involved in food poisoning cases at schools in Terengganu.

The findings of our study can be used for determining the most frequent food vehicles, aetiological agents and the critical control points (CCP) involved in food handling that may contribute to food poisoning. This study also can give accurate information on the factors that can be contributed to the food poisoning outbreak in schools. These may include the about the usual implicated food vehicles and how should food be handled. This important data can aid the school and CDC unit in proper planning of effective prevention and control programs.

1.3 Research questions

1.3.1 What is the prevalence of food poisoning outbreak cases involving school children in Terengganu in year 2016?

1.3.2 What are the causes of food poisoning involving school children in Terengganu?

1.3.3 Is there any association between food vehicles with food poisoning cases involving school children in Terengganu?

1.3.4 Is there any association between critical control points (CCP) with food poisoning cases involving school children in Terengganu?

1.4 Objective of study

1.4.1 General:

To determine the proportion of food poisoning cases involving school children in Terengganu in year 2016 and its associated factors.

1.4.2 Specific:

1.4.2.1 To determine the proportion of food poisoning cases involving school children in Terengganu in year 2016.

1.4.2.2 To describe associated factors of food poisoning outbreak involving school children in Terengganu.

1.4.2.3 To determine the association between factors associated with the occurrence of food poisoning outbreak involving school children in Terengganu.

1.5 Hypotheses

1.5.1 There is an association between food vehicle and food poisoning outbreak involving school children in Terengganu.

1.5.2 There is an association between critical control points and food poisoning outbreak involving school children in Terengganu.

CHAPTER 2

LITERATURE REVIEW

2.1 Definition of Food Poisoning

Clinical case definition of food poisoning is an acute onset of vomiting and or diarrhoea and or other acute symptoms associated with ingestion of food (include drinks). Food poisoning may also present with neurological symptoms such as paraesthesia, muscle weakness and paralysis. Any case notified that fulfilled the clinical case definition of food poisoning is considered confirmed case (MOH, 2017). The ingested food or food products can be contaminated with physical, chemical and biological agents. These contaminations can occur at different steps in food production and preparation (WHO, 2007).

2.2 Epidemiology of Food Poisoning

WHO African and South-East Asia Regions have the highest burden of foodborne diseases. From the WHO report on the Global Burden of Foodborne Disease, South-East Asia Region has the second highest burden of foodborne diseases per population, after the African Region. However, in terms of absolute numbers, more people living in the WHO South-East Asia Region fall ill and die from foodborne diseases every year than in any other WHO Region, with more than 150 million cases and 175 000 deaths a year. Some 60 million children under the age of 5 fall ill and 50 000 die from

foodborne diseases in the South-East Asia Region every year. Diarrhoeal disease causing agents, Norovirus, non-typhoidal Salmonella and pathogenic E. coli cause the majority of foodborne disease deaths in the Region. Globally, half of the people who are infected and die from either Typhoid fever or hepatitis A reside in the South-East Asia Region. (WHO, 2015).

In a surveillance done in United States in 2009-2010, biological agents contributed to the largest causes of food poisoning outbreaks among 790 total outbreaks with a laboratory–confirmed aetiological agents. Norovirus was the most commonly reported (42%) with Salmonella spp. (30%) contributed to the second confirmed aetiological agent (CDC, 2013).

Based on National Health and Morbidity Survey III (NHMS III), the overall incidence of self-reported acute diarrheal illness within a two weeks' period in Malaysian population was 5.0% (95% CI: 4.8 – 5.2) or 1,036,518 episodes. Among children age group, the reported highest incidence was among teenagers aged 15-19 years old (7.7%), followed by aged 0-4 years old (4.5%) and lastly by 5-9 years old (3.4%). The longest mean duration of diarrhoea in children was 2.7 days, 30% of the children less than 10 years old also has vomiting with 54.9% having abdominal cramps as the associated symptoms. Acute diarrhoea had caused school absenteeism; it was reported that 27.7% of children aged 10-19 years old had some absentees because of experiencing diarrhoea. The school going children had the greatest impact of

experienced limitation, where children aged 5-9 years old had limitation activities due to diarrheal symptom (IPH, 2008).

2.3 Causes of food poisoning

Foodborne disease occurs due to ingestion of bacteria, viruses or parasites. The ingested organisms than multiply in intestines and cause illness. Non-infectious agents like toxin and chemicals can also cause food poisoning (Linscott, 2011).

Foodborne disease agents can be furthered classified using taxonomy and mode of transmission of the biological agents. Another classification is based on the clinical sign and symptoms such as nausea and vomiting (*Staphylococcus. aureus, Bacillus cereus, Norovirus, Escheria coli,* and *Vibrio cholera*), non-inflammatory diarrhoea (non-typhoidal *Salmonella spp., Shigella spp.*, Enteroinvasive *E.coli,* Enterohemorragic *E.coli, Campylobacter, V. parahaemolyticus, Yersinia spp.* and other enteroinvasive pathogens), neurological sign and symptoms (*C. botulinum*, scrombroid toxin, mushroom toxin, and monosodium glutamate), systemic and miscellaneous symptoms (*Listeria monocytogenes, Trichinella spiralis, group A Streptococci, Hepatitis A virus,* and *Brucella spp*.) (Cliver, 2011).

From the analysis by World Health Organization (WHO) on the Global Estimate and Regional Comparisons of the Burden of Foodborne Disease in 2010, Norovirus and *Campylobacter spp*. were the most frequent agents causing foodborne diarrhoeal illness. Death in diarrhoeal disease in majority of food borne diseases in

the most region of the world was contributed by Norovirus, non-typhoidal *Salmonella spp.* and pathogenic *E. coli*. Foodborne diarrhoeal disease agents, particularly non-typhoidal *Salmonella enterica*, caused 230,000 deaths. Other agents that also contributed to deaths were *Salmonella typhi, Taenia solium* and *Hepatitis A* virus (Havelaar, 2015).

Olsen *et al*. (2000) reported in a surveillance study of foodborne disease outbreak in year 1993-1997 that bacterial pathogens caused most of the food poisoning outbreak in United States (US). There were also 68% of foodborne disease outbreak with unknown aetiology that need to be highlighted because improvement must be done on the laboratory and epidemiological investigations of the outbreak. The remaining 32% of known bacteriological agent, *E. coli* O157:H7 and *S. Enteritis* continued to be the major cause of severe illness and cause higher mortality rate (Olsen *et al.,* 2000). Another study done in United States, Canada and Europe had shown that 70% of foodborne disease outbreak were contributed by *Salmonella enteritidis* (46.95), Norovirus (13.5%) and *E. coli* (9.5%) (Greig & Ravel, 2009).

2.4 Mode of transmission

Faecal-oral route is usually the mode of infection of agents that cause diarrhoea. This route includes the ingestion of faecal contaminated food and water, person-to-person transmission, and direct contact with the infected faeces. Majority or 36% of transmission is caused by food borne transmission. As most of the enteric infection patients are asymptomatic, they are able to transmit many enteric pathogens that include bacteria, viruses and parasites. As the asymptomatic patients are unaware that they are sick, they can highly transmit the infection if they practise poor hygiene, and migration may increase the risk of infection (Mbonye, 2004).

Foodborne bacteria can be transmitted at difference stages of food preparation. These include contamination at the farm, for example milk is contaminated with animal faeces, or the animals are already being infected by pathogenic microorganisms. Transmission can also occur during slaughtering where meat comes into contact with animal intestine, skin or fur and finally in the kitchen during food preparation due to improper handling (Hugas & Beloeil, 2014).

2.5 Factors that contribute to food poisoning

2.5.1 Food Handling Process

Several factors contribute to foodborne illnesses like lack of self-hygiene of food handlers, no clean water supply and unclean environment (Meftahuddin, 2002). Food handlers are the most common source of contamination because they can spread harmful organisms by means of faecal-oral route or skin lesions, as well as unclean kitchen utensils or kitchen counters (Linscott, 2011).

Meftahuddin (2002) had shown that factors that contributed food poisoning outbreak in Malaysia were unhygienic food handling practices, poor environmental sanitation and inadequate of safe drinking water supply in the slum and squatter areas. MOH in 2007 also showed that 50% of foodborne disease outbreaks were due to unhygienic food handling practices. Besides that, among causes of food poisoning cases that occur in school or academic institutions were inappropriate food handling practices, too early prepared meals and meals kept at ambient temperature until being served (Kusumaningrum *et al.,* 2003). Some of the main risk factors are inappropriate storage (32%), inadequate heat treatment (26%) and cross contamination from raw to cooked foods (25%) (Smerdon *et al.*, 2001).

2.5.2 Food Vehicle

US food surveillance for Foodborne Disease Outbreak found that the involved food vehicles were beef (13%), dairy and fish (13% respectively) and poultry (11%) (CDC, 2013). Food poisoning outbreak cases in England and Wales (1992-1996) showed that 64.3% involved food came from animal origins; with 18.7% from red meat, 18.5% from poultry and 15.7% from seafood. *Salmonella spp.* also was found to be 67.3% associated with poultry. Proteinaceous and precooked has involved with staphylococcus food poisoning. These findings were shown in the food poisoning outbreak after eating school lunch programme (Panisello *et al*., 2000).

In Malaysia, it is found that most of the raw food such as raw meat and vegetables had been contaminated with foodborne bacteria such as Salmonella, *Listeria spp.* and *E. coli* O157:H7. Salmonella were detected from 35% of the vegetables samples examined in Selangor, Malaysia (Salleh, 2003), and they were also found in 32% of the raw foods (chicken pieces, liver and gizzard) and 17% of the ready-to-eat cooked foods (including cooked chicken meat, beef, prawns and satay) (Arumugaswamy *et al*., 1995).

2.6 Food poisoning at school

There was slight increase in total episodes of food poisoning in schools in Malaysia from 244 in 2013 to 246 in 2014. The percentage of schools affected with food poisoning in Malaysia was similar with 49.2% in 2013 and 49.1% in 2014. A study done by Meftahuddin (2002) showed that 66.5% of total food poisoning cases occurred in primary and secondary school. Data in Indonesia also showed that prevalence rate of diarrhoea in Indonesia is around 42.2% and 9% of cases occurred among school age children (5-14 years old) (Agustina *et al.*, 2015).

According to Meftahuddin (2002) unhygienic food handling practice, poor environmental sanitation and inadequate of safe drinking water have contributed to food poisoning outbreaks in Malaysia. Most of the implicated food settings occur in schools and academic institutions, and inappropriate food handling practices such as too early meals preparations, and food were kept in ambient temperature until being served contributed to the outbreak in school (Soon *et al*., 2011). Besides that, the higher kitchen temperature than the dining area makes a perfect condition for bacterial growth. It has also been proven that foodborne bacteria can grow on most of the surfaces in the kitchen like cutting boards, cloths, sinks, cleaning sponges and knives (Abdul-Mutalib *et al*., 2015).

At school, one of the factors that contributed to acute diarrhoea in school was poor hand washing practice before meals. A study in Myanmar had shown that 43% of students with poor hand washing practice were more likely to report an episode of diarrhoea and vomiting. Younger age has higher risk for food poisoning. The reason for it may reflect low level of body immunity to infection and responsibility to actively maintain good hygiene as the getting more mature. The number of hand wash stations with soap availability clearly showed to reduce risk of diarrhoea and vomiting in school (Weaver *et al.,* 2016).

2.7 Risk factors of food poisoning in children

In Malaysia, a study done among children with acute diarrhoea had isolated Non Typhoidal Salmonella (NTS) as the commonest bacterial pathogen isolated (55%), followed by *Shigella spp.* (13.1%) and enteropathogenic *E. coli* (10.4%) (Lee & Puthucheary, 2002). It is important to deliver good food safety information to the students as they are the net consumers of food in their school canteens. A study among Johor secondary students found that 44.4% of secondary students did not know that Salmonella can cause food illnesses. This is a worrying issue as Salmonella is one of the commonest bacteria that causes food outbreak in Malaysia and also the rest of the world (Norazmir *et al*., 2012). Another challenge in the bacterial agents is the increase of antimicrobial resistance that will reduce the efficacy of antibiotics and it make food poisoning very difficult to treat (Jamali *et al.,* 2015).

Children deserve added attention in the study of microbial foodborne illness because the risks of some foodborne illnesses, such as salmonellosis, are relatively higher for children than for other demographic groups. Children are more susceptible for foodborne disease because their immune system is not fully developed and they have lower mean- weight in comparable to adults. The lower mean weight of children makes them prone to foodborne illness as they only need small quantity of pathogens to make them sick (Buzby, 2001).

During the six hours of schooling session, students are unable to purchase food other than food sold at school canteen, so they were exposed to food poisoning if food were not prepared properly (Yabancı & Şanlıer, 2007). As children's meals were prepared by others, they have limited control over food safety risk. These all factors need more attention in the study of microbial foodborne illness to foodborne disease among children.

It was reported in the literature that the younger the children are, the faster parents brought them for treatment of acute diarrhoea. In the NHMS III data, 67.7% of children with acute diarrhoea and 56.5% of children five to nine years old are more likely to seek early treatment for acute diarrhoeal disease. But, the age of 10 to 19 years old child showed significantly lower percentage of seeking medical treatment. The most frequent reason for not seeking treatment was generally consistent for all age groups as they reported that being the illness was mild, and the ability to self-medicate.

This behavioural factor can lead to high morbidity and mortality of children with acute diarrhoeal disease (Tee *et al.,* 2011).

2.8 Food poisoning in urban and rural area

Previous research done by Knight *et al.*(1992) showed that, there were multiple factors involved with acute diarrhoea in children living in rural area. The factors were consumption of unboiled water, prolonged storage of cooked food before consumption and bottle feeding. From the observational study, there were presence of animal in the house, and importantly the poor hand washing behaviour and the absence of water for hand washing in their toilets.

In urban area, the growing street food sector in low-income countries offers easy accessibility to cheap food. This has become one of the new public health challenges for the urban population. Safe food hygiene will not be the crucial practice in handling street foods, thus there is an increase risk to develop acute diarrhoea with the consumption of street food. It was also found that both vendors and customers had shown minimal knowledge on food safety, but they did not emphasize on the basic hygiene practices. These include the importance of proper hand washing, cleaning of utensils, washing of raw vegetables, and quality of ingredients (Rheinländer *at al*., 2008). In Korea, a study showed that, 50% of the school children of fourth to sixth grades consume street food for snacking because of hunger and good appearance of the food (Kang *et al.,* 2004).

2.9 Foodborne outbreak investigation

A foodborne outbreak was defined as an incident where two or more persons experienced a similar illness after consuming a common food or meal (Bryan *et al*., 1997) and analytical epidemiological and/or microbiological evidence implicated the food or meal as the source of illness (Hennekinne *at al*. 2012).

In Malaysia, the current foodborne disease surveillance data is collected mainly through physician-based surveillance and outbreak investigations by the Communicable Diseases Centre (CDC) Surveillance Section, Diseases Control Division, Ministry of Health. Notification of food poisoning outbreak is received from all the government and private health facilities. These include health clinics, outpatient departments, private general practitioners, public and private hospitals (MOH, 2007).

Notifications are received through electronic reporting system known as the Communicable Diseases Control Information System (CDCIS) (MOH, 2007). In the Prevention and Control of Infectious Diseases Act 1988 (Act 342), there are five types of food and waterborne diseases which are required to be notified; namely cholera, typhoid/paratyphoid fevers, viral hepatitis A, food poisoning and dysentery (MOH, 2007). Reporting or notifying of infectious diseases is mandated by the Prevention and Control of Infectious Disease Act 1988. The Prevention and Control of Infectious Diseases (Notice Form) regulations was gazetted in 1993, and currently a total of 28 infectious diseases conditions are required to be notified by law (MOH, 2017).

Detection of foodborne disease outbreak affected the school children is much easier as there would be number of school children be sent to hospital for treatment. It is more difficult to detect outbreak in food outlet since the affected individual would go to the different general practitioner clinics or hospital outpatient departments where the vast majority of cases are not notified (Soon *et al.*, 2011).

In the investigation of foodborne disease outbreaks, the aim is to prevent on-going transmission of disease and to prevent similar outbreaks in the future. It is done for the detection and removal of implicated foods, to identify specific risk factors related to the host, agent and the environment. Besides that, it also identifies factors that contributed to the contamination, growth, survival and dissemination of the suspected agent. The outbreak investigation will include full investigation method including epidemiological investigations, environmental and food investigations, and laboratory investigations. (Skovgaard, 2009).

2.10 Food Safety

Food safety issue is an important to be implemented in public health. Food contamination can occur anywhere along the food processing and preparation. It can occur during production and processing phase, and during the preparation and consumption phase. Food safety is the responsibility of all people in catering or food service operation in food handling.

From previous study, general food handling mistakes besides serving contaminated raw food also include inadequate cooking, heating, or reheating of food, consumption of food from unsafe sources, cooling food inappropriately and allowing too much of time lapse. Those errors might lead to food poisoning (Aziz & Dahan, 2013).

Many studies identified the need for training and education of food handlers in public hygiene measures on microbiological food hazards, temperature ranges of refrigerators, cross contamination and personal hygiene (Worsfold *et al*., 2004). However, some preceded studies showed no differences between staff who attended educational course with those who did not (Aziz & Dahan, 2013).

The importance of food safety knowledge must be introduced to children because they are the end consumers at schools and they will be the food preparator in the future. The need for enhanced food safety education has been recognized as importance in the United States and Europe for the benefits of educating the consumers especially children (Haapala & Probart, 2004). A study showed that knowledge of food safety in males and females consumers among students was similar; but practice and attitudes of safe food safety was higher in females (Şanlıer, 2010). Besides that, the knowledge on food safety issue also needs to be given to food handlers.

In Malaysia, it was found that Malay and Indian hawkers had a better knowledge on food safety information that includes cross-contamination, clean equipment and utensils, and HACCP as compared to Chinese hawkers. It was also shown that hawkers with better educational level had better knowledge and attitudes towards food safety (Toh & Birchenough, 2000). So, strategies for intervention to reduce food poisoning should also include the appropriate training of food handler as food handling training program is very important and have a positive and significant relationships with safe food handling behaviour (Saidatul & Hayati, 2013).

2.11 Hazard Analysis and Critical Control Point (HACCP)

In food preparation, it is crucial to pay attention to the microbiological quality of food, but the food handling process is also an important component to be aware of. So, it is very important to implement Hazard Analysis and Critical Control Point (HACCP) along the whole food processing. WHO had acknowledged HACCP in year 1995 as the most cost-effective method of controlling foodborne hazard from 'farm–to–fork'. It is important to implement HACCP method in outbreak investigation to point the most important Critical Control Point (CCP) violated during the food preparation and processing (Panisello *et al.,* 2000).

Bryan (1997) had suggested a system outbreak investigation using a classify-food borne outbreak information involving the food vehicles, the causative agents, and the CCP involved in the outbreak since 1988. According to Sun & Ockerman (2005);

CCP can be categorized as inadequate cooking and reheating, incorrect storage (improper cooling or hot holding), cross contamination from unclean materials, and infected food handler that are also stated by the United States Centre for Disease Control and Prevention (CDC, 2013).

According to CDC, more than half of all food borne illnesses is due to keeping foods at room temperature for more than two to four hours. Besides that, cooked foods held at below 60°C until being served can be a significant source of food borne illness. In the risk of inadequate reheating; the risk is higher when previously cooked foods are not reheated to above 74°C. Sick food handlers are implicated in one out of every four food borne illnesses outbreaks, the condition is worsened if they had poor hand hygiene practice (CDC, 2013).

Cross contamination prevention includes the implementation of First in First Out (FIFO) system, separation of raw and cooked food item and washing all the cooking utensils before use (Ejemot *et al*., 2008). Longer holding time can increase the risk of bacteria growth in food. Food Drug Act (FDA) had recommended that all cooked food must be served and consumed within 4 hours and 60ºC is the recommended holding temperature. For chilled food, the temperature should be kept between -10ºC to 5ºC (Musa *et al.*, 2010) MOH also promotes food safety through the certification of the Malaysian Certification Scheme for HACCP. In 2008, HACCP was introduced to hospitals' food service establishments in Malaysia (Soon *et al*., 2011).

2.12 Conceptual framework

Figure 2.1 illustrated the conceptual framework of this study. There are many factors that lead to food poisoning outbreak at school based on literature search. In the sociodemographic factor, the variables studied were age, gender, type of school, geographical area (urban or rural area). For the aetiological agent, the studies agents were *Bacillus cereus*, *Staphylococcus aureus*, *Salmonella spp.* and *E. coli*. Other aetiological agents such as virus and parasite were not included in this study. The food vehicles studies were poultry, red meat, eggs, rice/grain, fish and seafood. All critical control points listed in the conceptual framework were studied.

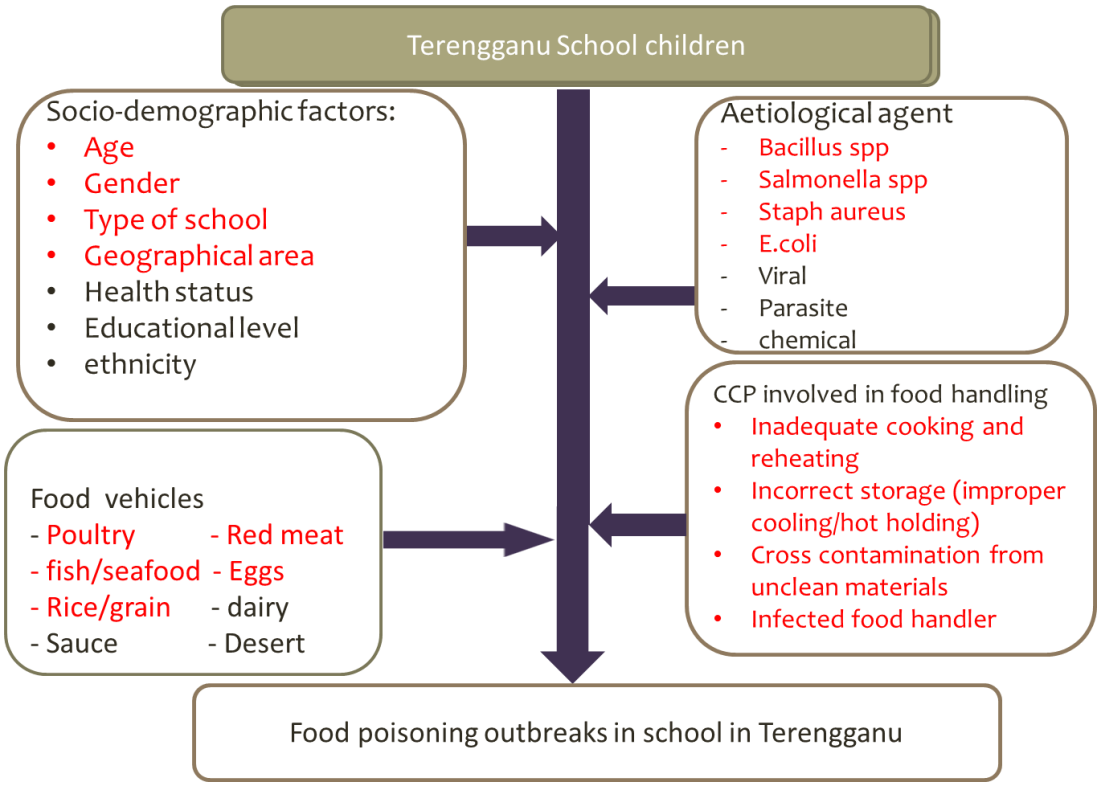

Figure 2.1: Conceptual Framework of Study.

CHAPTER 3

METHODOLOGY

3.1 Study design

This was a cross –sectional study using secondary data.

3.2 Study duration

This study was done from January 2018 to 30th April 2018.

3.3 Study location

The study involved all districts in state of Terengganu. Terengganu Darul Iman is located at the East Coast of Peninsular Malaysia with Kelantan and Pahang are the neighbouring states. The land mass of Terengganu state is approximated to be 1,295,638.3 hectares. It has eight districts namely Kuala Terengganu, Kuala Nerus, Kemaman, Dungun, Setiu, Besut, Marang and Hulu Terengganu. Kuala Terengganu is the capital town of Terengganu. The estimated total population in Terengganu is about 1.29 million. The children ages ≤18 years old population is about 441,000 and make up 36.5% population in Terengganu (DOSM., 2017).