Schistosomiasis outbreak in Essuekyir, Cape Coast Metropolis, Ghana, January 2023

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ABSTRACT

Introduction: On 4th January 2023, a 14-year-old boy was hospitalised for schistosomiasis-related severe anemia in Essuekyir. Data reviewed revealed 11 additional cases that was unusually higher than expected for the period. We investigated to determine the magnitude of the outbreak, assess risk factors, and implement control measures. **Methods:** We reviewed medical records and conducted community case searches after stakeholder engagement. A suspected case was any resident with bloody urine between 1st October 2022 and 13th January 2023. Urine from suspected cases was examined microscopically for Schistosoma ova. Demographic, clinical, and exposure information were collected. Community inspection of water, and sanitation facilities was conducted, while directly observing residents' contact with the river, which we hypothesized as a source of infection. Kakum River was examined for snails. An unmatched 1:1 case-control study was conducted from 11th through 17th January 2023. Attack rates and odds ratios at 95% confidence levels were calculated. **Results:** Of 118 suspected cases, 94.1% (111/118) were confirmed. The mean age of cases was 12±5.4 years. Majority, were males (77.5%(86/111)) and pupils (85.6%(95/111)). Among residents, 62.5%(125/200) practiced open defecation. Household and community attack rates were 23.4%(84/359) and 5.6%(108/1912) respectively. River exposure through swimming (aOR=5.0,95%CI:1.7-14.5), fishing (aOR=2.1,95%CI:1.1-4.0), and drawing water (aOR=2.9,95%CI:1.4-6.4) increased the odds of infection. The Kakum River, which residents frequently contacted, is the source of infection as some snail species were recovered from it. **Conclusion:** Male children were mainly affected. Exposure to Kakum River was the predominant risk factor. Cases were treated with praziquantel, and residents were educated to avoid nonessential contact with the river or wear protective boots. Triennial praziquantel mass administration by Ghana Health Service was recommended.

Introduction

Schistosomiasis is an acute or chronic disease caused by parasitic trematodes (flukes)[1,2]. It is common among poor populations in tropical and subtropical regions without access to clean water or proper sanitation. According to the World Health Organization (WHO), schistosomiasis affects almost 240 million people worldwide, with almost 90% living in sub-Saharan Africa (SSA)[3].

Schistosomiasis is the second most common parasitic disease in SSA, responsible for about 534,000 annual fatalities and an estimated 57 million years of life lost to incapacity [4]. Schistosomiasis is endemic in Ghana with several clusters of cases reported and investigated with current prevalence at 23.3% [4,5]. The most predominant species is *Schistosoma haematobium* causing urinary schistosomiasis in the affected population, although Schistosoma mansoni is also present in Ghana [2,6].

Schistosomiasis affects all ages, especially those who partake in agricultural, domestic, occupational, and recreational activities that expose them to infested water [2,7]. Infested individuals fuel the cycle when they urinate or defecate into or around the same water bodies. Women who perform household tasks in contaminated water, such as washing clothes, run the risk of developing female genital schistosomiasis [2]. Schistosomiasis has severe debilitating health and economic consequences leading to poor performance status, anaemia, stunting, and decreased capacity to learn in children [8].

Addressing schistosomiasis outbreaks in Ghana is critical for reducing the immediate health burden, and promoting broader public health goals, particularly the Sustainable Development Goals (SDGs) and the global fight against Neglected Tropical Diseases (NTDs) [9].

Schistosomiasis, mostly induced by Schistosoma haematobium and Schistosoma mansoni, disproportionately impacts marginalized groups, exacerbating cycles of poverty and deteriorating health outcomes [10]. Reducing the frequency of this infection can reduce morbidity, increase access to education (since children are frequently afflicted and miss school), and boost production which contributes to economic growth. Furthermore, schistosomiasis control contributes to SDG 6 (Clean Water and Sanitation) by addressing environmental factors that promote transmission, such as a lack of access to safe water and proper sanitation [11,12].

The WHO's primary goal in schistosomiasis control is to reduce disease burden by regularly treating specific groups with praziquantel on a wide scale [2]. Target groups are preschoolers, school-age children, adults in endemic areas who are deemed at risk, and persons engaged in vocations that require contact with infected water such as fishermen, farmers, and irrigation workers [2].

In January 2023, a 14-year-old male resident in Essuekyir was admitted with severe anaemia due to confirmed schistosomiasis. There were 11 other cases confirmed and managed at Essuekyir Community-Based Health Planning and Services (CHPS) during the same period which exceeded the expected number usually reported through the District Health Information Management System (DHIMS) (**Figure 1**). The community had previously benefited from mass drug administration (MDA) of praziquantel until an assessment in 2018 which led to their exclusion. The Ghana Field Epidemiology and Laboratory Training Programme was invited to support the district in investigating the outbreak, determine the extent of infection and source, identify risk factors for the outbreak, and implement preventive measures. Based on these objectives, the investigation aimed to answer specific questions such as who is affected (demographic profile of affected individuals) and any specific high-risk groups, when did the outbreak start, how many cases are there, and where the cases are occurring. We also intended to find the water sources involved and whether there is evidence of contamination.

Methods

Outbreak Setting

The investigation occurred in Essuekyir, a community in the Adisadel sub-metro of the Cape Coast Metropolis, Ghana, from January 11th through 17th, 2023. It is about 8km Northwest of Cape Coast and lies 5.3622°N, 0.6299°W. The climate of Essuekyir, largely that of Cape Coast is usually Tropical wet and dry or Savanna with temperatures ranging between 24°C to 32°C and relative humidities between 60% to 80%. There are 34 private and public health facilities within the metropolis which serve the populace. The Essuekyir

Community-based Health Planning and Services (CHPS) compound serves the Essuekyir community.

There are three main surface water bodies (Kakum River, Fosu Lagoon, and Iture Estuary) in the Cape Coast municipality. The Kakum River serves as the main raw water source for treatment for the Cape Coast municipality and surrounding districts´ water treatment and supply system. The water is polluted from domestic waste being dumped into it, runoff from farmlands, and bathing of both humans and animals. The Kakum River is the main water body in the community which inhabitants use for domestic or recreational activities. Open defecation and the use of Kumasi Ventilated Improved Pit latrine (KVIP) are the most practiced ways of sewage disposal in the community.

The Essuekyir community previously was endemic for schistosomiasis and benefited from mass drug administration (MDA) of praziquantel as a public health intervention, until an assessment in 2018 which led to their exclusion from the program. Currently, apart from surveillance and health education on schistosomiasis, there are no routine screening services, MDA of praziquantel, or snail control ongoing in the community. The community has a population of 3,953, including 1212 children, and engages in various economic activities such as fishing, farming, baking, and civil services [13]

Stakeholder Engagement

The team held debriefing meetings with relevant stakeholders to discuss terms of reference and planned activities. Assemblymen and opinion leaders of Essuekyir were engaged in mobilizing community support.

Epidemiologic investigation

The index case was interviewed to obtain additional information on exposures. Case definitions used were:

Suspected case: Any resident of Essuekyir with blood in urine from 1stOctober 2022 through 13th January 2023

Confirmed case: Suspected case with parasitological evidence of Schistosoma ova or cercariae in urine.

Case search: Health facilities and community case searches were conducted to identify confirmed schistosomiasis cases and other conditions presenting with blood in urine. Outpatient and in-patient health registers were reviewed at Essuekyir CHPS, Cape Coast Teaching Hospital, Adisadel Polyclinic, Ando Children´s Clinic, and Kakomdo CHPS. All cases were line-listed.

Selection of cases and controls

All confirmed cases (census) from the case search were recruited. For each case, neighbors without blood in urine were identified, and listed, and one was randomly selected as a potential control. An unmatched 1:1 case-control study was conducted to determine factors associated with contracting Schistosomiasis.

Case: Any resident of Essuekyir with blood in urine and laboratory confirmation of Schistosoma ova in urine

Control: Any resident of Essuekyir without hematuria and tests negative for *Schistosoma* ova in urine

Exclusion criteria: Controls who had microscopic hematuria were excluded.

An interviewer-administered semi-structured questionnaire was developed, mounted in Google form, pretested, and used to collect data from cases which included age, sex, occupation, place of residence, signs and symptoms, date of onset, sources of water for domestic use, exposure to water from the river, type of toilet facility used, perceived risk and severity of schistosomiasis. We hypothesized that exposure to or use of water from the Kakum River increased the odds of schistosomiasis. We also hypothesized that residents´ perception of the risk and severity of schistosomiasis influenced odds of infection.

Sample collection

Urine samples were collected from all cases and potential controls in a sterile container after clear instructions were given for laboratory confirmation of *Schistosoma* ova at the University of Cape Coast Teaching Hospital.

Laboratory investigation

Samples collected were tested for hematuria using Urit Combi 10 Urine test strips. Results were recorded as positive or negative. From positive urine samples, 10ml was decanted into a test tube, centrifuged for 3 minutes at 3000 rpm, sediment was placed on a grease-free slide, and examined using 10x and 40x objective lenses for Schistosoma haematobium ova.

Environmental assessment

The community was inspected for Water, Sanitation, and Hygiene (WASH) infrastructure through structured observations and interviewing of residents. Direct observations were made of residents´ contact with Kakum River. They were observed and interviewed on where they defecate, whether they wash their hands after defecating and the availability of soap and clean water at the place. Kakum River was assessed for the presence of snails. The snails were identified using the shapes of their shells and the nature of their apertures.

Data Analysis

The filled Google form questionnaire responses were imported into Microsoft Excel, cleaned, exported into Stata/SE 14.1, and analyzed. Descriptive statistics were performed to generate frequencies, proportions, means, and standard deviations. Overall and category-specific attack rates were calculated. Chi-square tests for significant associations between exposure factors and risk of developing schistosomiasis and logistic regression for strength of association were analyzed. Potential confounders were identified from previous studies and were controlled using multivariable logistic regression. The level of significance was set at 0.05. Trend distribution of the cluster of schistosomiases was depicted using epicurve.

Ethical Considerations

Since an outbreak is a public health emergency requiring swift response, no ethical clearance from an IRB is required for its investigation in Ghana and from the GFELTP (Ghana Field Epidemiology and Laboratory Training Program). Instead, permission is sought from the necessary stakeholders from the health and local authorities. Consistent with this, prior to the outbreak investigation, permission was obtained from the Central Regional Deputy Director of Public Health and Cape Coast Metropolitan Director of Health Services. Assemblymen and opinion leaders were informed, and stakeholder privacy and confidentiality were ensured. Written informed consent was obtained from all participants, and assent was obtained from minors. All confirmed case patients were treated with a single dose of Praziquantel according to their weight (40mg/kg).

Results

Magnitude of Outbreak

Of 118 suspected cases; 10 were detected through health facility records review, and 108 through community case search. Of them, 94.1% (111/118) were confirmed. A total of 359 households, comprising 1912 individuals were screened during community case search. Household and community attack rates were 23.4% (84/359) and 5.6% (108/1912), respectively. The mean age of cases was 12 years (plusmn; 5.4). Most, 77.5% (86/111) were male, and 85.6% (95/111) were pupils aged 6 to 15 years. Of them, 95.8% (113/118) reported blood in urine and 14.4% (17/118) reported blood in stool. Other symptoms reported were skin rash 12.7% (15/118) and abdominal pain 5.1% (6/118). Confirmed cases were treated with a single dose of Praziquantel according to their weight (40 mg/kg).

Sociodemographic characteristics of participants

A total of 101 cases and 101 controls were recruited. The mean age of cases was 11.9 years (plusmn;5.1), significantly lower than the mean age of controls 18.2 years (plusmn;14.8). Most of the participants 59.4% (120/202) were males, with 80.7% (163/202) pupils aged 6 to 15 years

Factors associated with Schistosomiasis Infection

Residents aged 15 years or lower (cOR=4.2, 95%CI: 2.1-8.5), males (cOR=3.6,95%CI: 2.0-6.5), and pupils (cOR=6.2, 95%CI: 2.6-14.9) expressed higher odds of infection (Table 1). Exposure to the river through swimming (cOR=6.3, 95%CI:2.3-17.3), fishing (cOR=2.9, 95%CI: 1.6-5.2), and drawing water (cOR=2.2, 95%CI: 1.1-4.4) was associated with increased odds of infection. After adjusting for

sex, age, and occupation, exposure to Kakum River remained a significant risk factor for infection. Drinking water from the river, however, was not associated with Schistosomiasis (Table 1).

After adjusting for differences in age, sex, and occupation, residents who had perceived lower susceptibility to infection (aOR=2.3, 95%CI: 1.2-4.3) and perceived lower severity (aOR=2.1, 95%CI: 1.1-4.0) were about twice as likely to have Schistosomiasis, compared to residents who thought otherwise.

Assessment of WASH infrastructure

Residents use various sources of water for domestic use, including tap, boreholes, protected wells, and rivers. Tap water is the primary source for 88% (177/202) of residents, while 67.3% (136/202) use river water. Only 1.6% (1/64) treat river water properly. Over half 62.4% (126/202) of the residents use open defecation. During a one-hour observation, 66 people contacted the river, with 80.3% (53/66) being male. Most, 48.5% (32/66) were children aged 10 years or under. Observed residents engaged in various activities, including drawing water, 40.9% (27/66), swimming 24.2% (16/66), bathing 21.2% (14/66), washing 9.1% (6/66), and fishing 1.5% (1/66). Others, 3.0% (2/66), were seen wading through the river.

Water quality assessment

Two snail species, Bulinus and Oncomelania, were identified from the Kakum River, with Bulinus species shedding cercaria larvae confirmed by microscopy at the University of Cape Coast.

Outbreak Response and Management

The outbreak was effectively managed through various strategies including case management, risk communication, social interventions, logistics management, coordination, and surveillance.

Discussion

Schistosomiasis is still endemic in certain parts of Ghana, [5,8], evidenced by this outbreak in Essuekyir, a community that once benefited from the MDA of Praziquantel which was withdrawn after an assessment in 2018. Schistosomiasis is the second most common neglected tropical disease (NTD) after hookworm in Sub-Saharan Africa with distressing morbidity and mortality which are born by Children and young adults[14].

Magnitude of the outbreak

The prevalence of schistosomiasis during this investigation was lower than in previous Ghanaian studies [5,8] among the same setting and population. Similarly, a Nigerian study found that infection was high among children below 16 years of age [15]. The low prevalence in the current investigation could be because only urine samples were examined, which could lead to missing those who presented with blood in the stool. Irrespective of the level of prevalence in this study, previous studies showed multiple organ involvement of both urogenital and gastrointestinal systems by both S. Mansoni and S. Hematobium [5,6]. The involvement of the urogenital system can cause infertility in females and bladder cancer in both sexes [9] and has been implicated in a vicious cycle of being caused by poverty [11] and can worsen the living standards of the person, family, and country at large.

Characteristics, source, and risk factors associated with the outbreak

Majority of cases were school-aged children which is similar to a Namibian study with most affected age-group being 11-15 years [14]. This age-group is mainly affected because they like swimming and wading through the infested water. An earlier study in communities along Kakum River revealed that schools had the highest infection burden(65.6%) [5], with children more susceptible due to poor hygiene, and more contact with river as after-school entertainment.

The investigation also found the infection more prevalent in children aged 15 years and below compared to those above 15-years. The low prevalence in older children may be attributed to their increased awareness of risks associated with infested water bodies [8], which contradicts these findings [16]. Majority of the cases were males, which is consistent with studies in Ghana [8], and the sub-region [15,17]. Furthermore, water contact activities such as swimming, fishing, and drawing

water were associated with increased odds of schistosomiais infection [5,8,18].

From the analytical study, although the perceived risk of Schistosomiasis was observed to be high, among the respondents, knowledge of the cause, mode of transmission, signs, and symptoms remained low. This is consistent with studies [19,20] which reported similar findings, but contrasted findings by Chimberengwa and colleagues[21].

Finally, in assessing quality of the Kakum River, two snail species were identified, Bulinus and Oncomelania, with the latter shedding cercaria larvae. This is of great concern as nearly 70% of the residents use water from the river with about 2% treating it before use. WASH infrastructures are crucial for preventing neglected tropical diseases like schistosomiasis [22]. Again, over 60% of respondents practiced open defecation which facilitates re-contamination of water bodies and hence new or re-infection. Improved sanitation is crucial for preventing schistosomiasis, which affects the poorest [8,15], and those in communities with low socio-economic status [2].

Limitations of the Study

The use of only urine samples to test for schistosomiasis, instead of adding stool samples, may have led to underestimation of the prevalence of the disease. More so, taking just a single urine sample instead of multiple could have further reduced the chances of detecting the disease.

Conclusion

There was low proportion of residents of Essuekyir with overt hematuria and schistosomiasis. Male children were more affected with majority living with prolonged infection. The Kakum River, frequented by residents, is the most likely source of infection. Activities like swimming, bathing, and fishing in the river significantly contribute to infection, while open defecation in the area maintains the transmission cycle. We recommended the Metropolitan Disease Control Officers should educate the public on Schistosomiasis, highlighting risk factors, and complications, the importance of early detection and treatment of infected people; Metropolitan Director of Health Services should collaborate with political leaders, and traditional authorities to improve community toilet facilities, and National Programme on Neglected Tropical Diseases should implement school-based mass drug administration of praziquantel every three years, in line with WHO recommendations for areas with less than 10% prevalence. In the future, at least two early morning samples of urine and stool should be taken, preferably on different days for each suspected individual to determine the risk of co-infection with the various schistosoma types. Also, a study on the prevalence of organ sequelae from schistosomiasis infection could shed more light on the disease burden in the study area.

What is known about this topic

- Essuekyir has had previous outbreaks of schistosomiasis
- The disease was known to be endemic in the communities along the Kakum River
- The community used to be one of the areas benefiting from the Mass Drug Administration of praziquantel

What this study adds

- Male children are mostly affected
- Exposure to the Kakum River was the predominant risk factor
- The importance of regular surveillance on diseases after withdrawing an interv ention
- The need to maintain the Mass Drug Administration of praziquantel until permanent control methods are fully implemented

Competing interests

The authors declare no competing interests.

Authors' contributions

GAO: Conceptualized the original idea of the research, conducted the data analysis, drafted the zero draft of the manuscript, addressed all the reviewer's comments, and proofread and fine-tuned the manuscript. HFA: Assisted in data collection and cleaning, proofread, and reviewed the manuscript drafts. SSS: Assisted in initial data

collection and analysis, proofread and reviewed the manuscript drafts. BA: Assisted in data collection and cleaning, reviewed the manuscript drafts. Seth Baffoe: Assisted in data collection and cleaning, reviewed the manuscript drafts. DD: Conceptualized the original idea of the research, oversaw the entire process including its planning, execution, and manuscript preparation, revised the zero draft manuscript for intellectual content, clarity, and accuracy, assisted in addressing all the reviewer's comments. GKS: Approved the outbreak to be investigated, revised the zero draft manuscript for intellectual content, clarity, and accuracy, assisted in addressing all the reviewer's comments involved in the drafting, revising the manuscript, reading, and approving the final work. PZN: Assisted in data collection and cleaning, reviewed the manuscript drafts. DA: Revised the zerodraft manuscript for intellectual content, clarity, and accuracy, oversaw manuscript preparation and execution, assisted in addressing all the reviewer's comments and fine-tuned the manuscript. CNL: Conceptualized the original idea of the research, oversaw the entire process including its planning, execution, and manuscript preparation, revised the zero-draft manuscript for intellectual content, clarity, and accuracy, and assisted in addressing all the reviewer's comments. EK: Approved the original idea of the research, oversaw the entire process including its planning, execution, and manuscript preparation, revised the zero-draft manuscript for intellectual content, clarity, and accuracy, assisted in addressing all the reviewer's comments involved in the drafting, revising the manuscript, reading, and approving the final work.

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Tables and figures

Table 1: Factors associated with Schistosomiasis infection

Figure 1: Recorded Schistosomiasis cases, Adisadel sub-district, 1 January 2020 - 14 January 2023

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Table 1: Factors associated with Schistosomiasis infection

Variable	Case (n=101)	Control (n=101)	Crude Odds ratios (95% CI)	p-value	Adjusted odds ratio (95% CI)	p-value
Age group (years)						
>15	14	41	1	<0.001		
≤ 15	87	60	4.2 (2.1-8.5)			
Sex						
Female	26	56	1	<0.001		
Male	75	45	3.6 (2.0-6.5)			
Occupation						
Not Pupil	7	32	1	<0.001		
Pupil	94	69	6.2 (2.6-14.9)			
Draws water from river						
No	15	28	1		1	
Yes	86	73	2.2 (1.1-4.4)	0.027	2.9* (1.4-6.4)	0.006
Washes in river						
No	23	36	1	0.041	1	0.015
Yes	78	64	1.9 (1.0-3.5)		2.3* (1.2-4.7)	
Swims in river						
No	5	25	1	<0.001	1	0.003
Yes	96	76	6.3 (2.3-17.3)		5.0*(1.7-14.5)	
Drinks water from river						
No	63	73	1		1	
Yes	36	28	1.5 (0.8-2.7)	0.191	1.3* (0.7-2.5)	0.432
Fishes in river						
No	49	74	1	<0.001	1	0.027
Yes	52	27	2.9 (1.6 – 5.2)		2.1* (1.1-4.0)	
Source of water for drinking						
Not river	62	75	1			
River	39	26	1.8 (1.0-3.3)	0.051		
Source of water for household chores						
Not river	25	37	1	0.068		
River	76	64	1.8 (1.0-3.2)			
Source of water for cooking						
Not river	60	70	1			
River	41	31	1.5 (0.9-2.8)	0.143		
Knowledge on cause						
Incorrect	57	60	1			
Correct	35	39	0.9 (0.5-1.7)	0.848		
Knowledge on transmission						
Incorrect	56	62	1			
Correct	35	39	1.0 (0.6-1.8)	0.983		
Perceived risk*						
High	53	71	1	0.015	1	0.013
Low	46	30	2.1 (1.1-3.7)		2.3* (1.2-4.3)	
Perceived severity						
High	34	51	1	0.103	1	0.023
Low	54	50	1.6 (0.9-2.9)		2.1* (1.1-4.0)	

*Adjusted for sex, age, and occupation

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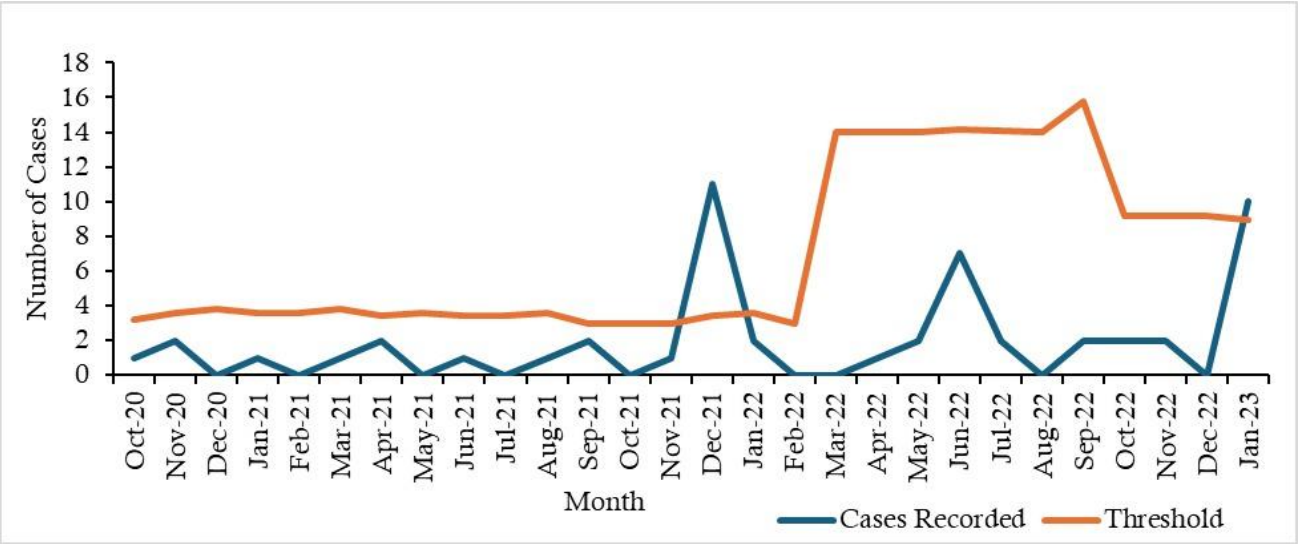

Figure 1: Recorded Schistosomiasis cases, Adisadel sub-district, 1 January 2020 – 14 January 2023