Scientific Research Publishing

Open Journal of Epidemiology, 2022, 12, 492-504
https://www.scirp.org/journal/ojepi
ISSN Online: 2165-7467
ISSN Print: 2165-7459

Varicella Outbreak at a Boarding School, Chikomba District, Mashonaland East Province, Zimbabwe, 2019

Govha Emmanuel[1], Nyika Howard[2], Simukai Tirivanhu Zizhou[3], Notion Tafara Gombe[4], Addmore Chadambuka[1], Tsitsi Patience Juru[1], Mufuta Tshimanga[1]

[1]Department of Community Medicine, University of Zimbabwe, Harare, Zimbabwe
[2]AIDS and TB Unit, Ministry of Health and Child Care, Harare, Zimbabwe
[3]Mashonaland East Provincial Medical Directorate, Ministry of Health and Child Care, Marondera, Zimbabwe
[4]African Field Epidemiology Network, Harare, Zimbabwe
Email: govha86@gmail.com, simuzizh@gmail.com, tshimangamufuta@gmail.com, howiezim@gmail.com, ngombe@afenet.net, tsitsijuru@gmail.com, achadambuka1@yahoo.co.uk

How to cite this paper: Emmanuel, G., Howard, N., Zizhou, S.T., Gombe, N.T., Chadambuka, A., Juru, T.P. and Tshimanga, M. (2022) Varicella Outbreak at a Boarding School, Chikomba District, Mashonaland East Province, Zimbabwe, 2019. *Open Journal of Epidemiology*, **12**, 492-504.
https://doi.org/10.4236/ojepi.2022.124039

Received: August 8, 2022
Accepted: November 19, 2022
Published: November 22, 2022

Abstract

Background: Varicella is a contagious illness, caused by varicella zoster virus (VZV). It is transmitted via the respiratory route and through contact with the infected person. Fourteen cases of varicella from a boarding school in Chikomba District, Zimbabwe were reported on 14 February 2019. We investigated the outbreak to determine its scope, identify risk factors for transmission and recommend evidence-based control measures. **Methods:** A 1:2 unmatched case-control study was conducted. A case was a form one student at a boarding school in Chikomba District who developed acute onset of diffuse maculopapulovesicular rash without other apparent cause from 22 January 2019 to 24 February 2019. A control was a form one student at the same boarding school who did not develop the signs and symptoms of varicella during the same period. The diagnosis was based on clinical signs and symptoms. An interviewer-administered questionnaire was used to collect data. Epi info 7™ was used to calculate frequencies, odds ratios and perform logistic regression to control for confounding variables. **Results:** We recruited 31 cases and 62 controls. Independent risk factors for contracting varicella were classmate contact [AOR 24; (95% CI 4.4 - 83), $p < 0.01$], dormitory contact [AOR 14; (95% CI 2.7 - 75), $p < 0.01$] and previous history of varicella like illness [AOR 0.08; (95% CI 0.02 - 0.30), $p < 0.01$]. Only 35% (11/31) of cases and the majority 58 % (36/62) of controls, knew at least three signs and symptoms of varicella ($p = 0.04$). All cases were reported to the health facility within two days of onset of illness but were not managed according to guidelines. **Conclusion:** A perfect setting for the spread of infection was available

in the form of students in a naive community living in close proximity both at class and at dormitories, which lead to the rapid transmission of the virus. Screening and isolation of the infected students controlled the outbreak.

Keywords

Varicella Outbreak, Risk Factors, High School, Chikomba

1. Introduction

Varicella is a highly contagious illness caused by the varicella-zoster virus, a type of herpes virus [1]. It can cause an itchy, blister-like rash [2]. The rash first appears on the chest, back, and face, and then spreads over the entire body, causing between 50 and 500 itchy blisters [2]. Primary infection with varicella zoster virus (VZV) causes varicella (chickenpox). After the primary infection, VZV stays in the body as a latent infection and its reactivation causes herpes zoster (HZ) [2]. HZ usually occurs later in life, with ≥95% of immunocompetent individuals over 50 years of age being seropositive for VZV and at risk of developing the disease. VZV is highly transmissible via respiratory droplets or direct contact with characteristic skin lesions of the infected person [3].

The first symptoms of clinical varicella generally appear after a 10 - 21 day incubation period [3]. Persons with varicella are considered infectious from 1 to 2 days before the rash appears and until all lesions are crusted over [4]. Varicella is not a universally notifiable disease, but standardized annual incidence rates from 300 - 1291 per 100,000 population have been reported in Europe [5]. There is little literature on varicella in low to medium income countries. In temperate high-income countries in the prevaccination era, >90% of infections occurred before adolescence and are more severe in adults than in children [4]. Periodic large outbreaks occur with an inter-epidemic cycle of 2 - 5 years. Varicella outbreaks continue to occur even in settings such as schools where most children are vaccinated [2].

In Africa, risk factors for VZV include the rapidly growing elderly population due to wide use of antiretroviral therapy among HIV-positive clients [6]. VZV seropositive status has been noted to be associated with a higher number of individuals per household [7]. High seroprevalence rates (94% - 96%) have been reported in crowded refugee camps that had experienced varicella outbreaks [8] [9]. The later acquisition of varicella is thought to be possibly protective against developing shingles, as immunity developed during the initial infection could last longer [10].

In Zimbabwe, varicella is a notifiable disease but there is limited documented literature on outbreaks. On 16 February 2019, the nurse at a high school dispensary in Chikomba District attended to 14 students who presented with complaints of headaches, fever and itchy diffuse (generalized) maculopapulovesicular rash. The district rapid response team (RRT) visited the school on February

18, and eight more cases were found during active search. On further inquiry, the index case was found to have experienced similar symptoms on 22 January 2019. All reported cases were students in form one from the high school. The attack rate among the form ones was 11.3%. Blood samples were collected from the 22 students, but the National Virology Laboratory was not carrying out varicella confirmatory tests. A varicella outbreak was declared based on clinical diagnosis. Zimbabwe has no public VZV vaccination program. This poses a risk of a major outbreak if no investigation and control measures are implemented. Apart from that, there is no published literature on VZV outbreaks in Zimbabwe. We investigated the varicella outbreak to determine risk factors and institute relevant control and preventive measures.

2. Methods

2.1. Study Setting

We carried out a study from 25 to 27 of February 2019 at a boarding school in Chikomba District, Mashonaland East Province, Zimbabwe. The school draws students from all parts of the country. The boarding school enrolls students from Form 1 to six and had an enrolment of 861 students, 60 teachers and 10 non-teaching staff at the time of the outbreak. There are four form one classes with a total of 194 students. There is provision of water from a borehole and meals are prepared at the school kitchen. Each form has its own dormitory with several partitions. Healthcare services are offered at the school dispensary that is manned by a registered general nurse.

2.2. Diagnostic Criteria

At the time of the outbreak, the Zimbabwe National Virology Laboratory was not conducting varicella PCR confirmatory blood test. Therefore, a varicella outbreak was declared based on clinical diagnosis where a case was defined as any student at the boarding school who developed acute onset of diffuse maculopapulovesicular rash without other apparent cause from 22 January 2019 to 24 February 2019

2.3. Case Investigations

We visited the school and used a line list of cases by the date of onset of symptoms to conduct a preliminary case investigation. The line list captured demographic data, epidemiological information on signs and symptoms, date of onset, age and class of the patient. All cases on the line list were interviewed and were Form 1 students. The index case had onset of symptoms on 22 January 2019. She reported no history of varicella contact either at home or at school. When she got treatment at the school dispensary two days after appearance of symptoms, she was not isolated, no contact tracing was done, and the case was not reported. We used the Zimbabwe Integrated Disease Surveillance and Response (IDSR) assessment tool to assess the level of district preparedness and response to the

outbreak.

2.4. Descriptive Epidemiology and Hypothesis Generation

We analysed the data gathered from case investigation by time, place and person to generate a hypothesis for our investigation. Findings of our descriptive epidemiology suggested that all cases had a contact either at the dormitories or in class before the onset of illness. We also found that all cases were Form 1 students. We hypothesised that there was an association between having a dormitory contact and contracting varicella.

2.5. Environmental Assessment

On suspicion that close contact might have been the risk factor for the outbreak basing on the descriptive epidemiology, we developed an environmental checklist to assess the environment. We assessed the cleanliness of the dormitories, clothing and floor space area per student. We also assessed availability of safe water sources and clean and functional toilets in the dormitories.

2.6. Case-Control Study

Study Design and case definitions

We conducted an unmatched 1:2 case-control study to test the hypothesis. We restricted our study to the form one students. We defined a case as a form one student at the boarding school who developed acute onset of diffuse maculopapulovesicular rash without other apparent cause from 22 January 2019 to 24 February 2019. A contact was defined as a student at the school sharing a confined space for a prolonged period from 22 January 2019 to 24 February 2019, increasing the risk of exposure to secretions on either explosive sneeze or cough. We defined a control as a form one student at the school who did not develop acute onset of diffuse maculopapulovesicular rash without other apparent cause from 22 January 2019 to 24 February 2019.

Sampling technique

We recruited all the 31-suspected cases on the line list. Controls were selected randomly using the lottery method where each name on the list of all Form Ones who did not suffer varicella were allocated a number on pieces of paper, which were put in a box and randomly picked. The name corresponding to the number was recruited into the study until we reached the sample size of 62 controls.

2.7. Data Collection

We designed an interviewer-administered questionnaire that had three sections (A to C) with a total of 40 questions. Section A had demographic questions that included age, gender, educational level, and religion of study participants. Section B had questions related to varicella knowledge (transmission, prevention, signs and symptoms of varicella, when to stop medication and if varicella is curable), attitudes (perceived benefits of individual and community vaccination and

if varicella is dangerous) and practices (vaccination status, isolation regulations, treatment of varicella). Finally, section C had case specific questions on clinical management of cases. We pretested our interviewer-administered questionnaire by administering 10 questionnaires to five cases and five controls who were not included in the study. Initially the questionnaire had few unclear questions that we modified and validated, and the investigators agreed upon reliability of the questionnaire. We used the questionnaire to collect data from both cases and controls as listed in the three sections above. We also assessed and measured timeliness and quality of outbreak detection, investigation and response using a checklist adopted from the Zimbabwe Integrated Disease Surveillance and Response Technical Guidelines.

2.8. Data Analysis

We created the questionnaire in Epi Info 7™ statistical software package for data analysis. We used the software to generate frequencies of various independent variables, calculate Odds Ratios (ORs), p-values and 95% Confidence Intervals (CI). We performed forward stepwise logistic regression analysis using the same software to determine the independent factors associated with contracting varicella. All variables associated with contracting varicella in the bivariate analysis with a p-value ≤ 0.25 were included in the logistic regression model. Knowledge was assessed on a 5-point Likert Scale where a score of 0 - 2 was poor knowledge, 3 fair knowledge and 4 - 5 was good knowledge.

2.9. Ethics Approval and Consent to Participate

The Institutional Review Board (IRB) for Mashonaland East Provincial Health Directorate reviewed the study protocol on 23 February 2019 and approved the study. Permission to conduct the investigation was obtained from the Health Studies Office (HSO), Provincial Medical Director (PMD) and Provincial Education Director (PED) Mashonaland East Province, District Medical Officer (DMO) Chikomba district and the headmaster of the boarding school. We fully explained the aim of the study to the headmaster and participants, and we obtained informed consent from the headmaster. We maintained and assured confidentiality throughout the study. Records of the data and the consent forms were kept under lock and key all times.

3. Results

3.1. Descriptive Epidemiology

A total of 31 varicella cases were seen between 22 January and 24 February 2019 at the school dispensary. The attack rate was 11.3% among the form ones and no deaths were recorded. None of the cases had laboratory confirmation because local laboratories were not carrying out the confirmatory tests. Out of the 31 cases only 3 (10%) were males and 28 (90%) were females. The majority, 28 (90%) of cases were students in the 12 - 14 years age group and none was below

12 years.

Figure 1 is the epidemic curve showing the number of cases by date of onset of symptoms. The epidemic curve demonstrated a propagated type of disease spread signifying person to person contact. Three major peaks were seen with the first peak seen on 14 February 2019 and last peak was on 19 February 2019. The first case occurred on the 22nd of January 2019. Another case occurred four days later, and the majority occurred 24 days after the first case. Most cases occurred on 14 February 2019. There was a gradual decrease in the number of cases from 16 February 2019 until zero cases were recorded on 24 February 2019 when the investigation ended.

3.2. Case Presentation and Case Management

All cases presented with a typical varicella diffuse maculopapular vesicular rash. Fourteen (45%) of cases presented with generalised body malaise and only 2 (6.5%) presented with loss of appetite. Fifteen (49%) of cases were classified as having moderate disease and only 2 (6.5%) as having severe disease. All the 31 cases reported no prior history of vaccination against varicella zoster virus.

All 31 cases were managed with calamine lotion. Twenty-four (77%) and 20 (65%) of cases received antibiotics (amoxicillin) and antihistamines (chlorpheniramine) respectively. Although acyclovir is the antiviral drug of choice none of the cases got it because it was not available in the district. Thirteen (42%) of the cases were admitted with a 3-day median stay in hospital. At the time of the investigation 20 (65%) had already recovered and none of the cases developed complications.

Epidemic preparedness and response to varicella outbreak, Chikomba District, 2019

Although the first cases reported to the health facility within stipulated time

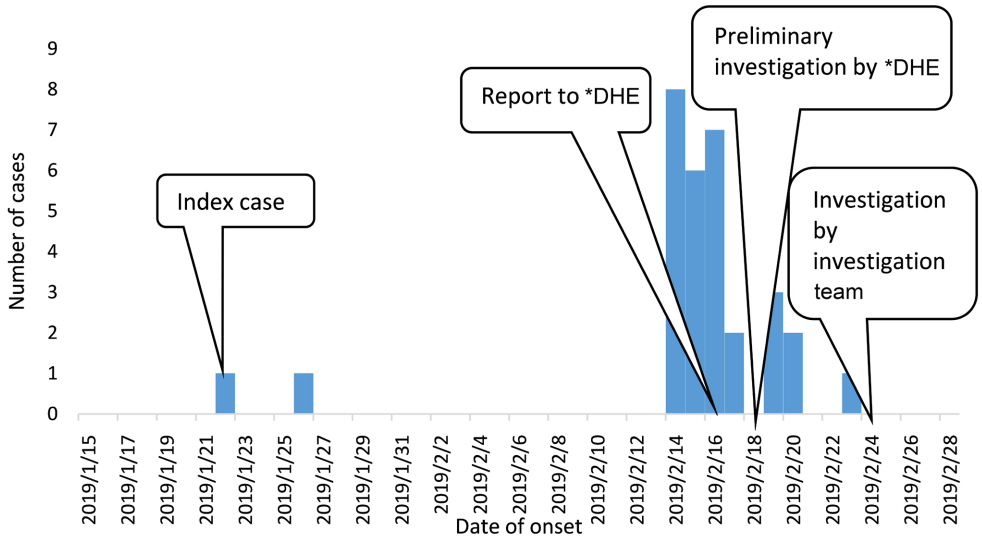

Figure 1. Epidemic curve for varicella outbreak at a boarding school, Chikomba, Zimbabwe, 2019. *DHE = District Health Executive.

frame, the outbreak was not relayed to the district in time despite the clinic having health workers trained on the Rapid Disease Notification System (RDNS) reporting. The outbreak was relayed 25 days later after an upsurge in the number of cases. The district rapid response team (RRT) responded within 2 days and control measures were put in place. Cases were screened, treated and quarantined. Cases were not allowed to mix with other students at dormitories and at school. They were not allowed to play and sleep together with others until after the infectious period, 4 - 7 days after crusting of lesions. Line lists were compiled daily. Resources were not adequate for the outbreak response for instance acyclovir was not available in the district. Apart from that, there are no reports and treatment guidelines for varicella in Zimbabwe.

Environmental assessment at the boarding school, Chikomba District, 2019

The school has 12 dormitories, six for boys and six for girls. Each form has its own compartmentalized dormitory. In the form one dormitories, we noted that students were overcrowded with an average of 8 to 10 students per compartment. According to the education regulations, Statutory Instrument 24 of 1980, each student in a dormitory should occupy an area of at least 3.75 square metres. Students at the high school who were staying in these dormitories were occupying an area of 2.8 square metres. All dormitory walls and floors were clean. Each dormitory had an average of 6 functional squat holes and were adequate. Running water from the school borehole was available all the time.

3.3. Analytic Epidemiology

The study recruited all 31 cases from the line list and 62 controls. The majority 28 (90%) of cases and 58 (93%) of controls were from the 12 - 14 years age group. The median age was 13 years [IQR (12 - 14.5)] for cases and 13 years [IQR (13 - 14)] for controls. The majority 13 (42%) of cases and 24 (39%) of controls were from the Pentecostal religious group. Thirteen (42%) of the cases were from class one white and for controls the majority 18 (29%) were from class one yellow. However, there was no statistical difference in terms of class ($p = 0.8$). Twenty-three (74%) of cases and 33 (53%) of controls were staying in dormitories with 8 - 10 students (Table 1).

Significant factors associated with contracting varicella at a boarding school, 2019

The significant risk factors associated with contracting varicella at the high school were, classmate contact, [OR 4.7, 95% CI (1.8 - 12.0), $p < 0.01$], dormitory contact, [OR 4.1, 95% CI (1.6 - 10.3), $p < 0.01$], friend contact [OR 5.6, 95% CI (2.2 - 14.5), $p < 0.01$] and sharing clothes during outbreak [OR 3.2, 95% CI (1.2 - 9.0), $p = 0.015$]. Students who had a classmate contact were 4.7 times more likely to develop varicella as compared to students who did not have a classmate contact. Students who had a dormitory contact were 4.1 times likely to develop varicella than those who did not. Having suffered from varicella like illness before was protective [OR 0.10, 95% CI (0.04 - 0.31), $p < 0.01$] (Table 2).

Table 1. Demographic characteristics of students at a boarding school, Chikomba, Zimbabwe, 2019.

Variable	Category	Cases n = 31 (%)	Controls n = 62 (%)
Age	<12 years	0 (0)	1 (2)
	12 - 14 years	28 (90)	58 (93)
	>14 years	3 (10)	3 (5)
Median age (IQR*)		13 (12 - 14.5)	13 (13 - 14)
Sex	Male	3 (10)	37 (60)
	Female	28 (90)	25 (40)
Religion	Apostolic	8 (16.1)	18 (29.0)
	Pentecostal	13 (41.9)	24 (38.7)
	Orthodox	10 (32.3)	20 (32.3)
Class	1 blue	5 (16.1)	16 (25.8)
	1 yellow	6 (19.4)	18 (29.0)
	1 orange	7 (22.6)	13 (21.0)
	1 white	13 (41.9)	15 (24.2)
Dormitory dwellers size	11 - 13	23 (74)	33(53)
	8 - 10	8 (26)	29 (47)

*IQR = interquartile range.

Table 2. Factors associated with contracting varicella at a boarding school, Chikomba, Zimbabwe, 2019.

Factor	Category	Cases n = 31 (%)	Control n = 62 (%)	OR (95% CI)	p-value
Friend contact	Yes	20 (64.5)	15 (24.2)	5.6 (2.2 - 14.5)	<0.01
	No	11 (35.5)	47 (75.8)		
Classmate contact	Yes	18 (58.1)	14 (22.6)	4.7 (1.8 - 12.0)	<0.01
	No	13 (41.9)	48 (77.2)		
Roommate contact	Yes	21 (67.7)	21 (33.9)	4.1 (1.6 - 10.3)	<0.01
	No	10 (32.3)	41 (66.1)		
Sharing clothes	Yes	11 (35.5)	9 (14.5)	3.2 (1.2 - 9.0)	0.015
	No	20 (64.5)	53 (85.5)		
Dormitory size	Yes	23 (74)	33 (53.0)	2.5 (1.0 - 6.5)	0.05
	No	8 (26)	29 (47.0)		
History of varicella like rash	Yes	5 (16.1)	40 (64.5)	0.1(0.04 - 0.31)	<0.01
	No	26 (83.9)	22 (35.5)		

Independent factors associated with contracting varicella at a boarding school, Chikomba, 2019

Contact with a classmate [AOR 24, 95% CI (4.4 - 83), $p < 0.01$] and having contact with a dormitory mate [AOR 14, 95% CI (2.7 - 75), $p < 0.01$] were independent risk factors for contracting varicella. Prior history of varicella like illness was an independent protective factor against contracting varicella [AOR 0.08, 95% CI (0.02 - 0.30), $p < 0.01$] (Table 3).

Table 3. Independent factors associated with contracting varicella at a boarding school, Chikomba, Zimbabwe, 2019.

Factor	AOR	95% CI	P value
Classmate contact	24	4.4 - 83	<0.01
Dormitory contact	14	2.7 - 75	<0.01
History of varicella like illness	0.08	0.02 - 0.3	<0.01

Knowledge of participants on varicella at a boarding school, Chikomba, 2019

Majority 22 (71%) of case and 49 (79%) of controls knew that varicella can be transmitted by having a contact with a case. Twenty (65%) of cases and 46 (74%) of controls knew measures to prevent themselves from contracting varicella. Less than 50% of cases knew at least three signs and symptoms of varicella and importance of completing varicella treatment course. All cases and controls knew that they should visit the clinic if they suspect varicella infection. Overall, both cases and controls were knowledgeable about varicella with the majority 15 (48%) of cases and 36 (58%) of controls rated as having good knowledge. There was no significant difference in knowledge between cases and control (p = 0.83) (Table 4).

4. Discussion

Our study highlights the epidemiological factors contributing to an outbreak of varicella. A perfect setting for the spread of infection was available in the form of students in a naive community living in close proximity, which lead to the rapid transmission of the virus. In this study we found out that this was a propagated type of disease spread which signifies person to person contact. Contact with a dormitory mate, contact with a classmate, and sharing clothes were significant risk factors for contracting varicella. History of varicella like illness prior to the outbreak was a significant protective factor.

In our study, most cases were staying in rooms, which had 11 to 13 students. According to the Zimbabwe education regulation statutory instrument 24 of 1980, each student in a dormitory should occupy a space area of 3.75 square metres [11]. Students at the high school were overcrowded, each occupying an area of 2.80 square metres. The illness was easily spread through sneezing and coughing due to lack of social distance. This was consistent with a study by Nichols, *et al.* (2011) were household size with mean population of 14.5 people was considered as a risk factor for VZV transmission [12]. Schaftenaar *et al.* (2014) in South Africa reported that crowded living conditions were fuelling the spread of VZV [7]. But in areas with lower mean household sizes, attendance at childcare and school was documented as a much more important risk factor [13]. Most varicella cases mixed with other students in classes, dining and dormitories during their illness. This also exacerbated the spread of the disease.

We also found out that history of varicella illness prior to the outbreak was a

Table 4. Knowledge of participants on varicella, at a boarding school, Chikomba, Zimbabwe, 2019.

Knowledge attribute		Cases n = 31 (%)	Controls n = 62 (%)	P value
Varicella can be contracted by contact with a case	Yes	22 (71)	49 (79)	0.30
Knew at least 3 signs and symptoms of varicella	Yes	11 (35)	36 (58)	0.04
Knew how to prevent self from contracting varicella	Yes	20 (65)	46 (74)	0.35
Knew that completion of treatment course is important	Yes	13 (42)	38 (61)	0.12
Knew what to do if suspecting varicella	Yes	31 (100)	62 (100)	-
Know > 3 knowledge attributes and rated as good	Yes	15 (48)	36 (58)	0.83

protective factor. This is because after an infection the immune system will mount a response through formation of antibodies. In our study, many controls had previous history of varicella whereas less than a tenth of the cases had. This was consistent with a study in Iran where 81% of those with a history of varicella were seropositive while only 9% of those without a history were seropositive. Children with a history of varicella had seropositivity of 39 times greater than children without this history [14]. Hence, this current outbreak was easily contained because of the possibility of many students being seropositive. In United Arab Emirates, nearly half of children before 10 years old and 68% of 11 - 20 year-old individuals were seropositive [15].

Varicella is generally self-limiting and vesicles gradually develop crusts, which disappear over a period of 7 - 10 days [3]. Management is therefore centred on isolation of infected individuals [16]. The first case which occurred at the school reported to the clinic 2 days after onset of symptoms and continued to be in contact with other students. The outbreak could have been timely prevented if the healthcare worker had isolated this index case when she presented for clinical examination and treatment. Despite the school having reported an outbreak on 16 February 2019, 14 students who were sick were not isolated and this exacerbated the spread of the disease. Most cases were managed with chlopheniramine, which is the antihistamine of choice according to guidelines. Antibiotics should only be given to cases who will have developed superimposed bacterial infection complications [17]. This was not observed in our study where none of the cases had a complication but more than 70% of them received antibiotics (amoxicillin).

More importantly, we found out that varicella cases did not develop any complication and at the time of investigation more than half had already recovered. Severe complications (mainly secondary bacterial complications, pneumonia and encephalitis) are more frequent in adults, young infants, pregnant women, immunocompromised persons, and those with congenital varicella [18]. All the cases were of the 12 to 15 years age group, none had an immunosuppressive disease, and this might explain why we did not encounter any fatality or complications. In two studies that looked at varicella zoster virus causing complications, the prevalence ranged from 0% in Malawi to 3.9% in Zambia [19] [20].

The absence of the varicella zoster vaccine in Zimbabwe put individuals at risk

of contracting varicella. In this situation, it seems that the best strategy to control the VZV infection is to offer the vaccine to particular at-risk population including students and day-care personnel. This recommendation is in accordance to the WHO statement for VZV immunization in developing countries, which prefer the introduction of other new vaccines with much greater public health impact, such as rotavirus, and pneumococcal vaccines, prior to introducing varicella vaccine in routine childhood immunization programs [4].

5. Limitations

By asking questions concerning past events, we could have introduced recall and social desirability bias. Recall bias might have led to overestimation or underestimation of the strength of associations between exposures and the outcome of interest. We minimized recall bias by providing respondents adequate time to think before responding to the questions and the use of a well-structured data collection tool for both cases and controls. We minimized social desirability bias by giving a brief history of the study so that the participants would not respond in a socially desirable way. Due to lack of varicella PCR, confirmatory tests in Zimbabwe some cases may have been misdiagnosed using the clinical criteria leading to misclassification bias. This could have underestimated or overestimated the measures of association.

6. Conclusion and Recommendations

The form ones in the 12 - 14 years age group were the most affected with varicella at the boarding school. The significant risk factors for contracting varicella were classmate contact, dormitory contact and sharing clothes. The outbreak was clinically confirmed, and most of the cases presented with classical symptoms of varicella. Both cases and controls were knowledgeable about varicella. However, the outbreak should have been contained if the index case and contacts were isolated on identification. Establishment of a varicella surveillance system and consideration of varicella vaccination could prevent similar outbreaks in the future.

We recommended isolation and exemption of children with varicella from attending school and mixing with others and discouragement of students from sharing clothes. The school authorities were advised to allocate the recommended 3.75 m^2 space per child in the dormitories. As a long-term recommendation, varicella should be added to the weekly notifiable diseases list. A study on varicella seropositivity among school-going children will guide varicella vaccination policy formulation.

Following this investigation, we sensitized school children and teachers on risk factors of contracting varicella, performed active case finding at the school and participated in the isolation of cases at the school.

Acknowledgements

The researchers would like to thank all participants for agreeing to participate.

Conflicts of Interest

The authors declare that they have no competing interests.

Authors' Contributions

Govha Emmanuel, Zizhou Simukai Tirivanhu: conception, design, acquisition, analysis and interpretation of data and drafting the manuscript. Govha Emmanuel, Tsitsi Juru, Nyika Howard, Chadambuka Addmore: conception, design, data collection, analysis, interpretation and reviewing of several drafts of the manuscript for important intellectual content. Tsitsi Juru, Gombe Tafara Notion, Tshimanga Mufuta, Chadambuka Addmore: conception, design, data collection, analysis, interpretation and reviewing of several drafts of the manuscript for important intellectual content. All authors read and approved the final manuscript.

References

[1] Chickenpox (Varicella Zoster Infection). https://www.health.ny.gov/diseases/communicable/chickenpox/fact_sheet.htm

[2] Chickenpox|About|Varicella|CDC (2019). https://www.cdc.gov/chickenpox/about/index.html

[3] WHO|Varicella. WHO. https://www.who.int/teams/health-product-policy-and-standards/standards-and-specifications/vaccine-standardization/varicella#:~:text=Varicella%20is%20characterized%20by%20an,of%20one%20to%20two%20weeks

[4] Varicella and Herpes Zoster Vaccines: WHO Position Paper, June 2014. https://www.who.int/publications/i/item/who-wer-8925-265-288

[5] Wutzler, P., Bonanni, P., Burgess, M., Gershon, A., Sáfadi, M.A. and Casabona, G. (2017) Varicella Vaccination—The Global Experience. *Expert Review of Vaccines*, **16**, 833-843. https://doi.org/10.1080/14760584.2017.1343669

[6] Hussey, H., Abdullahi, L., Collins, J., Muloiwa, R., Hussey, G. and Kagina, B. (2017) Varicella Zoster Virus-Associated Morbidity and Mortality in Africa—A Systematic Review. *BMC Infectious Diseases*, **17**, Article No. 717. https://doi.org/10.1186/s12879-017-2815-9

[7] Schaftenaar, E., Verjans, G.M.G.M., Getu, S., McIntyre, J.A., Struthers, H.E., Osterhaus, A.D.M.E., *et al.* (2014) High Seroprevalence of Human Herpesviruses in HIV-Infected Individuals Attending Primary Healthcare Facilities in Rural South Africa. *PLOS ONE*, **9**, e99243. https://doi.org/10.1371/journal.pone.0099243

[8] Leung: Seroprevalence of Varicella-Zoster Virus in.... https://scholar.google.com/scholar

[9] Hannachi, N., Marzouk, M., Harrabi, I., Ferjani, A., Ksouri, Z., Ghan-Nem, H., Khairi, H., Hidar, S. and Boukadida, J. (2011) Seroprevalence of Ru-Bella Virus, Varicella Zoster Virus, Cytomegalovirus and Parvovi-Rus B19 among Pregnant Women in the Sousse Region, Tunisia. *Bulletin de la Société de Pathologie Exotique*, **104**, 62-67. https://pubmed.ncbi.nlm.nih.gov/21243459/

[10] Forbes, H.J., Thomas, S.L. and Langan, S.M. (2012) The Epidemiology and Prevention of Herpes Zoster. *Current Dermatology Reports*, **1**, 39-47.

https://link.springer.com/article/10.1007/s13671-011-0004-4
https://doi.org/10.1007/s13671-011-0004-4

[11] Statutory Instrument 24 of 1980, Education Regulations. Zimbabwe.

[12] Nichols, R.A., Averbeck, K.T., Poulsen, A.G., al Bassam, M.M., Cabral, F., Aaby, P., *et al.* (2011) Household Size Is Critical to Varicella-Zoster Virus Transmission in the Tropics Despite Lower Viral Infectivity. *Epidemics*, **3**, 12-18. https://doi.org/10.1016/j.epidem.2010.11.003

[13] Nardone, A., de Ory, F., Carton, M., Cohen, D., van Damme, P., Davidkin, I., *et al.* (2007) The Comparative Sero-Epidemiology of Varicella Zoster Virus in 11 Countries in the European Region. *Vaccine*, **25**, 7866-7872. https://doi.org/10.1016/j.vaccine.2007.07.036

[14] Ardakani, A.T., Soltani, B., Sehat, M., Namjoo, S. (2013) Seroprevalence and Risk Factors of Varicella-Zoster among Children of Kashan-Center of Iran. *Jundishapur Journal of Microbiology*, **6**. https://doi.org/10.5812/jjm.8388

[15] Uduman, S.A., *et al.* (2001) Varicella Susceptibility among Children and Healthy Adults in the United Arab Emirates. *Eastern Mediterranean Health Journal*, **7**, 604-608. https://www.ncbi.nlm.nih.gov/pubmed/15332755

[16] Chickenpox|Outbreak Manual|Control and Investigation Strategies|Varicella|CDC (2019). https://www.cdc.gov/chickenpox/outbreaks/manual.html

[17] Wolfson, L.J., Castillo, M.E., Giglio, N., *et al.* (2019) The Use of Antibi-Otics in the Treatment of Pediatric Varicella Patients: Real-World Evidence from the Multi-Country MARVEL Study in Latin America & Europe. *BMC Public Health*, **19**, Article No. 826. https://doi.org/10.1186/s12889-019-7071-z

[18] Poulsen, A., Cabral, F., Nielsen, J., Roth, A., Lisse, I.M., Vestergaard, B.F., *et al.* (2005) Varicella Zoster in Guinea-Bissau: Intensity of Exposure and Severity of Infection. *The Pediatric Infectious Disease Journal*, **24**, 102-107. https://doi.org/10.1097/01.inf.0000151034.15747.4a

[19] Siddiqi, O.K., Ghebremichael, M., Dang, X., Atadzhanov, M., Kaonga, P., Khoury, M.N. and Koralnik, I.J. (2014) Molecular Diagnosis of Central Nervous System Opportunistic Infections in HIV-Infected Zambian Adults. *Clinical Infectious Diseases*, **58**, 1771-1777. https://pubmed.ncbi.nlm.nih.gov/24668125/

[20] Benjamin, L.A., Kelly, M., Cohen, D., *et al.* (2013) Detection of Herpes Viruses in the Cerebrospinal Fluid of Adults with Suspected Viral Meningitis in Malawi. *Infection*, **41**, 27–31. https://doi.org/10.1007/s15010-012-0292-z