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Foodborne Disease Outbreaks in the Philippines (2005–2018)

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The study detailed 209 reported Philippine foodborne disease outbreaks (FBDOs) for the period 2005 – Jun 2018. Multiple implicated foods were associated in majority of the studied outbreaks. Meat-containing dishes were the most common causative foods in the evaluated outbreaks with defined food vehicles. Food service eating facilities and households were found more prone to outbreak occurrences. Although there were reported outbreaks with unidentified causative agents, *Salmonella* spp., Henipavirus, *Entamoeba histolytica,* and *Vibrio parahaemolyticus* were cited as primary causes of infections. Human intoxications involved staphylococcal enterotoxins, carbamate toxin, and paralytic shellfish poisoning (PSP) toxin. Impact of the study on the implementation of national food safety controls of the Philippines was also cited.

Keywords: foodborne diseases, foodborne outbreaks, food safety, Philippines

INTRODUCTION

An FBDO is defined by the US Center for Disease Control and Prevention (CDC) as an occurrence in which at least two persons experience a similar illness resulting from the ingestion of a common food (CDC 2012). Foodborne illness is a global issue with the continuous increase in food safety risks brought about by internationalization of food trade (Choi 2008). These include outbreaks that are due to microbial pathogens, residue contaminations, biological toxins from fishery products, and other chemical and physical contaminants (Spiric *et al.* 2015).

There is usually a high prevalence of FBDOs in developing countries due to poor sanitation (O'Ryan *et al.* 2005). The World Health Organization (WHO), through the Foodborne Disease Burden Epidemiology Reference Group, identified the West Pacific Region – including the Philippines – to have intermediate burdens in the range of 140–360 disability-adjusted life years per 100,000 population (WHO 2015). Although unhygienic food preparation occurs both in developing and industrialized countries, it was reported that a safe food supply chain becomes more difficult to obtain in developing countries because of poverty (Kaferstein 2003). Several unhygienic food preparation conditions that were cited in developing countries included poor personal hygiene of food handlers, restricted access to clean facilities, and lack of food storage facilities at the appropriate temperatures (Kaferstein 2003). The main reason for FBDOs in Malaysia was also attributed to unsanitary food handling procedures, which contributed to 50% of the cases (MOH 2007). Analysis of surveillance data in South Vietnam (2009–2013) also showed that most outbreaks were associated with canteens and the cases were linked to poor personal hygiene and time-temperature abuse (Vo *et al.* 2014).

In the Philippines, a national food safety program was initiated in 2013. Collective efforts of food regulatory

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agencies have increased awareness and significance of food safety in the country with the signing of the Philippine Food Safety Act (2013) into law. This law aims to promote the right to health of the people and strengthen the food regulatory system in the country (Republic Act 10611). However, the Implementing Rules and Regulations (IRR) of this law have only been finalized in Feb 2015 (DA and DOH 2015). The positive impact of the food safety act of the country cannot still be fully appreciated in this study since the law enactment is only in its infancy.

Systematic monitoring of foodborne disease outbreaks by country is required to allow evaluation of outbreak trends. Normally, food regulatory agencies involved in the implementation of food safety systems must rely heavily on surveillance data for the appropriate formulation of prevention and control measures to ensure national food safety control. The data collection rests on the competence of health officers up to the municipality level, the professionals involved in the food supply chain, and the facilities and laboratories for testing and analyses (Collado *et al.* 2015). A previous study already presented trends of FBDOs in the Philippines for the preceding period of 1995–2004 (Azanza 2006). Continuous monitoring and analyses of information from outbreaks occurring in the country could help contribute to the development of national food safety systems. The objective of this article was to present trends in the foodborne disease outbreaks in the Philippines for the period of 2005 – Jun 2018.

MATERIALS AND METHODS

Data from 209 Philippine FBDOs for the period of Jan 2005 – Jun 2018 was covered in this study. Secondary archival data analyses were conducted on information accessed from five web portals, five electronic archives of local news agencies, five electronic archives of local newspapers, two government websites, and printed reports from the Epidemiology Bureau of the Philippine Department of Health (DOH).

The data gathered were categorized and evaluated in terms of associated food vehicles, etiological agents, venues of outbreaks, and morbidity and mortality cases. The associated food vehicles were grouped into seven major groups – namely meat-based dishes (includes all types of pork, chicken, beef and other meats fresh or processed); fish and other seafood dishes (includes fish and fish products plus other seafoods); inedible materials (plant or animal-based materials that have toxins and considered inedible); noodles and pasta dishes (all types of noodles and pasta); bakery and confectionery products (include all types of baked foods and confectionery products such as cocoa, chocolates, and candies); rice and root crops (rice, rice-based products, and root crops); and vegetables. If mixed foods or meals were associated with FBDOs and no specific food vehicle was identified as the main cause, the cases were classified under "Multiple implicated food dishes." Lastly, foods that do not fall under the enumerated major food categories and the multiple implicated foods were classified as "Others" and this group includes egg, desserts, and beverages. Further, the distribution of recorded FBDOs was also mapped out by regions. Relative percentages were calculated for the compiled data.

Outbreaks with multiple implicated food vehicles were those involving cases that implicated the consumption of several types of foods and no exact food vector was definitively identified as the cause of the outbreak. Institutionally prepared implicated foods were classified as those prepared and consumed on site or delivered outside of the food service area preparation. Home-prepared foods reported in this study were classified either as those prepared or consumed by a single household or prepared and consumed by multiple households.

RESULTS AND DISCUSSION

Food Vehicles of Outbreaks

Multiple implicated foods. Different food types that served as vehicles for Philippine FBDOs from 2005 to Jun 2018 were classified (Table 1). Most of the FBDOs involved were categorized as multiple incriminated foods (27.27%). The highest incidences involving multiple food vehicles were institutionally prepared, followed by home prepared foods. Ninety five percent (95%) of the disease manifestations that were described for the FBDOs associated with multiple food vehicles in this report with unknown etiological agents of illnesses were gastrointestinal symptoms including vomiting, diarrhea, and stomach ache. Amoebiasis, fever, and cholera were associated to a lesser percentage to these food vehicle group causing FBDOs.

The DOH undertaking epidemiological studies should be more focused in identifying the food vehicles of these outbreaks to strategically control future related FBDOs. Food service institutions were restaurants (GMA News 2006, Uy 2006); hotels (Carcamo 2009, Cinco 2014); and canteens or cafeterias. Outbreaks involving canteen-prepared take-out foods (Uy 2006; GMA News 2008, 2013) or served on-site were reported (Araneta 2011, Manlupig 2012, SunStar 2013). The reported high occurrence of FBDO under the institutionally prepared category may be linked to the fact that these establishments cater to large number of consumers, which in turn increases the probability of FBDO occurrences and

Table 1. Foodborne disease outbreaks in the Philippines classified by incriminated food vehicles from 2005 to Jun 2018 (N = 209).

Food Vehicles	Occurrence	Relative Percentage (%)
Multiple implicated food dishes		
Food service (catering, school and work place canteens, hotel, restaurant)	41	27.27
Home-prepared food (birthday, outing, funeral)	13	
Unknown	3	
Subtotal	**57**	
Meat based dishes		
Pork dishes (adobo, fried, roasted, stew)	15	14.35
Fried processed meat (beef loaf, hotdog, sausage, hamburger)	6	
Chicken dishes (adobo, roasted)	3	
Beef dishes (stew, braised)	2	
Other meats (water buffalo, horse, dog)	4	
Subtotal	**30**	
Fish and other seafood dishes and manufactured products		
Fish dishes (mackerel, roundscad, snapper, tuna, silver fish, barracuda, anchovies)	11	12.92
Shellfish dishes (oyster, green mussel)	10	
Shrimp dishes (salad, steamed, fried)	2	
Other seafoods (grilled squid, sea hare, sea turtle)	3	
Canned seafood (sardines)	1	
Subtotal	**27**	
Toxin-containing or inedible materials		
Puffer fish and family (orbicular batfish, goby fish)	12	10.53
Wild yam (*Dioscorea hispida*)	4	
Wild mushrooms	3	
Big purge nut (*Jatropha curcas*)	2	
Wild lima beans and wild cassava	1	
Subtotal	**22**	
Noodles and pasta dishes		
Rice-based noodles	11	10.05
Pasta (spaghetti, lasagna, macaroni)	10	
Subtotal	**21**	
Bakery and confectionery products		
Candies	9	9.57
Cakes and pies (cake icing, expired cupcake, cake rolls)	5	
Sugar products (molded powdered sweets)	2	
Biscuits	1	
Sandwich (egg, peanut butter, meat, vegetables)	2	
Fried quick bread	1	
Subtotal	**20**	
Rice and root crop		
Rice (cake, steamed and congee)	6	7.18
Cassava (cake, fried, boiled)	7	
Rice congee	2	
Subtotal	**15**	

likelihood to attract more media attention and reports. Collado *et al.* (2015) enumerated areas of concern for food safety within the food service sectors in the Philippines to include restaurants, catering establishments, and street food vending outlets as the more difficult to regulate. Similarly, CDC (2014) reported that more than half of FBDOs that occur in the U.S. each year are associated with food from restaurants. Reheating of food exposed to extended hold on period at ambient temperature has been cited as one of the major causes contributing to association of food service dishes implicated in FBDOs (Azanza and Ortega 2000).

Home-prepared foods reported in this study were classified either as those prepared or consumed by a single household or prepared and consumed by multiple households. The country observes a type of community food preparation custom called *bayanihan*, where a number of people help each other in accomplishing a task (Roces and Roces 2013). The *bayanihan* food preparation was practiced for the fiestas and nuptial related outbreaks reported in this study (Gorit and Serrano 2014, Franco *et al.* 2015). The propensity of FBDOs in *bayanihan* related outbreaks may be attributed to possible general paucity of control in quality and safety of food preparation practices, resulting from the more casual or random gathering of cooks for quantity food preparation. Volume food preparation increases the chances of food contamination and this poses danger to the health of consumers (Akabanda *et al.* 2017). Quantity food preparation that happens in a *bayanihan* event is very much conducive to exposure of prepared food to ambient conditions for extended periods. The temperature in the Philippines ranges from 25 to 35 °C, which is well within the temperature danger zone conducive to the growth and multiplication of spoilage and pathogenic microorganisms that cause FBDOs (Collado *et al.* 2015). The CDC recently issued a reminder regarding risks of food from fairs and festivals due to absence of the usual safety controls that traditional kitchens can provide, such as monitoring of food temperatures, refrigeration, and washing facilities (CDC 2018).

This study also recognizes the possible general underreporting of outbreaks related to home prepared foods. Often, the medical resolution of home-based FBDOs may not be reported, documented, and investigated. Overall, the high percentage of FBDOs with multiple implicated foods, either prepared from food service institutions or home prepared, should alert the local food regulatory agencies to intensify the identification of food vehicles responsible for FBDOs. Collado *et al.* (2015), in a review of the challenges that are faced by the food safety control and regulatory systems in the Philippines, attributed the absence of a coherent national policy that imposes control measures to protect food from different hazards as it moves along the food chain as the main limitation in the surveillance of FBDO in the country. Specifically, FBDOs were not routinely reported previously since there was no existing national laboratory-based integrated food chain surveillance system for this disease group (Carlos 2007). Fortunately, the IRR of the Food Safety Act of 2013 finally articulated the need to create an integrated foodborne disease monitoring system for the country (DA and DOH 2015).

Meat-based dishes. Second to multiple implicated foods for the higher incidences of FBDOs were the meat-based dishes (14.35%). Interestingly, *adobo* dishes were implicated in the three outbreak occurrences (Sun Star Davao 2011, GMA News 2015, Panay News 2015). The root word of *adobo* is *adobado*, meaning stewed meat cooked in vinegar-based pickling solution with condiments that may include bay leaf, garlic, and peppercorns as original ingredients of the recipes coming from Spain and Mexico, and with soy sauce as more recent ingredient due to Chinese influence (Kirshenblatt-Gimblett and Fernandez 2003). *Adobo* dishes are traditionally considered as shelf-stable recipes due to high acidity (low pH value) and low water activity (A_w). Low pH values are brought about by using vinegar as acidulant. On the other hand, low A_w is due to the use of high concentration of salt, sugar, and soy sauce. Examples are canned chicken meat adobo with pH values of 5.50–5.60 and Aw of 0.880–0.885 (Cabrera 1993), and pork adobo with pH values of 4.8–4.9 (Sison 2000). Sample reported variants of the recipe include pork adobo jerky with pH value of 4.35–4.45 and Aw of 0.533–0.731 (Landicho 2010), and chicken gizzard adobo with pH values of 4.90–5.20 (Quinto 1970). The utilization of several spices with antimicrobial activities like bay leaf, pepper, and allium ingredients further promote shelf life stability of the dish. The *adobo* way of cooking was introduced during the Spanish colonial era as a form of meat preservation in the absence of cold chain (Fernandez 1994). Eventually, its mode of preparation has been indigenized in the country, leading to modifications in ingredients and the final cooked dish quality. Perhaps the more contemporary ways of cooking *adobo* have eliminated the benefits of shelf life extension and therefore this dish has already been implicated with FBDOs.

Similar to a previous study by Azanza (2006), processed meat product category was also ranked as amongst the meat-based dishes as vehicles of FBDOs. The involvement of processed meat products to FBDOs in the country may be attributed to the flourishing Philippine meat processing industry, with reported average sales growth of 6.4% and average export growth of 13.8% from 2010 to 2015 (Peñaflor 2016). The Philippines also have problems related to compromised quality of meat supplies, as in

the case of reported *hot meat* finding its way to the local meat supply chain. Good quality meat in the Philippines can be obtained from accredited meat establishments, including abattoirs or slaughterhouses. As of Jan 2019, there are 95 class "AA" slaughterhouses in the National Meat Inspection Service official list of accredited establishments and only one class "AAA" (NMIS 2019). Class "AA" covers establishments with sufficiently adequate facilities and operational procedures to slaughter food animals for inter-provincial distribution and these are with acquired GMP status (NMIS 2013). Class "AAA" establishments are already accredited up to HACCP status and therefore can be involved in international meat trade (NMIS 2013). Although there is no official listing of illegal slaughterhouses in the Philippines, several reports regarding their operation were documented – including those in Quezon City (Locsin 2014a), Bacolod City (Esmalla 2014), and Cebu (Managaytay 2016). Likewise, a number of related reports to the confiscation of *botcha* or hot meat sold in the market exists (Galupo 2018, PNA 2018), most probably associated with the operation of illegal slaughterhouses.

Hot meat is a colloquial term referring to meat from animals that are slaughtered in unregistered establishments and has not undergone necessary food regulatory inspection (DA 2005). A worse derivation of *hot meat* in the Philippine meat supply is *botcha* or double dead meat, which is from butchered dead animals (Alonzo 2013).

Even if some frozen meat supply can come from formal sources like commercial supermarkets, the practice of *ladlad* or the retailing of frozen processed meat at temperatures ranging from refrigerated conditions to near ambient conditions can also be one of the reasons for unhealthy supply of meat in the Philippines. Further, there seems to be minimal regulations in terms of entry of food supplies to public wet markets or operating small stores (Digal 2001) that attract many investors to retail meat products that have not passed the government food safety standards.

Less commonly consumed meats from other sources such as water buffalo (Silubrico 2015); horse (PNA 2014); and dogs (Times Wire Reports 2005, Lazaro 2014) were also implicated in FBDOs. The killing of any animal other than cattle, pigs, goats, sheep, poultry, rabbits, carabao, and horse is considered unlawful in the Philippines [The Amended Animal Welfare Act (RA 8485/RA 10631)], thus dog meat should not be even sold for human consumption. The Department of Agriculture (DA) has signed an administrative circular (DA 2016) prescribing a national plan of action to eliminate the trade of dog meat in the Philippines. Even though the law forbids killing of dogs for human consumption, the illegal sale of dog meat in the country is still a problem and continues to flourish (Brown 2015).

The outbreak implicating horse meat involved a group of sick, dying, and dead horses established to be suffering from Henipavirus infection butchered for consumption, which led to 100 cases of morbidities and five mortalities (Bajo 2014, Ching *et al.* 2015). For this outbreak, a team from the DOH, DA, and WHO interviewed affected individuals and with an epidemiologic link to the affected area and who had experienced acute encephalitis syndrome, severe influenza-like illness, or meningitis – and a total of 17 human cases matched the profile (Ching *et al.* 2015).

Fish and other seafood dishes and manufactured products. Fish and other seafood dishes and its manufactured products (12.92%) follow meat-based dishes; this is to be expected since the Philippines is an archipelago. Both fish and shellfish dishes are the leading foods associated with FBDOs under this category for the period 2005 – Jun 2018. In the Philippines, vast resources of sea foods are sourced from coastal and freshwater areas either from natural sources or from commercial inland fishery businesses (BFAR 2014). The FBDOs involving fish and other seafood were due to the consumption of fishery products with PSP and ciguatera toxins (Visperas 2009, Ponsaran-Rendon 2010, Gabieta 2013, Pareño 2014). The FBDOs involving the consumption of spoiled fish were also reported (Unson 2005, Tactay 2013). Other seafood implicated with FBDOs included shrimps (Lopez 2006, Uy 2006); squid (Borromeo 2007); and sea cucumber (Asutilla 2009).

Toxin-containing or inedible materials. Closely following fish and seafood dishes as vectors of FBDOs were the toxin-containing or inedible materials (10.53%) that include foods which are unfit for human consumption. Puffer fishes and related species were the leading vehicles of poisoning under this category. Inedible wild yams and wild mushrooms ranked next to puffer fish and related species. Isolated occurrences were also linked to wild mushroom, *Jatropha curcas*, wild lima beans, and wild cassava.

Inedible wild yams and wild mushrooms rank next to toxin fish among the toxin-containing causative agents of foodborne illness. Tubers of the wild yam – *Dioscorea hispida*, which contains the toxic alkaloid dioscorine – have been reported to cause morbidities in the country (Philippine Daily Inquirer 2010, Andrada 2014, Agamon *et al.* 2015). Vulnerable population often include farmers from remote areas, especially those who are experiencing dry spell for extended periods, forcing them to eat wild yams (Pellegrina 2015). The tubers of this wild yam can be rendered edible only after repeated washing, soaking in water or brine, boiling, and drying for days – as cited by Azanza (2006).

Wild mushroom intoxication was also reported to cause FBDOs (The Freeman 2011, Dinoy 2013, Magbanua 2015). In these outbreaks, poisonous mushrooms were mistaken for edible varieties. Only a handful of mushroom species are said to produce poisonous secondary metabolites – with amatoxin, orellanine, and methylhydrazine being the most hazardous (Faulstich 2005). Intoxication caused by mushroom consumption usually involves mushrooms collected in the wild and the inability of affected individuals to discern poisonous mushroom varieties. Other poisoning cases reported were caused by the consumption of seeds of *J. curcas* (Orejas 2013, Business News Asia 2015). Children consumed the inedible fruit because of its attractive appearance and peanut-like or sweet taste (Mampane *et al.* 1987). Although the plant is commonly promoted for medicinal purposes and as raw material for biodiesel, it is frequently associated with food poisoning – with children being the most susceptible (Singh *et al.* 2010). *Jatropha curcas* contains curcin, a toxalbumin which is a strong irritant and produces deleterious effects on blood (Osoniyi and Onajobi 2003). Both wild cassava and wild lima beans were implicated in one outbreak involving four morbidities and one mortality (Locsin 2014d). Both crops are known to produce cyanogenic glycosides with elevated levels in some wild varieties, although when properly cooked and processed hydrogen cyanide can be released and volatilized – thus rendering the food safe for consumption (Coultate 2002). In the case of lima beans, difficulties in its preparation in a way that eliminates their toxicity have led to the breeding of certain varieties with reduced levels of cyanogenic glycosides (Coultate 2002, Ballhorn *et al.* 2009).

Noodles and pasta dishes. Noodles and pasta dishes (10.05%) rank fourth among the FBDOs with known incriminated food types. Different versions of rice-based noodles and pasta products were included, with spaghetti still being one of the more common leading causes of FBDOs under this category. Rice-based noodles are handmade or machine-cut that are either air- or oven-dried, fried, or wet-prepared (Lu and Collado 2010), while pasta refers to those that are extruded and made up of semolina flour (Malcolmson 2003). The findings of Azanza (2006) also established that spaghetti with meat sauce was the leading cause of FBDOs for the period of 1995–2004. A possible explanation for this trend may again be due to the use of poor quality raw materials as well as improper handling, cooking, and storage. Indigenized preparation and handling of the dish in the country include practices: quantity preparation coupled long holding time at ambient temperature and just instantaneous reheating of the stored noodles and sauces.

Bakery and confectionery products. High prevalence of FBDOs was also reported for bakery and confectionery products (9.57%). Interestingly, candies in various forms were the leading vehicles for FBDOs under this category, unlike in the earlier report of Azanza (2006) for the period 1995–2004 where cakes and pies topped under this category. For 2015 alone, over 2000 reported morbidity cases were caused by various types of candies such as durian (Serrano *et al.* 2015), *macapuno* (Macolor 2015), chocolate (Mascarinas 2015), and mint-flavored candy (Inigo 2015). The durian candies, which were contaminated with bacteria, were distributed in Surigao del Norte and Agusan del Sur and spread to neighboring towns by ambulant vendors – affecting many school children (Geronimo 2015). It is also significant to note that among the bakery and confectionery products implicated in the outbreaks, egg has been identified as a major ingredient such as in the case of cakes and egg sandwich. Eggs have been established as a major vehicle of foodborne disease outbreaks worldwide, particularly those implicating the pathogenic *Salmonella* spp. (Gast and Holt 2000, Braden 2006).

Rice and root crops. There were also reported FBDOs involving cooked rice and root crop products (7.18%) from 2005 to 2018, whereas only rice congee was implicated in the previous report of Azanza (2006). Rice is the country's main staple and remains an important crop as food and source of livelihood (DA 2012). One major outbreak linked to rice and rice-based products in 2008 involved *puto* (a form of traditional steamed white rice cake) as the vehicle, which resulted to 134 morbidities (133 pupils and a teacher) (Ronda 2008). The *puto* was made by a local couple several hours before these were sold to different public schools and it was reported that the rice cakes were not properly packed (Ronda 2008).

Vegetables. There were only a handful of food poisoning incidents involving vegetables (1.44%) as food vehicles. No causative agent was identified in the three reported occurrences. Two incidents involved bitter gourd dishes, while another one implicated deep fried squash patties, locally known as *okoy*. Fruits and vegetables can support the growth of pathogens such as *Staphylococcus aureus* and *Salmonella typhi* at room temperature with given sufficient time (Viswanathan and Kaur 2001). Likewise, other ingredients (eggs, coconut milk, shrimp) incorporated to the cooked vegetable may provide enough nutrients to support growth of contaminating pathogens. Contamination of vegetables may occur during agricultural production and harvest and may be aggravated by inappropriate postharvest operations and handling practices, as well as conditions which favor persistence and proliferation of disease-causing agents when the food is prepared and cooked (Koo 2011).

Other food types. Other food types (6.70%) like eggs, frozen desserts, salt, milk tea, coffee, and seaweed salad have also been implicated in food poisoning. Cases of salted egg poisonings in the northern provinces of the country, especially in Pangasinan, were reported (Bombo Dagupan 2014, Locsin 2014b). As emphasized earlier, eggs had been established as a major vehicle of foodborne disease outbreaks, particularly those implicating *Salmonella* spp. (Gast and Holt 2000, Braden 2006). Meanwhile, a family of six from Surallah, Cotabato was also poisoned by alleged contaminated salt bought from a local convenience store (Lopez 2015). Two incidents of FBDOs were also attributed to frozen desserts (Refraccion 2012, Ocampo 2015). Interruptions in cold chain usually account for the deterioration of supposedly chilled and frozen food vectors. Another incident involved consumption of seaweed salad (Taguinod 2008). Since the seaweeds were eaten raw, there was a high risk for FBDO (Cheney 2016). Finally, an FBDO with associated mortalities due to consumption of tainted milk tea in a commercial outlet was due to oxalic acid contamination in the premix for milk tea formulation (Dioquino 2015). Oxalic acid that was accidentally mixed in a local dish called *sinantac* (noodles in broth) was also declared as the cause of two deaths in Tugeugarao, Cagayan (Lagasca 2011).

Outbreak Locations

Food service facilities. Different location types of 209 FBDOs covered in this study were summarized (Table 2). Food service eating facilities (74) and households (102) were the most prone to FBDOs in terms of location. Out of 74 FBDO occurrences in food service establishments, more than 50% occurred in small scale establishments – specifically within school premises (*e.g.*, school canteens). On the other hand, about 16% and 9% of the cases happened in restaurants and in hotels, respectively. The rest of the cases (6%) were linked to foods sold outside school premises by ambulant street food vendors. Azanza (2006) reported that during 1995–2004, home was the most susceptible location to FBDO in the country. However, there was an upsurge of cases that happened in food service eating facilities – especially in school environment – for the last 13 years. In the Unites States, foods consumed in institutions and other food services are considered the leading locations for foodborne outbreaks (Olsen *et al.* 2000). The common food preparation practices in schools that led to FBDOs were improper food storage and holding temperatures and contamination of food handlers (Daniels *et al.* 2002). These cited causes of FBDOs in school premises may also be true in the Philippine setting. What is unique though in the Philippine setting is that school children also have access to vendors selling foods outside of the school premises, aside from those sold in their school canteens. These foods sold by vendors outside the school facility are inexpensive, ready-to-eat foods that are home-prepared by the informal sellers. Unfortunately, the nature of the foods prepared by informal sellers make it prone to contamination, which in turn compromises food safety. Many street food vendors overlook the importance of food safety in the preparation of food they sell, which may compromise the safety of the consumers (Buted and Ylagan 2014).

Table 2. Outbreak location for Philippine foodborne disease from 2005 to Jun 2018 (N = 209).

	2005 – June 2018		
Location	**Occurrence**	**Cases**	**Mortalities**
Food Service Eating Facility (school, canteen, restaurants, hotels)	74	4946	31
Household (Single and multiple household involvement) (community, fiestas, birthday celebrations)	102	4972	63
Others (office, public gathering, orphanage facility, jail)	33	3673	3

Tinker (2003) reported that the most important health problem in the Philippine street foods was the absence of clean water for hand and utensil washing during vending. Hilario (2015) observed that street food vendors practiced minimal hygienic and sanitary practices in certain places near a university in Manila, Philippines. The hygienic practices in question included food preparation, handling of utensils, place for food preparation, personal hygiene, and methods of storing cooked food. In addition, a study by Rustia *et al.* (2017) involving 53 street food vendors closely monitored by their local government showed that not all provisions in the Code on Sanitation of the Philippines are actually practiced by street food vendors. Despite the food safety risk, many people patronize street foods because it plays an important role in meeting the food and nutritional needs of consumers at affordable prices.

Single and multiple households. Those FBDOs involving single and multiple households rank second to food service eating facility outbreaks in the number of morbidities. The multiple household outbreaks can be characterized as those outbreaks that spread to the community composed of multiple households pointing to one source of food vehicle. Examples of the reported outbreaks in multiple households were those with 70 cases for wild yam poisoning among indigenous people in Kidapawan City (Philippine Daily Inquirer 2010), 78 cases of consuming salted eggs sold on the various towns of Pangasinan (Bombo Dagupan 2014, Locsin 2014b) and

1909 cases of poisoning upon eating *durian* candy in the Caraga Region (Serrano *et al.* 2015). The first of these three outbreaks involved the consumption of the toxic wild yam among ethnic *lumad* people in the Kidapawan City, North Cotabato during the drought period (Philippine Daily Inquirer 2010). *Lumad* is a term adopted by the 15 indigenous groups from more than 18 Mindanao ethnic groups to distinguish them from the other Mindanaons – Moro and Christian (Filipinos in the southern part of the country) (Ulindang 2015).

The second outbreak in various towns of Pangasinan, Northern Luzon was attributed to salted eggs that were contaminated with suspected *Salmonella* spp. These salted eggs were sourced from one supplier and were bought by the consumers in the local wet market or local convenience stores (Bombo Dagupan 2014, Locsin 2014b). Poisoning caused by the *durian* candy was the third multiple household outbreak that was distributed in the entire region of Caraga (southern part of the Philippines), and was found out to be contaminated with *S. aureus* (Geronimo 2015, Serrano *et al.* 2015). The *durian* candy is a local sweet delicacy made from the tropical fruit *durian* (*Durio zibethinus* Murr.) (Bareja 2012). The reported figures involving households may be an underestimated value because as there were possible outbreaks that were not reported. It may be possible that many small outbreaks of food poisoning at home were not even reported to authorities and received little attention by the news media (Worsfold and Griffith 1997).

Other locations. There were 33 out of 209 FBDOs that occurred in other locations such as offices (Zambotimes 2015); public gatherings; orphanages; and jails (GMA News 2008, The Freeman 2013). FBDO occurrences that happened in other locations classified in Table 2 also had numerous cases of outbreaks for the last 13 years. Some incidences in these locations happened in public or private spaces with activities such as protests (Fernandez 2015), athletic meets (Bombo Naga 2015), fun-runs (The Philippine Star 2011), and outings (Cabrera 2015), among others initiated by the local government, non-government organizations (*e.g*., religious groups), or private groups. In these outbreaks, although the events occurred for one day, the morbidity cases manifested even days after the event. The foods served in these outbreaks were prepared in quantity and usually from food service providers and served pre-packed (Dedace 2008, Punay 2005, Viray and Sapnu 2006).

Morbidities

In the 13,577 morbidity cases recorded from the 209 documented outbreaks that occurred in the past 13 years (Table 3), 87.97% or 11,956 cases have no identified causative agents. The high percentage of unidentified causative agents reported in this paper emphasizes the already cited limitations in the surveillance system of FBDOs in the country, such as lack of funding support for laboratories and the many laboratories that cannot identify major pathogens associated with FBDOs (Carlos 2007).

Table 3. Ranking of causative agents of foodborne poisoning in the Philippines based on the recorded cases in 2005 – June 2018 (N = 13,591 cases out of 209 outbreaks).

Types of Food Poisoning		Cases	Percentage (%)
Microbiological	Chemical / Toxin		
Unknown		11956	87.97
Salmonella spp.		335	2.46
	Staphylococcal enterotoxin	169	1.24
	Carbamates	130	0.96
	PSP	155	1.14
Salmonella Enteritidis		112	0.82
Henipavirus		102	0.75
Entamoeba histolytica		99	0.73
Vibrio parahaemolyticus		95	0.70
	Dioscorine	95	0.70
	Tetrodotoxin	93	0.68
	Cyanogenic glycoside	93	0.68
	Oxalic acid	47	0.35
	Toxalbumin curcin	41	0.30
	Ciguatoxin	40	0.29
	Nitrate	18	0.13
Escherichia coli		11	0.08
Total		**13,591**	**100**

The IRR of the Food Safety Act of 2013 now clearly expresses the strong commitment of the government to implement programs related to FBDO monitoring system that links to the sources of food contamination and the definitive identification of hazards within the food supply chain (DA and DOH 2015).

The total cases of morbidity due to chemicals or toxins involved 881 cases related to staphylococcal toxin, carbamates, PSP toxin, dioscorine, tetrodotoxin, cyanogenic glycoside, oxalic acid, toxalbumin curcin, ciguatoxin, and nitrate. Pathogens were also identified as causative agents for 754 morbidity cases. These pathogens identified were *Salmonella* spp., *Salmonella enteritidis*, *Henipavirus*, *E. histolytica*, *V. parahaemolyticus*, and *E. coli.*

Biological agents. *Salmonella* spp. was shown as the leading microbiological cause of FBDO poisoning in the Philippines from 2005 to Jun 2018, while foodborne intoxications were attributed mainly to staphylococcal enterotoxins, PSP toxins, and carbamate. These findings agree with the previous report of Azanza (2006) Philippine FBDOs for the period of 1995–2004, in which *Salmonella* spp. was the main cause of food infections while staphylococcal enterotoxins and PSP were identified main etiologic agents of food intoxications.

Salmonella spp. is still one of the major causes of foodborne illnesses throughout the world and is generally transmitted to humans through consumption of contaminated foods of animal origin – mainly meat, poultry, eggs, and milk (WHO 2014c). Human salmonellosis are usually characterized by enteric fever and self-limiting acute gastroenteritis (IFT 2004). Infections generally cause diarrhea, fever, abdominal cramps, and vomiting that occur about 6–48 h from the time of ingestion (FSIS 2014). The infections may be life-threatening illnesses for outbreaks involving typhoid fever and other forms of foodborne salmonellosis, which are caused by *Salmonella enterica* serovars Typhi, Enteritidis, or Typhimurium (Azanza 2006).

Vibrio parahaemolyticus has also been linked to an FBDO in 2007 when participants in a cultural event held at Cebu city experienced abdominal pains. Laboratory findings showed that the cold grilled squid served was contaminated with *V. parahaemolyticus* (Borromeo 2007). *V. parahaemolyticus* is a common cause of bloody diarrheal disease worldwide and is generally transmitted to humans through consumption of raw and undercooked seafood (WHO and FAO 2008). The organism generally causes bloody diarrhea, abdominal cramps, nausea, vomiting, and fever that occur about 4–96 h from the time of ingestion (FSIS 2014).

Escherichia coli has been linked to FBDO with 11 morbidity cases, in which the victims of the reported outbreak were local tourists in a resort in Boracay, Aklan (The Philippine Star 2011). The infections caused by *E. coli* are generally abdominal cramps, diarrhea, fever, and vomiting that occur about 1–3 days from the time of ingestion (FSIS 2014). Also, it may cause life-threatening illnesses like hemorrhagic colitis and other *E. coli* infections (WHO 2014b).

Entamoeba histolytica, a protozoon that causes amoebiasis , was confirmed to be the causative agent of the outbreaks that occurred in Jul and Aug 2015 among hospitalized victims from Maguindanao and Iloilo City (ABS-CBN News 2015, Cabrera 2015, PNA 2015). Amoebiasis involves dysentery that causes small, frequent, and often bloody stools (WHO 2014a). The transmission of this protozoon is through the fecal-oral route or by drinking or eating contaminated water and food.

The current study also showed that 1.24% of the FBDOs cases were due to staphylococcal toxin. The FBDO that involved students and staff members in a university was attributed to staphylococcal enterotoxin. Several hours after eating packed meals at an assembly of student leaders, the victims complained of dizziness and vomiting (Colina 2012, Manlupig 2012). The symptoms involved coincide with staphyloenterotoxicosis, which includes profuse vomiting and diarrhea occurring about 1–6 h after consumption of food containing the enterotoxin (FSIS 2014).

Chemical agents. Dioscorine and cyanogenic glycoside are chemical toxins of biological origin and may not be completely removed during food processing, which renders the food unfit for consumption. Dioscorine, a toxic alkaloid found in tubers of wild yam *Dioscorea hispida*, has been linked to at least 95 morbidities. Cyanogenic glycoside has been linked to 0.68% of the morbidities from 2005 to Jun 2018. In the reported outbreaks, the victims were reported to suffer abdominal pains, headache, vomiting, dizziness, and difficulty in breathing (GMA News 2006, The News Today 2008, Agamon *et al.* 2015).

Ciguatera FBDO has been implicated in 2010 and 2014. The ciguatoxin poisoning was implicated from the consumption of *maya-maya* (Ponsaran-Rendon 2010) and barracuda fishes (MindaNews 2014). It was reported that the victims suffered shortness of breath, dizziness, and vomiting. The manifestations of ciguatera poisoning are linked to the gastrointestinal (vomiting, diarrhea, abdominal pains); cardiovascular (hypertension, arrhythmia); neurologic (paresthesia, chills/sweating, headache); and neuropsychiatric (hallucinations, depression) symptoms and signs (Friedman *et al.* 2008). The morbidities of chemical FBDO in the country were caused by the chemicals carbamate, nitrate, and oxalic acid which can be linked to the cross-contamination of these chemicals during food preparation.

Mortalities

Causative agents that led to mortalities were presented (Table 4). The chemical toxins carbamate (27.84%) was the leading cause of FBDO mortalities, followed by unidentified causative agents (24.74%) and tetrodotoxin (21.65%). Carbamate is a cholinesterase-inhibiting insecticide widely used in agriculture as pesticide (Crisostomo 2005, Leibson and Lifshitz 2008). The FBDO that involved carbamate resulted to 27 mortalities of school children in the elementary level, while the food retailer was left in critical condition after consuming the fried cassava balls (Daily News 2005). Cyanide poisoning was the initial suspected cause of the deaths; however, the DOH found very little traces of cyanide but significant pesticide content in the implicated cassava products (Daily News 2005, Crisostomo 2005). The barangay where the outbreak occurred used pesticides for farming, and carbamate was commonly used (Crisostomo 2005). Symptoms for carbamate are difficulty in breathing, excessive sweating, frothy discharge, loss of consciousness, convulsions, urinary incontinence, vomiting, weakness in arms or legs, and death (Martin *et al.* 2011). The diarrhea and dehydration brought by the poisoning during the 2005 incident further aggravated the situation of the victims, as observed by the health secretary in an interview (Crisostomo 2005).

Table 4. Ranking of causative agents of foodborne poisoning in the Philippines based on recorded mortality cases in 2005 – June 2018 (N = 97 cases out of 209 outbreaks).

Types of Food Poisoning		Cases	Percentage (%)
Microbiological	Chemical / Toxin		
	Carbamates	27	27.84
	Tetrodotoxin	21	21.65
Unknown		24	24.74
	PSP	12	12.37
Henipavirus		5	5.15
	Oxalic acid	4	4.12
	Cyanogenic glycoside	4	4.12
	Total	**97**	**100**

Tetrodotoxin (21.65%) was also recorded as one of the leading cause of FBDO mortalities. This finding is similar to that previously reported by Azanza (2006) where it is also the second cause of mortality during the 1995–2004 periods (19%). Tetrodotoxin is a potent neurotoxin (Noguchi *et al.* 2011) and its poisoning is usually caused by consumption of puffer fish (USFDA 2012). Tetrodotoxin poisoning has been reported to cause numbness, headache, epigastric pain, nausea, diarrhea, vomiting, floating sensation, paralysis, and death (USFDA 2012). In the reported outbreaks included in this study, it was said that the fish eaten by the victims were puffer and goby fishes (Visperas and Ramirez 2005, Palaubsanon 2008, Sun Star 2010, GMA News 2011). The 2005 incident that resulted to two mortalities were due to eating *bunog,* a brown spotted type of goby fish (*Gobius criniger*) (Visperas and Ramirez 2005). Meanwhile, the other vector of tetrodotoxin was caused by what is locally known as *butete*, which refers to either two species of puffer fish with a scientific name of *Lagocephalus lunaris* and *Lagocephalus lagocephalus*. Both the puffer fishes and the goby species were permanently banned by the Bureau of Fisheries and Aquatic Resources against any gathering, marketing, and consumption (Sarmiento 2005). However, a number of local residents still harvest them. Moreover, in the poisoning that occurred in 2008, the local government of Bantayan, Cebu was prompted to pass an ordinance that bans the catching, eating, and mere possession of the puffer fish (Palaubsanon 2008). In the cases that occurred on 2011, the symptoms manifested by the patients upon consumption of puffer fish were dizziness, stomach ache, and vomiting (GMA News 2011). Puffer fish is well-known to contain a potent neurotoxin (tetrodotoxin) that blocks voltage-dependent sodium channels, resulting in respiratory paralysis and often fatality to humans (Nagashima *et al.* 2003).

Mortality cases on foodborne poisoning were also attributed to PSP toxin (12.37%). PSP in humans is caused by ingestion of shellfish that contain PSP toxins (FAO 2004). The PSP toxins come from different dinoflagellates with different toxins that are accumulated by shellfish (CDC 2005). The PSP toxins are also generally called saxitoxins and are linked to the dinoflagellates of the genera *Alexandrium* (formerly *Gonyaulax*), *Gymnodinium*, and *Pyrodinium* (Etheridge 2010, Cetinkaya and Mus 2012). In the reported food poisoning incidences, the PSP toxins commonly accumulated green mussels locally known as *tahong* – with the occasional report on other shellfish known as *badong-badong*, which is similar to green mussel but larger than the former (Visperas 2009).

In the Philippines, PSP is caused by blooms of *Pyrodinium bahamense* var. *compressum*, although incidents in Bolinao, Pangasinan have also been implicated with *Alexandrium minitum* (Azanza and Benico 2013). Moreover, in the study conducted by Azanza *et al.* (2006), it was found out that bacterial endosymbionts of *Pyr. bahamense* var. *compressum* were able to produce saxitoxins. The endosymbionts, which could produce PSP toxins, included those belonging in the *Moraxella* spp., *Erythobacter* spp., and *Bacillus* spp. group. The PSP intoxication generally cause tingling or numbness of the face, arms, and legs as well as headache, dizziness, nausea,

and muscular incoordination (CDC 2005). In fatal cases, muscle and respiratory paralysis occurs within 2–25 h after consumption of the PSP-contaminated food (CDC 2005).

Another identified cause of mortalities was henipavirus (5.15%), which resulted to human deaths in Sultan Kudarat, Mindanao (Ching *et al.* 2015). Cyanogenic glycoside has been linked to 4.12% of the mortalities. The toxicity of a cyanogenic plant depends primarily on the potential concentration of hydrogen cyanide that may be released upon consumption (FSANZ 2005). Hydrogen cyanide release occurs through the contact of cyanogenic glucoside with β-glucosidase as a result of the disruption of plant tissue (Moller 2010). Careful and proper preparation of cyanogenic plants such as cassava should be ensured to avoid food poisoning.

Lastly, oxalic acid (4.12%) – which is a bleaching substance – was reported to have caused four mortalities. In the case of oxalic acid in a milk tea, an official of the DOH indicated the clinical signs and symptoms of the cases were consistent with cyanide poisoning; however, no confirmatory laboratory test was available thus cyanide was not ruled out as a causative agent (GMA News 2015, Interaksyon 2015).

FBDO in Philippine Regions

After gathering relevant information on reported FBDOs and quantifying the obtained data, the values were mapped out based on regions where these outbreaks occurred. Philippine regions are composed of different provinces that were grouped based on geographical, linguistic, historical, and ethnic characteristics and these were formed to be used by the executive branch of the government for administrative purposes and for statistical reference (Boquet 2017). The FBDOs for the years 2005, 2008, 2011, 2015, and 2017 were mapped out based on significant total number of reported cases (Figure 1). The distribution of recorded morbidity cases was sporadic and the FBDOs occurred nationwide over the years.

Regions 4A (CALABARZON), 13 (CARAGA), and National Capital Region (NCR) had the highest morbidity cases. Region 4A and NCR are densely inhabited regions with populations reaching approximately 14.4 million and 12.9 million based on the 2015 census, respectively (PSA 2016, UN OCHA 2017). Both regions have more than 50% of the working force involved in services sector (UN OCHA 2017), while less than 1% and around 7% of the working force are in agriculture, hunting, and forestry in NCR and Region 4A, respectively (PSA 2018). Further, these two regions are more accessible to major news agencies in the country and because they are highly urbanized, there are numerous health facilities available. With this kind of profile, it is expected that there would be higher risk of FBDOs in these regions and, at the same time, higher probability of the outbreaks getting media coverage and being reported.

On the other hand, CARAGA region has an estimated population of 2.5 million (PSA 2016, UN OCHA 2017). Approximately 29% of the employed individuals in this region are involved in agriculture, hunting, and forestry (PSA 2018). The high number of morbidity cases reported in this region in 2015 was due to an outbreak that affected many individuals owing to the nature of the food vector and the involvement of ambulant vendors.

CONCLUSION AND RECOMMENDATIONS

The presented data may underestimate the actual number of Philippine FBDOs for the period of 2005 – Jun 2018. Problems related to access of information on Philippine FBDOs are still prevalent because government health agencies are yet to fully provide compiled consolidated data for the topic. Significant reliance of this present study to web portals of news agencies provided an alternative route to obtain information with regards to FBDOs in the country. A study on FBDO profiling dependent on the reports by the DOH would have been ideal. Nonetheless, the information obtained can be considered significant since there is paucity of FBDO studies and literature in the country that consolidate and establish trends in FBDOs. In the meantime, regulatory health officials and food industry personnel can use the present information for understanding the causes of Philippines FBDOs.

This present study for 2005–2018 has shown definitive similar trends related to FBDOs during 1995–2004. These trends may serve as basis of strategies for food safety controls. In fact, the data gathered for this paper was used for justification in the development of a three-year risk-based research project that was considered for funding and implementation starting 2019 by Philippine Council for Industry, Energy and Emerging Technology Research and Development – Department of Science and Technology. The funded project is entitled "Risk Profiling of Hazards in Philippine Food to Support National Risk Management."

The Philippine Republic Food Safety Act of 2013 has been formally enacted. The translated guidelines of the IRR are still on the infancy of implementation. Hopefully, the present information can be a relevant consideration to the food safety control system of the country. Stricter implementation of the said law and coordination among concerned government agencies will mitigate the occurrence of such outbreaks.

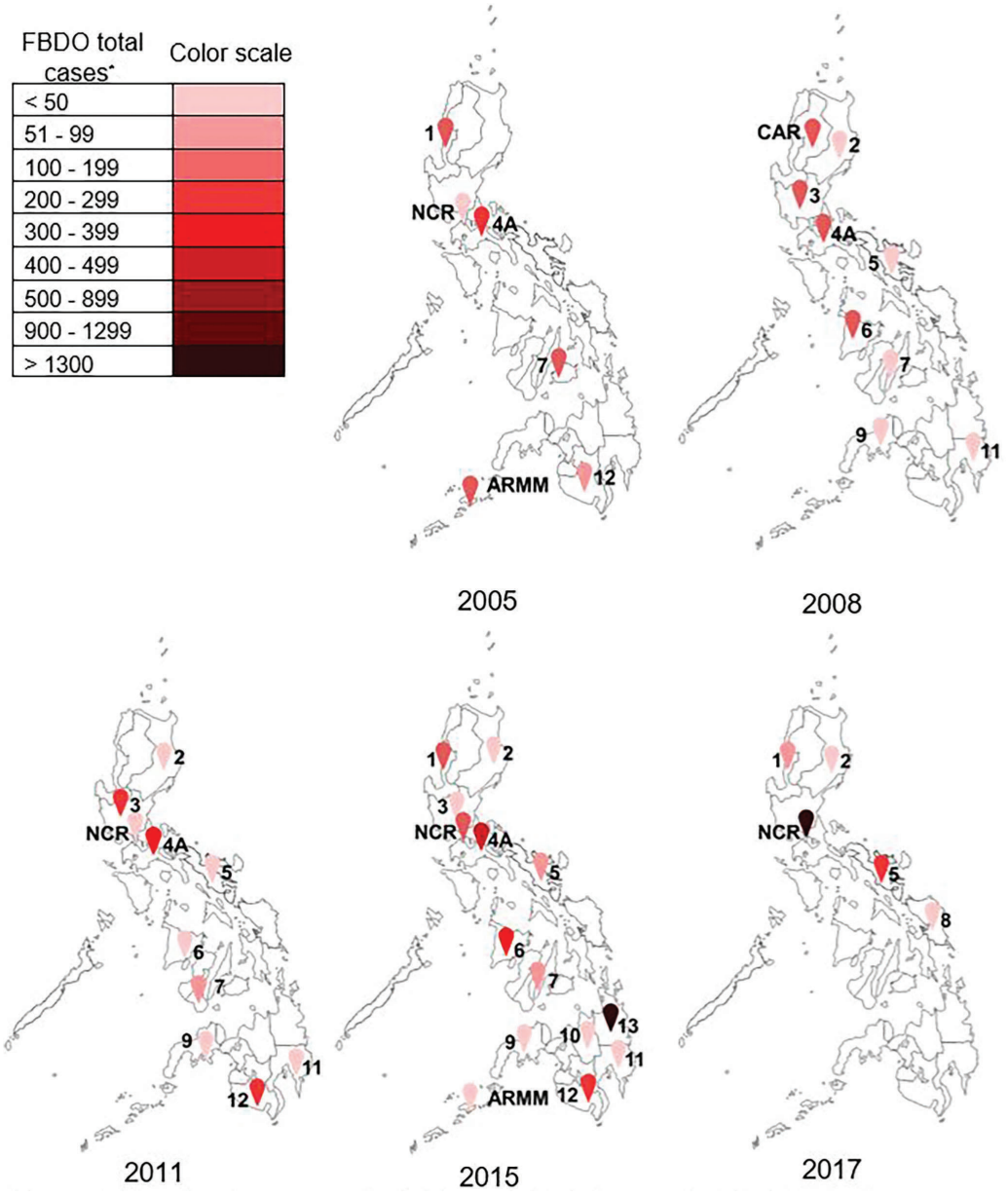

Figure 1. Map location per region** of reported total cases of FBDOs in the Philippines for 2005, 2008, 2011, 2015, and 2017.
*Total cases include mortalities and morbidities
**Philippine Map: Regions 1 to 13, Cordillera Administrative Region (CAR), National Capital Region (NCR), Autonomous Region in Muslim Mindanao (ARMM)

It has been established in this paper that multiple implicated foods are the leading vectors for the food poisoning cases in the country. Traceability of the causative agents of majority of the food poisoning cases therefore do not exist. Identification of the causative agents and a clear database on the food poisoning incidents in the country will increase the awareness and importance of food safety. Thus, official monitoring, documentation, and validation for FBDOs is highly recommended to better promote public health and safety.

Likewise, there is an upsurge in school-based location cases for FBDOs. The Department of Education and higher education institutions should strengthen their food safety measures on the food service operations and vendors within the academic premises. The Philippine Department of Interior and Local Government, together with local government units (LGUs), can re-evaluate their roles in the implementation of the food safety regulation in the country given the trends established in the paper. As a front-liner in responding FBDOs, focal persons at

the LGUs like sanitation officers should be competent and expert in handling FBDOs in the community. Regular trainings and assessment to sanitation officers can be implemented to equip them in preventing outbreaks in their respective town or city.

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