

Seasonal Trends and Risk Factors of Scombroid Fish Poisoning in Muscat, Oman: A Retrospective Observational Study

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Abstract

Background: Scombroid fish poisoning (SFP) is a significant but often underreported foodborne illness caused by histamine accumulation in inadequately refrigerated fish, especially species high in free histidine. Study have identified seasonal clustering, particularly in warmer months, attributed to high ambient temperature that promotes bacterial proliferation and histamine formation. Despite growing regional research, data from Oman remain limited. **Objective:** This study aims to examine the seasonal patterns and risk factors associated with scombroid fish poisoning in Muscat governorate, with focus on fish species, exposure sources, and case severity. **Methods:** This retrospective observational study was conducted in Muscat governorate, Oman, including 38 cases of suspected fish poisoning reported between 2020-2024. Data obtained from Disease Surveillance and Control Department, included month of occurrence, implicated fish species, source of exposure, severity and outcomes. All cases were analysed using descriptive statistics in Microsoft Excel to evaluate seasonal trends and exposure related risk factors. **Results:** A total of 38 cases of scombroid fish poisoning were analysed. A strong seasonal clustering was observed during the summer months, with 64.7% of cases occurring in August, 23.5% in October, and 11.8% in May. All cases were associated with the consumption of tuna, especially meals prepared in restaurants. Most case (94.7%) were classified as mild, while 5.3% were moderate. No severe cases or hospitalization were reported, and all patients fully recovered. Common symptoms included rash, flushing, headache, nausea and diarrhoea, consistent with histamine-mediated reactions. **Conclusion:** The study indicates that scombroid poisoning in Muscat is mostly associated with restaurants served tuna and shows distinct seasonal clustering in August. These findings highlight the need for well-founded food safety regulations, improved cold chain monitoring, and

targeted restaurant check-ups to reduce the risk during the summer periods.

Keywords

Scombroid Fish Poisoning, Histamine Fish Poisoning, Seasonal Trend, Tuna, Food Safety, Oman

1. Introduction

The Ingestion of fish containing high levels of histamine and other biogenic amines can result in scombroid fish poisoning (SFP), also known as histamine fish poisoning, a foodborne illness that is often underdiagnosed [1]. This condition typically occurs when bacteria convert the naturally occurring amino acid histidine into histamine. In certain fish species, this process can occur rapidly when they are exposed to temperatures above 4°C [2]. The most frequently implicated fish in scombroid poisoning are dark-meat species like mackerel, sardines, tuna, and mahi-mahi [3]. Scombroid fish poisoning (SFP) happens when fish with high histamine levels, produced during inadequate refrigeration or sustained exposure to elevated temperatures, are consumed [4]. The ingested exogenous histamine can overload the body's natural detoxification systems, such as diamine oxidase (DAO), resulting in symptoms that closely resemble IgE-mediated allergic reactions, including flushing, headache, and rash [4]. The most related symptoms include abdominal discomfort, diarrhoea, palpitations, dermal flushing, pruritus, urticaria, and, in certain cases, bronchospasm or hypotension [5]. Scombroid fish poisoning (SFP) is a non-IgE-mediated pseudo allergic condition activated by the consumption of spoiled fish with high histamine content [5]. Comparing to real food allergies, it can affect individuals regardless of their allergic history, as it does not involve immune sensitization but somewhat histamine overload [6]. Scombroid fish poisoning (SFP) is completely preventable with correct cold chain management and hygienic management, however, it remains a significant public health concern [6]. To protect consumers, the Food and Agriculture Organization (FAO) and World Health Organization (WHO) mention a maximum histamine level of 200 mg/kg in fishery products [7]. Histamine is also used as a key damage indicator in quality control [7]. Despite scombroid fish poisoning (SFP) is preventable, it continues to arise, mostly in tropical and subtropical regions where high ambient temperatures accelerate bacterial histamine production in inadequately stored fish [8]. Scombroid Fish Poisoning (SFP) is an important but likely underreported public health issue worldwide. According to the Centres for Disease Control and Prevention (CDC), it remains one of the most reported foodborne illnesses linked to seafood in the United States, accounting for approximately 30% - 40% of fish-related outbreaks in recent years [9] [10]. Global estimates from world health organization (WHO) and regional data from the European Food and Safety (EFSA) similarly underscore the persistent risk of histamine

poisoning in fish, particularly in countries with warm climates and high seafood consumptions [11] [12]. In September 2014, a food-borne poisoning outbreak in Tainan, southern Taiwan region affected 37 persons and was related to milkfish fish sticks containing high levels of histamine, revealing the risk of histamine formation in inappropriately stored fish products [13]. Similar seasonal trends and risk factors have been documented in Gulf and Mediterranean countries, where susceptible species like mackerel and tuna accumulate histamine due to warm weather, excessive fish consumption, and insufficient refrigeration [14]-[16]. Local research on SFP remains uncommon in Oman, despite the country's strong dependence on fish as a major dietary component. Initial reports from the DCSD unreliable evidence suggest a clustering of cases between May and August, most frequently associated with consumption of tuna from restaurants local markets. Challenges in maintaining cold chains storage in traditional and outdoor markets, combined with the persistently high ambient temperatures, may be a major contributing factor. The aim of this study is to investigate seasonal patterns the risk factors of scombroid fish poisoning in Muscat Governorate, Oman. It examines 38 reported confirmed or clinically suspected cases to identify possible correlations between improper storage, exposure to temperature changes, and seasonal variations. The findings are expected guide national food safety strategies, public awareness initiatives, and regulatory measures aimed at reducing the incidence of this preventable illness.

2. Methodology

Study Design and Setting:

The retrospective descriptive study was conducted in Muscat Governorate, Oman.

It aimed to examine seasonal trends and potential risk factors associated with Scombroid Fish Poisoning (SFP), based on cases reported to Disease Surveillance and Control Department over a defined study period.

Data Source and Population:

Data was received from the database of the Department of Environmental and Occupational Health at the Directorate General of Health Services (DGHS), Muscat. All 38 of confirmed or clinically suspected cases of foodborne disease reported between January 2020, and December 2024 were reviewed. Cases were included only if they were confirmed or clinically suspected scombroid fish poisoning (SFP) based on reported symptoms, recent fish consumption, and confirmation of exposure source.

Case Selection and Variable:

Inclusion criteria required a recorded history of fish consumption prior to onset of symptoms consistent with scombroid poisoning. Cases were excluded if they lacked essential data or involved other foodborne illnesses unrelated to scombroid fish poisoning (SFP). Cases attributed to other seafood toxins such as ciguatera or shellfish poisoning, were also excluded.

For each included case, the following variables were extracted: age, gender, symptoms, fish type, source of the meal (restaurant or home), and date of exposure.

Case Definition and Severity Classification:

A case of scombroid fish poisoning (SFP) was defined as an individual who developed flushing, rash, headache, diarrhoea, or other histamine-related symptoms within 1 - 2 hours of consuming fish, particularly dark-meat species such as tuna. Severity was classified according to clinical presentation:

Mild: Transient symptoms such as rash, flushing, headache, or nausea without systemic involvement.

Moderate: Symptoms including facial swelling, shortness of breath, or hypotension that required medical attention but resolved without hospitalization.

Data Collection Tool:

A structured data extraction form was developed to systematically collect relevant variables. The form included demographic details (age, gender, nationality), time and month of exposure, type of fish consumed, source of fish (restaurant versus home-prepared), clinical symptoms and patient outcomes. Restaurant information and fish type were confirmed via patient interviews and validated by Public Health Inspection Unit, when available. Cross-checking of case investigation forms was performed to minimise exposure misclassification.

Data Analysis:

Data were entered and analysed using Microsoft Excel. Descriptive statistics were used to summarize demographic, clinical and exposure -related characteristics. Seasonal trends and variable distributions were visualized using tables and graphs.

Ethical Considerations:

The study protocol was reviewed and approved by the Research and Ethical Review Committee at Ministry of Health, Oman. As the study involved retrospective analysis of de-identified data, the requirement for informed consent was waived. All Data were handled with confidentiality and privacy were precisely maintained throughout the study process.

3. Results

3.1. Seasonal Trend

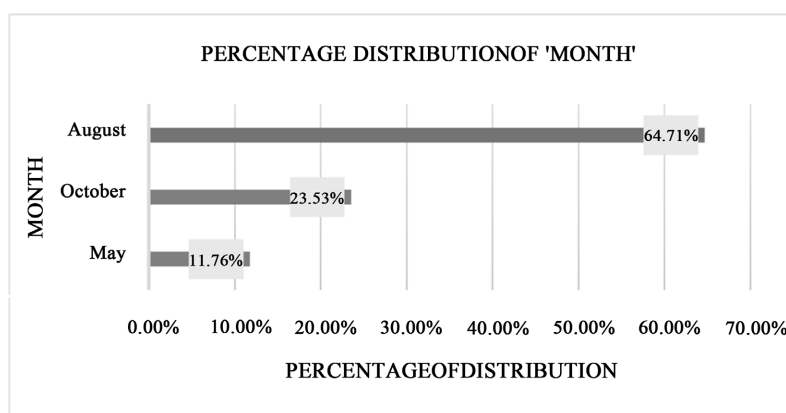
A total of 38 cases with complete month-of-exposure data were examined. August accounted for most cases (64.7%), followed by October (23.5%) and May (11.8%), indicating a distinct seasonal trend clustering during the summer period (**Table 1; Figure 1**). This pattern suggests that nearly two-thirds of scombroid poisoning cases occurred during the hottest summer months, demonstrating a potential association between elevated ambient temperatures and increased incidence.

3.2. Fish Type and Exposure Source

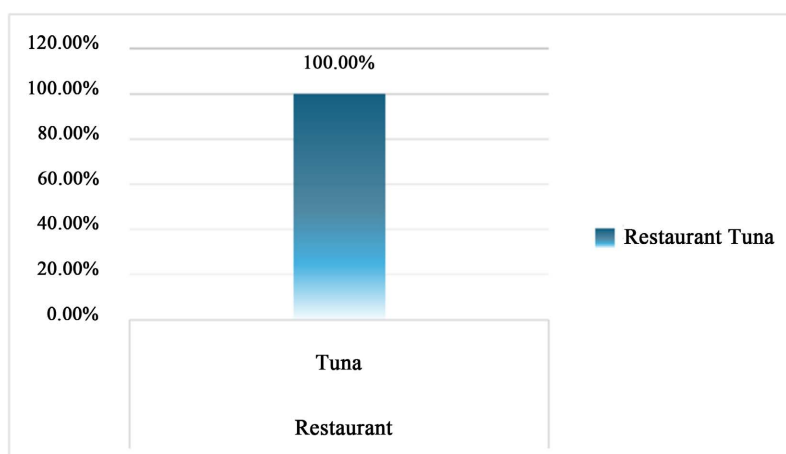
All cases (100%) were linked to tuna consumption (**Table 2; Figure 2**). No other fish species were concerned during the study period.

Table 1. Distribution of scombroid poisoning cases by month.

Month	Percentage %
August	64.71
October	23.53
May	11.76
Grand Total	100.00

**Figure 1.** Percentage of distribution of scombroid fish poisoning, showing high percentage in August.**Table 2.** Percentage of distribution of cases by fish type and source of fish.

Meal Source	Fish Type	Cases %
Restaurant	Tuna	100.00
Grand Total		100.00

**Figure 2.** Distribution of scombroid of fish poisoning cases by fish type and source.

3.3. Severity and Outcome

Most cases were classified as mild (94.7%), while (5.3%) were classified as moder-

ate. No severe cases were reported (**Table 3; Figure 3**). All patients (100%) of reported cases recovered without complications (**Table 4; Figure 4**). These findings indicate generally good prognosis for scombroid fish poisoning cases, with limited clinical severity and good recovery outcomes.

Table 3. Severity of scombroid fish poisoning cases.

Severity	Count of Severity
Mild	94.12%
Moderate	5.88%
Grand Total	100.00%

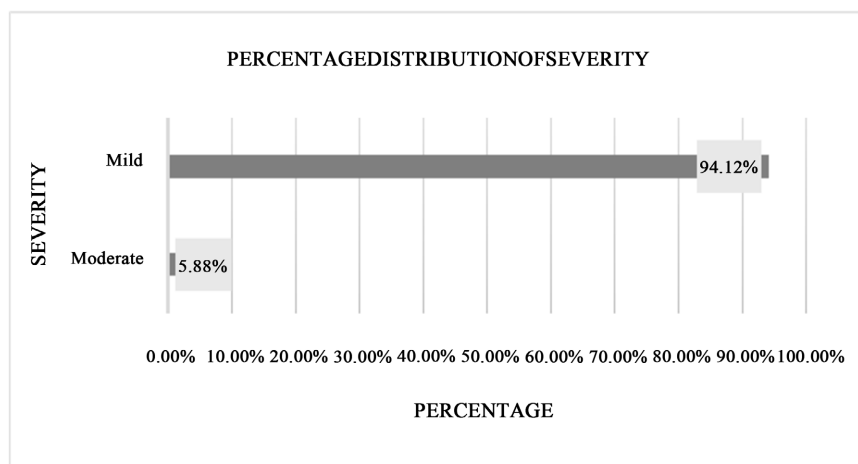


Figure 3. Severity of scombroid poisoning cases, most classified as mild.

Table 4. Outcomes of scombroid poisoning cases.

% distribution of "Outcome"	
Outcome	Count of Outcome
Recovered	100.00%
Grand Total	100.00%

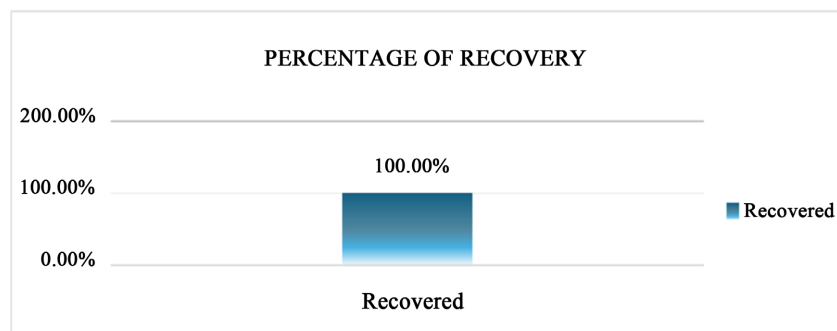


Figure 4. Outcomes of scombroid poisoning cases, all recovered.

3.4. Clinical Symptoms Pattern

The most frequently reported symptom cluster-accounted for 25% of cases including eye redness, headache, and hypotension. An additional 25% experienced facial redness, swelling, shortness of breath (SOB), and itching. Other symptoms combination including headache, nausea, and diarrhoea (12.5%), headache, fever, rash, vomiting and abdominal pain (12.5%) and rash alone (12.5%). Less frequently observed presentation were diarrhoea, rash, SOB, and facial swelling (6.25%), as well as headache, face redness, and palpitation (6.25%) (Table 5; Figure 5). Notably, only small proportion of patients developed moderate severity of symptoms, and no severe cases were documented. This symptom pattern is consistent with histamine-mediated reactions typically observed in scombroid fish poisoning.

Table 5. Percentage of symptoms distribution.

Symptoms	Percentage %
Eye redness, headache, rash, hypotension	25.00
Facial redness, swelling, SOB, itching	25.00
Headache, nausea, diarrhoea	12.50
Headache, fever, rash, vomiting, abdominal pain	12.50
Rash	12.50
Diarrhoea, rash, SOB, facial swelling	6.25
Headache, face redness, palpitation	6.25
Grand Total	100.00

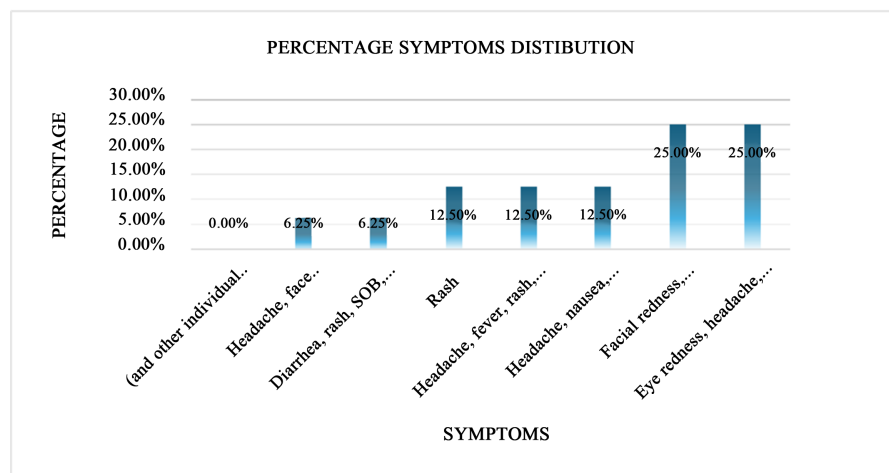


Figure 5. Distribution of clinical symptoms among scombroid fish poisoning cases.

3.5. Missing Data

Data on month of exposure was unavailable for four cases, which were excluded from the seasonal distribution analysis.

4. Discussion

This retrospective observational study examined the risk factors and seasonal distribution of scombroid fish poisoning (SFP) in Muscat, Oman. Analysis of 38 cases reported to the Disease Surveillance and Control Department showed that tuna consumption in restaurants was contributing factor in all cases with the majority occurring in August. All patients made a full recovery, and most cases were classified as mild.

4.1. Seasonal Trends

The clustering of cases in August indicates a strong seasonal association between scombroid poisoning and the hot summer months. Elevated ambient temperatures accelerate bacterial growth and histidine decarboxylation in fish muscle, leading to formation of toxic biogenic amines such as histamine [1]-[4]. This seasonal trend aligns with the studies from Asia and the Mediterranean, where the most SFP cases occur during warmer periods [14]-[16]. The high prevalence observed during the summer in Muscat likely reflects the weakness in cold chain in transportation or restaurant storage, especially when fish is inadequately refrigerated.

4.2. Fish Type and Source of Exposure

In all cases, the implicated fish was tuna, consistent with global evidence indicating that tuna, mackerel, and other dark-meat species contain high levels of histidine and are highly susceptible to histamine accumulation when improperly stored [3] [4]. Furthermore, the findings that 100% of cases originated from restaurant meals emphasize the importance of proper food handling and cold chain management at commercial setting [4]. Similar observations were observed in Taiwan region, where restaurants prepared meals, accounted for majority of SFP outbreaks [13]. These findings highlight the critical need for thorough restaurant hygiene practices and consistent temperature control to prevent histamine accumulation.

4.3. Severity and Outcome

All reported cases were mild to moderate, with no hospitalizations nor severe reactions. This is consistent with previous literature indicating that scombroid fish poisoning symptoms typically resolve within a few hours with supportive treatment [5] [6]. The absence of mortalities or long-term complications in this study reflects the effectiveness supportive of timely medical management and the generally self-limiting nature of SPF.

4.4. Clinical Symptoms Pattern

The clinical profile observed in this study characterized by flushing, rash, facial swelling, headache, nausea, and diarrhoea, is consistent with histamine-mediated reactions [5] [6]. These symptoms closely resemble allergic responses but are not

immunoglobulin E (IgE)-mediated [6]. The findings in this study align with previous reports describing the classical symptom's pattern of histamine fish poisoning.

5. Conclusions

Scombroid fish poisoning in Muscat shows a clear seasonal pattern, with a marked increase in August, likely due to elevated temperatures and old-chain failure. All cases were linked to the restaurant-served tuna and were clinically mild to moderate. Strengthening cold-chain practices and enhancing food safety awareness could significantly reduce the burden of this preventable illness.

Public Health Implications

The findings highlight the need for supported cold chain checking in restaurants, particularly during summer months when the risk for histamine formation is highest. Ensuring fish stored at temperature $< 4^{\circ}\text{C}$, improving food handlers training, and increasing public awareness about the risks of consuming unrefrigerated fish may significantly reduce scombroid poisoning incidents. Increased surveillance and timely reporting of sea-food related illnesses would further support prevention efforts.

6. Strengths and Limitations

This study provides the first descriptive analysis of scombroid fish poisoning in Muscat using systematically collected surveillance data. However, small sample size ($n = 38$) and retrospective design limit generalizability. The lack of laboratory confirmed histamine levels and storage temperature data restricted quantitative assessment of cold chain failure. Future studies should incorporate laboratory testing and temperature monitoring to strengthen connective power.

Ethical Approval

This study was approved by the Ministry of Health Research and Ethical Review Committee, Oman. Data were obtained from the Disease Surveillance and Control Department. All patient data were anonymized, and no identifying information was collected.

Conflicts of Interest

The authors declare no conflict of interest.

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