International Journal for Multidisciplinary Research (IJFMR)
E-ISSN: 2582-2160 ● Website: www.ijfmr.com ● Email: editor@ijfmr.com

Chronic Cyanide Poisoning from Improperly Processed Cassava, July to August, 2024: An Investigation of a Konzo Outbreak in Luampa District, Zambia

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ABSTRACT

Introduction: Konzo is a neurological disorder that causes permanent spastic paralysis. It occurs mainly in rural areas and results from chronic cyanide intoxication due to consumption of inadequately processed bitter cassava. In July 2024, Luampa district reported eight cases of spastic paralysis diagnosed as Konzo. We investigated to identify the clinical, demographic, temporal, and environmental characteristics of this suspected outbreak.

Methods: We conducted a field investigation in Luampa District from August 14–19, 2024. A case was defined as sudden onset of lower limb spastic paralysis with a history of regular cassava consumption; confirmation required elevated thiocyanate levels in blood or urine. Data were collected through structured interviews and medical record reviews. Environmental assessments included sampling of blood, urine, water, and food for cyanide analysis. Descriptive statistics summarized demographic data, and qualitative analysis identified common practices.

Results: Eight cases of spastic paralysis were identified, with a median age of 7 years (IQR: 6.5–9.5), and 75% were male. All cases reported consuming bitter cassava as a staple food. Symptom onset occurred between 10 and 16 July 2024, with a median onset date of 11 July. Six cases (75%) were reported from Nakayembe Health Facility, and four of these originated from Sikuka village. Laboratory analysis detected cyanide in the blood and urine samples of all affected individuals, as well as in processed cassava samples collected from their households. Cyanide concentrations were not quantified. Environmental assessments documented cassava processing practices such as soaking unpeeled cassava in shallow wells and a lack of basic sanitary facilities.

Conclusion: The findings are consistent with Konzo, likely resulting from chronic cyanide intoxication due to the consumption of inadequately processed bitter cassava. Immediate public health interventions are essential to prevent additional cases. These should include community education on safe cassava

processing methods, such as peeling cassava before soaking and using running water or regularly flushed wells, and the promotion of low-cyanide cassava varieties. Strengthening these preventive measures will help protect affected communities from future outbreaks.

Keywords: Konzo, Cyanide poisoning, Cassava, Spastic paralysis, Outbreak investigation, Zambia

1.0 INTRODUCTION

Konzo is a non-progressive neurological disorder characterized by sudden onset of spastic paraparesis, predominantly affecting the lower limbs. It primarily occurs in remote rural areas and is strongly associated with chronic cyanide intoxication resulting from the consumption of inadequately processed bitter cassava [1–3]. Bitter cassava contains high levels of cyanogenic glycosides, which, if not properly detoxified through techniques such as soaking, drying, or fermentation, release cyanide upon ingestion [2,3].

The disease disproportionately affects children and women of childbearing age and tends to emerge during periods of food insecurity and drought, when communities are more likely to depend on bitter cassava as a staple food [3,5]. Preventive strategies include improving cassava processing techniques and promoting dietary diversity to reduce reliance on high-cyanide cassava varieties [1,2].

In Zambia, Konzo has previously been reported in the Western Province, including the districts of Mongu, Luampa, and Senanga, with the last confirmed outbreak documented in 2019 [4]. The condition has been identified through the Acute Flaccid Paralysis (AFP) surveillance system, which was established in 1998 to monitor poliomyelitis and other causes of acute paralysis. Past investigations in Zambia have confirmed that these Konzo cases are not linked to viral infections but to cyanide toxicity from dietary sources [2,4].

On July 15, 2024, Luampa District reported two cases of acute flaccid paralysis involving children under 15 years from Luyi and Nakayembe health facilities. The number of AFP cases soon rose to four, surpassing the World Health Organization's (WHO) annualized AFP detection threshold of one case per 100,000 children under 15 years by mid-year. This unusual increase raised concerns about a possible outbreak of Konzo.

1.1 Study Question

What are the clinical, demographic, temporal, and environmental characteristics of the suspected Konzo cases reported during the outbreak in Luampa District, Zambia, in July–August 2024?

1.1.1 Specific Objectives

1. To confirm the occurrence and describe the extent of the Konzo outbreak in Luampa District.
2. To characterize the demographic, clinical, and temporal features of the reported Konzo cases.
3. To identify common exposures and environmental conditions among the affected individuals.
4. To document cassava processing practices in affected communities.

2.0 METHODS

2.1 Study Design

We conducted a descriptive case series involving eight suspected Konzo cases reported between July and August 2024 at Luyi and Nakayembe health facilities in Luampa District.

2.2 Study Setting

This investigation was conducted in Luampa District, Western Province of Zambia. Fieldwork focused on

Luyi and Nakayembe rural health facilities, located approximately 60 km and 35 km from the district center, respectively. The district has a projected population of approximately 63,500 as of 2024, with an estimated 45% under the age of 15 [5]. The local economy is predominantly agrarian, with cassava being a major food crop cultivated and consumed in the area.

2.3 Sampling procedures and Inclusion criteria

All eight suspected cases of spastic paralysis reported at Luyi (1 case) and Nakayembe (7 cases) rural health facilities during the study period (July 2024) were included in the investigation. Inclusion was based on presentation with clinical signs consistent with Konzo (i.e., sudden onset of spastic paraparesis in a previously healthy individual), as documented in medical records or reported by caregivers.

2.4 Case definition

2.4.1 Suspected case:

Any individual residing in Luampa District presenting with sudden onset of spastic paraparesis of both lower limbs and a history of regular consumption of cassava or cassava-based products.

2.4.1 Confirmed case:

A suspected case with laboratory evidence of elevated thiocyanate levels in blood or urine, indicating chronic cyanide exposure.

2.5 Study Variables

The investigation collected data on demographic characteristics (age, sex, residence, occupation, and socioeconomic indicators), water sources (type, accessibility, and quality), dietary practices (frequency and form of cassava consumption, dietary diversity), and cassava processing methods (peeling, soaking duration, drying techniques, and storage).

2.6 Data collection

Data were collected using a standardized questionnaire developed in KoboToolbox and administered to all affected individuals. Clinical data were extracted through a review of medical records to document signs, symptoms, and treatment. Additionally, interviews with healthcare providers were conducted to gather information on case management approaches. Community interviews were carried out to document cassava processing practices and community perceptions related to cassava use and health.

2.7 Data Analysis

Data were exported from KoboToolbox and cleaned in Microsoft Excel. Quantitative data were analyzed using R version 4.3.3 to generate descriptive statistics, including frequencies, medians, and interquartile ranges. Qualitative data from community and provider interviews were thematically analyzed and summarized. Findings were presented using tables, graphs, and narrative descriptions.

2.8 Ethical approval

Prior to data collection, the study objectives were explained to all participants, and informed oral consent was obtained. Participation was voluntary, and no incentives, coercion, or undue influence were applied. To ensure confidentiality and privacy, participants' names and other personally identifiable information were not recorded.

The study employed a non-experimental, observational design, and no invasive procedures were involved, minimizing the risk of harm. Community engagement activities were conducted to build trust, promote understanding, and encourage participation.

All ethical procedures were implemented in accordance with established public health emergency investigation protocols to safeguard the rights and well-being of participants.

3.0 RESULTS

3.1 Quantitative Findings

3.1.1 Case Distribution by Location

A total of eight suspected Konzo cases were identified. One case (12.5%) was reported from Luyi Health Facility, while seven cases (87.5%) were reported from Nakayembe Health Facility. Within Nakayembe's catchment area, Sikuka village accounted for the largest number of cases (n = 4; 57.1%).

3.1.2 Demographic Characteristics

Five of the cases were male (62.5%) and three were female (37.5%). All female cases (n = 3) were from Nakayembe. Among male cases, four were reported at Nakayembe and one at Luyi. The overall median age was 7 years (IQR: 6.5–9.5). The median age at Luyi was 9 years, while at Nakayembe it was 7 years (IQR: 6.0–9.0).

3.2 Clinical Presentation and Timeline

All eight cases presented with spastic paralysis affecting both lower limbs. Reported symptoms included limb weakness, muscle cramping, heaviness in lifting legs, and impaired mobility. Fever was reported in four cases (50%). At Luyi, the single case had fever, while three of the seven cases at Nakayembe reported fever.

The median date of symptom onset was July 11, 2024 (IQR: July 10–16). The median date of presentation to the health facility was July 17, 2024 (IQR: July 11–18). The single case at Luyi was seen on July 12. The remaining cases at Nakayembe were primarily seen on July 17.

3.3 Specimen Collection and Laboratory Results

Specimens were collected from seven of the eight suspected cases (87.5%). No specimen was collected from the case reported at Luyi. A total of 16 biological specimens—comprising urine and blood—were collected from the affected individuals. In addition, one water sample was obtained from a shallow well used for soaking cassava, and one sample of processed cassava meal was collected from a household. Laboratory testing detected the presence of cyanide in all human blood samples and in the processed cassava meal. The water sample tested negative for cyanide. However, the concentration of cyanide in all positive samples was not quantified.

3.4 Qualitative Findings

3.4.1 Clinical Management

All eight cases were managed at outpatient level. Review of clinical records revealed incomplete documentation of vital signs, with some cases missing temperature readings. Nutritional assessments were not recorded. Treatment primarily consisted of symptomatic management using paracetamol.

3.4.2 Water Sources and Sanitation

Households relied on untreated water from streams and shallow wells for domestic use, including drinking. Water was collected using various utensils and stored in containers. There was no evidence of water filtration or treatment. Households did not have latrines; open defecation in nearby thickets was commonly practiced.

3.5 Nutrition and Diet

The diet mainly consisted of nshima prepared from cassava meal. Cassava leaves and Roselle (*Hibiscus sabdariffa*) were commonly used as relish. Protein intake was limited. Most households reported consuming one main meal per day, supplemented by snacks made from cooked or roasted cassava.

3.6 Cassava Processing Practices

Both sweet and bitter cassava varieties were used for meals and snacks. Processing involved soaking unpeeled cassava in shallow pits dug near streams or floodplains for approximately one week. The cassava was then dried and pounded into mealie meal. Some cassava was roasted and consumed directly after soaking. During drought conditions, households used shallow wells as soaking sites, reusing the water repeatedly as long as it remained visibly clear.

4.0 DISCUSSION

4.1 Patterns of Suspected Cases

Fever was present in some cases, indicating a heterogeneous presentation of symptoms. A notable disparity in fever cases was observed between facilities, with Nakayembe reporting a higher prevalence than Luyi. This disparity may reflect varying local conditions or differences in symptom management and reporting, warranting further investigation into the clinical presentation of Konzo in this community.

4.2 Laboratory Results and Interpretation

The laboratory analysis provided critical insights into the underlying cause of the outbreak. The detection of cyanide in blood samples of all suspected Konzo patients and in the cassava meal sample strongly supports the hypothesis that cyanide poisoning, from improperly processed cassava, is the cause of the observed symptoms. This finding is consistent with previous Konzo outbreaks in Zambia and elsewhere, which have also linked the disease to chronic cyanide exposure from dietary sources [4, 6, 7].

4.3 Water Safety and Sanitation Concerns

The local diet, predominantly based on Nshima from cassava meal and lacking adequate protein sources, indicates potential nutritional deficiencies. Limited dietary variety and reliance on cassava could lead to malnutrition, which may weaken individuals and potentially exacerbate the effects of chronic cyanide exposure. Previous studies have suggested that malnutrition, particularly of sulfur amino acids, may impair the body's ability to detoxify cyanide, making individuals more susceptible to Konzo [8, 9].

4.4 Nutritional Deficiencies

The local diet, predominantly based on Nshima from cassava meal and lacking adequate protein sources, indicates potential nutritional deficiencies. Limited dietary variety and reliance on cassava could lead to malnutrition, which may weaken individuals and potentially exacerbate the effects of chronic cyanide exposure. Public health initiatives should focus on enhancing dietary diversity and providing nutrition education to improve overall health and resilience.

4.5 Cassava Processing Risks

Laboratory findings indicated the presence of cyanide in processed cassava meal and in biological samples from affected individuals, suggesting exposure linked to cassava consumption. These results underscore the potential health risks associated with current local cassava processing practices. For example, soaking unpeeled cassava in shallow wells, as observed in this community, is an ineffective method for detoxification compared to the recommended practice of peeling tubers and soaking them in running water or regularly refreshing the water [10, 11]. This is particularly critical during periods of drought when water in these shallow wells may be reused or have limited turnover, increasing the risk of incomplete cyanide

removal. To reduce future risk, public health interventions should focus on improving processing methods and promoting the cultivation of low-cyanogenic cassava varieties (e.g., *Kapumba* and *Nakamoya*), which have been successfully introduced in other Konzo-prone regions [12].

4.6 Enhanced Diagnostic and Surveillance Systems Capabilities

The potential identification of Konzo underscores the need for improved diagnostic capabilities and surveillance systems. While Konzo cases have previously been detected through the national AFP surveillance system [4], the findings from this outbreak highlight the importance of enhancing diagnostic training for clinicians to accurately differentiate Konzo from other neurological disorders. This is critical for effective intervention and case management.

4.7 Study Limitations

The study's primary limitations stem from its descriptive, non-experimental design and small sample size of eight cases, which restricts the generalizability of the findings and the statistical power to detect meaningful associations. A significant limitation is the lack of a control group, which prevents definitive conclusions about the risk factors, as the same dietary and environmental factors are likely present among unaffected individuals in the community. Furthermore, while the presence of cyanide was confirmed in biological and food samples, its concentration was not quantified, making it impossible to establish a dose-response relationship between cyanide levels and the severity of the illness. The reliance on self-reported data for dietary habits and cassava processing practices is also a source of potential recall and information bias. Finally, the study's focus on identifying a link to cyanide may have under-explored other co-factors, such as the specific role of nutritional deficiencies, which were noted but not quantitatively assessed, in exacerbating the clinical outcomes.

4.8 Conclusion

This investigation identified a cluster of acute spastic paraparesis cases consistent with Konzo, likely caused by chronic dietary exposure to cyanide from improperly processed cassava. The presence of cyanide in both clinical and food samples supports this conclusion. Environmental and dietary conditions observed among the cases included unsafe cassava processing practices, inadequate access to safe water, poor sanitation, and limited dietary protein.

The findings underscore the urgent need for community education on safe cassava processing, promotion of low-cyanogenic cassava varieties, and nutrition interventions to address protein deficiencies that may exacerbate cyanide toxicity. Strengthening clinical diagnostic capacity and surveillance systems is critical for early detection and response to similar outbreaks. Continued investment in community health education, improved sanitation infrastructure, and sustainable agricultural practices will be key to preventing future cases of Konzo and improving overall community resilience.

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