

## A Review on Foodborne Disease Outbreaks in Bhutan

### Abstract

Foodborne diseases (FBDs) are a public health threat that can result in loss of lives and are a hurdle to socioeconomic development. The Foodborne Disease Burden Epidemiology Reference Group estimated that the annual burden of FBDs in the South-East Asia Region was more than 150 million illnesses, causing about 175,000 deaths. This review paper aims to compile evidence from the published articles and gray literatures on food-related disease outbreaks in Bhutan. Information was generated from the annual health bulletin published by the Ministry of Health and data from the National Early Warning Alert Response Surveillance and Information System hosted by Royal Centre for Disease Control. The laboratory confirmation rate of FBD investigation outbreaks increased from 25.5% (2012–2018) to 91.7% in 2020, as per the National Food Safety Indicator (FSI). At least 0.15% of the total population had suffered FBD from 2015 to 2020, and the baseline report shows that most of the FBD events occurred during hot and wet seasons (June and August). The common pathogen causing FBD was *Salmonella* species accounting for 42.9% of cases, followed by *Shigella* species (21.4%). Most of the FBD events were reported in schools (46.5%). The frequency of the reported FBD outbreaks had increased from 8 events in 2015 to 15 events in 2017 and 10 events in 2018. The study confirms the improved surveillance for FBDs in Bhutan and highlights the need to raise public awareness on food safety.

**Keywords:** Bhutan, foodborne illness, food safety, pathogen

### Introduction

Foodborne diseases (FBDs) mostly present as gastrointestinal dysfunction. They are caused by consuming foods that are contaminated due to the use of polluted water for food preparation, pollution in soil where food is grown, as well as unsafe practices at any stage of the food preparation, delivery, and consumption chain, involving the entire process from farm to fork. Foodborne illness can either be an infection, intoxication, or toxico-infection, depending on the mode of action of pathogen.<sup>[1]</sup> Foodborne Disease Burden Epidemiology Reference Group (FERG) in 2006 identified 31 foodborne hazards worldwide, causing 32 diseases, including 11 diarrheal disease agents, 7 invasive disease agents (1 virus, 5 bacteria, and 1 protozoan), 10 helminthes, and 3 chemicals and toxins.<sup>[2,3]</sup>

The World Health Organization estimated that there were at least 600 million cases of FBDs, resulting in 420,000 deaths and 33 million disability-adjusted life years in

2010.<sup>[4]</sup> The report from FERG mentioned that South-East Asia Region recorded more than 150 million illnesses and 175,000 deaths<sup>[5]</sup> by FBDs in 2016.

Bhutan is a low-middle-income, land-locked country between India in the South and China in the North. There are several anecdotal evidences of occurrence of FBD outbreaks in the country, but the data on FBD outbreaks are limited. Some of the well-documented FBD outbreak events include *Campylobacter* outbreak in Bumthang in 2012 which affected about 400 students associated with meat consumed during sports celebration<sup>[6]</sup> and shigellosis outbreak that occurred in Mongar and Pemagatshel. In 2014, food poisoning was listed as one of the notifiable diseases in the country and was later integrated into the National Early Warning and Surveillance Response System (NEWARS). This review paper presents the recorded and published article on food-related disease outbreaks in Bhutan.

### Methodology

This review paper gathered and retrieved the information from the Annual Health

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Bulletin (AHB) published by the Ministry of Health ([www.moh.gov.bt](http://www.moh.gov.bt)), Royal Government of Bhutan, NEWARS hosted by Royal Centre for Disease Control (RCDC), and few available papers published in various journals, from 2012 to 2020. In 2015 RCDC developed a web based reporting platform for notifiable diseases and event based surveillance for diseases which had potential to cause outbreaks or events of public health concern. FBDs were notified as an event based reporting into the NEWARS, when two or more people visited a health center with the signs and symptoms of gastrointestinal dysfunction after consuming the same source of food. The percentage of the total population that suffered from FBD illness was estimated based on the total annual number of cases recorded suffering from FBD divided by national living population retrieved from the National Statistics Bureau. Descriptive information is presented as frequency and percentage. Secondary data from ABH and NEWARS were analyzed for the study purpose. Therefore, ethical clearance was not required. However, administrative permission was sought for the purpose.

## Results and Discussion

### Annual incidence of diarrhea in Bhutan

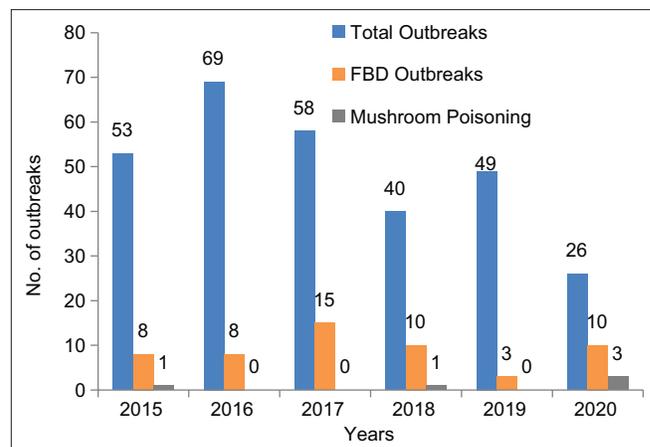
As per the ABH, diarrhea was one of the top 10 diseases causing morbidity in the country until 2018. However, in the last 10 years, the reported diarrheal cases have reduced by 35% (from 65,495 cases in 2009 to 42,366 in 2019). The morbidity rate due to diarrhea among Bhutanese children stands at 314.6/1000 for children under 5 years.<sup>[7]</sup> However, the comprehensive data on FBD outbreak events were not recorded in the ABH, and therefore, correlation between the diarrheal incidents and the FBD events could not be established. It has been reported that 88% of diarrhea-associated deaths were attributable to unsafe water, inadequate sanitation, and insufficient hygiene during food preparation.<sup>[8]</sup>

### Foodborne disease outbreaks

Of the total outbreaks notified during 2015–2020, the highest percentage for FBD was reported in 2020 (38.46%) and the lowest in 2019 (6.12%). Figure 1 shows the total outbreaks and the total FBD events notified into the NEWARS from 2015 to 2020. Of the total outbreaks notified during the period, 15.93% ( $n = 47$ ) were linked to FBD events. The percentage of the total population that suffered from FBD illness was estimated, and the current study found that 0.007%, 0.023%, 0.064%, 0.024%, 0.011%, and 0.017% of the population of all the age groups suffered FBD from 2015 to 2020, respectively.

### Seasonal pattern of foodborne disease events notified

Furthermore, 61 foodborne outbreak events were reported and recorded at RCDC from January 1, 2012, to December 31, 2020. The cases fluctuated during the study period, with



**Figure 1: Outbreaks recorded in the National Early Warning and Surveillance Response System from 2015 to 2020 in Bhutan**

the highest number of events reported in 2017 (15 FBD events) followed by 2018 and 2020 (10 FBD events each). The FBD events during the study period showed two peaks in June and August. Lesser number of FBD outbreaks were reported towards the colder months from November to February [Figure 2]. An earlier study conducted by Wangdi *et al.*<sup>[8]</sup> in 2017 concluded that incidence of diarrhea in Bhutan was seasonal, with most of the cases reported during the monsoon season (June). Similarly, a study by Wangchuk *et al.* reported that most of the diarrhea cases were reported in June. FBD events have higher peak during hot and humid months, as they are more conducive for microbial growth and also as water quality deteriorates.

### Total foodborne disease investigated

During the years 2012–2018, only 25.5% of the total FBD events were successfully investigated, which improved to 80% in 2019 and further improved to 91.7% in 2020. This was due to the development of Bhutan FSI. The percentage of FBD events successfully investigated is defined by the set criteria drafted in the National FSI of Bhutan report ([www.fao.org](http://www.fao.org)).

### Common pathogens isolated from foodborne disease events

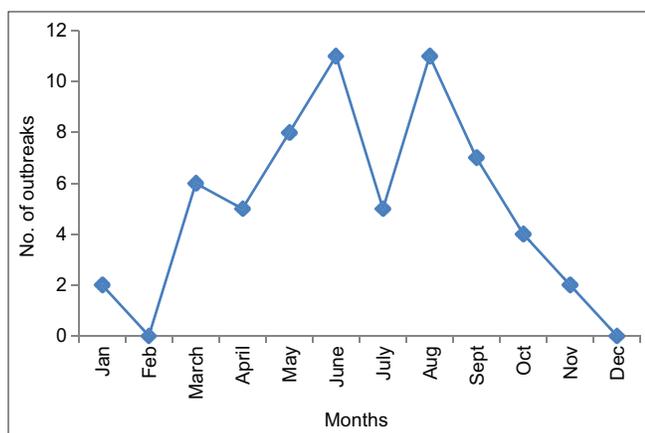
During the study period, samples from few of the FBD events could not be collected, and some FBD event samples did not have any causal pathogenic organism. Pathogenic organisms were detected from 25.93% ( $n = 14$ ) of the FBD events reported between 2015 and 2020 [Table 1].

The most common pathogen isolated from the FBD included *Salmonella* species, *Shigella* species, *Escherichia coli*, and *Staphylococcus aureus*. *Shigella flexneri* and *Shigella sonnei* are common diarrhea-causing pathogens detected in Bhutan<sup>[9]</sup> isolated from stool samples. A diarrheal outbreak caused by *S. flexneri* was reported in a remote village in Mongar.<sup>[10]</sup> Similarly, a novel strain of *Shigella* species was isolated from an outbreak in Pemagatshel that occurred in

**Table 1: List of foodborne diseases investigated with causative agent/pathogenic organism isolated**

Event location	Event date	Number of cases	Causative agent
Kuenselphodrang and near PNB Office in Thimphu	July 27, 2017	25	<i>Salmonella</i> species
Changzamtog, Thimphu	June 20, 2017	60	<i>Salmonella</i> species
Bjishong Central School	August 18, 2018	79	<i>Shigella</i> species
Jaringey, Samste	June 21, 2018	7	<i>Shigella</i> species
Gaselo Central School	March 30, 18	11	<i>C. nepalensis</i>
Tashiyangtse	August 23, 2019	63	<i>E. coli</i>
Martshala Central School	February 3, 2019	137	<i>Shigella</i> species
Tashigang Central School	August 29, 2019	34	<i>Salmonella</i> species and <i>E. coli</i>
Chokhor, Bumthang	October 10, 2020	24	<i>Salmonella</i> species
Bidung, Tashigang	October 10, 2020	18	<i>Salmonella</i> species
RTC area, Thimphu	September 3, 2020	4	<i>S. aureus</i>
Tshangkha, Dagana	August 28, 2020	6	Suspected Bongkreki acid poisoning
Nganglam, Pemagatshel	April 18, 2020	22	<i>Salmonella</i> species
Ura, Bumthang	January 27, 2020	40	<i>Salmonella</i> species

*E. coli*: *Escherichia coli*, *S. aureus*: *Staphylococcus aureus*, *C. nepalensis*: *Coriaria nepalensis*, PNB: Punjan National Bank, RTC: Royal Thimphu College



**Figure 2: Seasonal trend of foodborne outbreak in Bhutan (2012–2020)**

2012.<sup>[11]</sup> Since *Shigella* can spread by contaminated food, contaminated water, or direct contact with an infected person, shigellosis is a notifiable disease in Bhutan.

*Salmonella* species commonly causing salmonellosis include *Salmonella enteritidis*, *Salmonella typhimurium*, *Salmonella typhi*, and *Salmonella paratyphi*. Bakery is the common source of *Salmonella* infection outbreak due to the use of improperly washed eggs.<sup>[12]</sup> The current study found *Salmonella* as the most common pathogenic organism (42.86%) causing FBD in Bhutan. Tshokey et al.<sup>[13]</sup> mentioned that salmonellosis is probably endemic in the country, but an in-depth study has not been carried out.

The current review showed that 7.14% of FBD outbreaks were associated with contamination due to *S. aureus* and *E. coli*. *S. aureus* causes self-limiting foodborne illness either due to colonization or toxins. *Staphylococcus* species is halophilic in nature and is also a normal flora of human skin.<sup>[14]</sup> The other pathogens associated with FBD events reported in Bhutan included *Campylobacter jejuni* which was isolated following an outbreak in Bumthang

and was linked to consumption of contaminated beef curry.<sup>[6]</sup> An incident of FBD linked to consumption of carcass meat contaminated with *Aeromonas hydrophila* was reported from Samdrup Jongkhar district.<sup>[15]</sup> The other causative agent that was seldom associated was *Burkholderia cocovenenans* (Bongkreki acid poisoning) and consumption of *Coriaria nepalensis*.

Rotavirus is the most common cause of diarrhea among children <5 years of age globally.<sup>[16]</sup> In Bhutan, the rotavirus infection rate was higher during the dry winter–spring season (December–April).<sup>[17]</sup> The prevalence of *Norovirus* (ancestor strain of GII.3 replaced GII.21) was recognized in Bhutan as a diarrheagenic agent among children.<sup>[7]</sup> In addition, bufavirus was detected in children with severe diarrhea.<sup>[18]</sup> Therefore, it can be concluded that apart from pathogenic bacteria, virus can also contribute to the FBD, especially those occurring during the cold and dry seasons.

There was no reported FBD event associated with pathogenic parasites infection through NEWARS, though the overall prevalence of soil-transmitted helminth infection was 1.4%, most common being *Ascaris lumbricoides*.<sup>[19]</sup> The attributing factors to zero reported parasitic events were due to improved sanitation, living standard, good personal hygiene, and regular deworming program at schools and health facilities.

Apart from the FBD events, the most common outbreaks with food consumption were due to consumption of toxic mushroom. In 2020, 11.5% [Figure 1] of mushroom poisoning contributed to the total outbreaks and reported high fatality.

### Source and location of foodborne disease events

Although specific food acting as a vehicle of transmission could not be established, most of the FBD events that occurred in Bhutan were linked to the consumption of

food sources such as meat and meat products followed by bakery products. Among the 47 FBD events notified from 2015 to 2020, 79.62% of the events had mentioned about the location. The available data show that schools were the commonplace where FBD events were usually reported. The annual median number of FBD outbreak events from schools was 3.6. The different sources where FBD events occurred during the study period included schools (46.51%), villages (27.90%), residential areas (6.97%), monasteries (4.65%), bakeries (4.65%), restaurants (4.65%), institutes (2.32%), and prison (2.32%), respectively. The outbreaks in schools have been attributed to contamination of food by food-handlers who worked while ill or had poor personal hygiene<sup>[20]</sup> apart from the quality of the water used for food preparation.

## Conclusion

Notification and investigation of foodborne outbreak events have been significantly strengthened in Bhutan providing very useful information for public health action. However, conducting an FBD investigation continues to be challenging due to the requirements of multidisciplinary teams and intersectoral coordination, sophisticated laboratory for identifying toxins and viruses, and lack of availability of food samples. Since most of the diarrhea cases and FBD events are reported during monsoon seasons, better public awareness campaigns and food safety education need to be provided for the prevention of outbreaks and resultant morbidity.

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## Conflicts of interest

There are no conflicts of interest.

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