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Female Genital Schistosomiasis (FGS) Prevalence and Burden Across Endemic Countries, Timelines, and Age Groups: A Retrospective Study

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Abstract: Female Genital Schistosomiasis (FGS) is caused by *Schistosoma haematobium*, which causes chronic gynecological conditions that lead to substantial morbidity and infertility. This study's objective is to determine the prevalence and burden of FGS based on the presence of *S. haematobium*-specific DNA in females across age groups using our previously field-acquired filtered human urine samples from Zambia, Tanzania, and Ghana, collected over multiple years. For Ghana (2013), 39 out of 90 samples were from females, of which 31 (79.5%) were positive and 8 (20.5%) were negative. In Zambia (2016), 80 out of 133 samples were from females, of which 46 (57.5%) tested positive and 34 (42.5%) were negative. For Zambia (2017), 60 out of 110 samples were from females, of which 45 (75%) tested positive and 15 (25%) tested negative. In Tanzania (2018), 70 out of 104 samples were from females, of which 43 (61.4%) tested positive and 27 (38.6%) tested negative. FGS prevalence ranged from 57.5% (Zambia in 2016) to 79.5% (Ghana in 2013) and was found predominantly among the 11–20 years age group. The analytical outcome highlights that FGS is predominant among females in different endemic countries and in the age range of pre-teen to young adult.

Keywords: schistosomiasis; female genital schistosomiasis; *Schistosoma haematobium*; prevalence; disease burden

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1. Introduction

Schistosomiasis is the second deadliest parasitic disease in the world after malaria, affecting approximately 220 million people and accounting for approximately 200,000 human deaths [1,2]. It is a major source of morbidity and mortality in sub-Saharan Africa, caused by a trematode parasite of the genus *Schistosoma* and three common species that infect humans: *Schistosoma haematobium*, *S. japonicum*, and *S. mansoni*.

Female genital schistosomiasis (FGS) is caused by *S. haematobium* and is predominant in young girls between 12 and 15 years old. The disease is caused by the release of terminal-spine parasite eggs from female *S. haematobium*. FGS is a serious and chronic gynecological condition causing substantial morbidity among affected women [3,4]. When the eggs are deposited in the tissues of the cervix and lower female genital tract, the combination of the presence of the eggs with host inflammation and increased vascularity in the cervicovaginal mucosa produces typical intravaginal lesions that result in genital itching, pain, bleeding, and dyspareunia [5–7]. In addition, eggs deposited in the uterus and fallopian tubes can result in infertility [8]. It causes vaginal discharge, blood in urine, and abdominal and pelvic pain. It is a chronic gynecological condition that, if left untreated, can lead to a range

of complications for women living with FGS, including infertility [8], abortion, genital ulcers, modified immunological responses to HPV and HIV [9], and increased risks of contracting HPV [10] and HIV [11,12].

According to the World Health Organization (WHO), many young women in sub-Saharan Africa are at risk of acquiring FGS, HIV infection, and cervical cancer [13]. Furthermore, FGS remains largely overlooked within the national health systems and Neglected Tropical Disease (NTD) programs, and its prevalence is underestimated [14]. In some lower- and middle-income countries (LMICs) like Zambia, where schistosomiasis is endemic, knowledge and understanding of FGS among community members and healthcare workers (HCWs) within affected communities is often incomplete and confused with other Sexually Transmitted Diseases (STDs). In addition, there is a paucity of scholarly work exploring the knowledge, perceptions, and practices of women of reproductive age and in HCWs' knowledge about FGS. To sustainably control and prevent FGS, an understanding of community and HCWs' perceptions and attitudes towards people with FGS and their knowledge and practices may play an important role. In addition, a lack of knowledge may exacerbate levels of misconceptions [15] that may, in turn, create stigma among women misdiagnosed with STDs instead of FGS.

The absence of definitive policies for FGS may, in turn, have caused the following: (i) a lack of treatment and diagnostic guidelines, (ii) limited investment, (iii) a lack of awareness among multiple stakeholders, and (iv) poor FGS surveillance among women of reproductive age. When treatment and diagnostic guidelines are lacking, there is an increased risk of misdiagnosis, inappropriate treatment, and missed opportunities for developing innovative solutions to control FGS in endemic communities. Hence, having the right knowledge, attitude, and improved perception of FGS is essential in reducing cases of stigma and modifying risk behaviors to reduce the odds of re-infection at both the individual and community levels.

This proposed pilot study will provide substantial evidence of the presence, prevalence (infection intensity), geographic distribution, age group, and gender-specific infection prevalence for FGS in females from a database of extracted DNA from field-collected urine samples from Ghana, Zambia, and Tanzania, over multiple years. The project will determine and explore the burden of FGS to develop strategies to improve the control of FGS among endemic communities in sub-Saharan Africa.

2. Materials and Methods

2.1. Data Source

The data used for this study were preexisting. All the collected data came from analyzing the field-acquired filtered urine samples from previous studies, which were acquired from three different geographical locations over four years. The existing data sources were from previously individually published and unpublished studies conducted in Ghana in 2013, Zambia in 2016 and 2017, and Tanzania in 2018. The existing data were extensively analyzed (Figure 1) to determine the FGS presence, prevalence, distribution, and burden across age groups.

2.2. Model of Data Analysis

2.2.1. Overall FGS Prevalence

The total FGS-positive samples for each year were determined based on the polymerase chain reaction (PCR) testing. All the duplicates and missing samples were discarded before analysis. The total number of positive and negative results for *S. haematobium* among females was determined based on three countries (Ghana, Zambia, and Tanzania). The disease prevalence was calculated based on the proportion of positive infections from each test out of the total number of samples evaluated. For *S. mansoni*, PCR was carried out by amplifying a highly repeated 121 bp Sm1-7 fragment (GenBank: M61098.1) [16]. For *S. haematobium*, 121 bp *Dra*, one repeat fragment (GenBank: DQ157698.1) was amplified [17,18]. For both schistosome species, the repeat fragments that makeup 12–16% of each parasite

genome (~600,000 copies per cell) are species-specific and occur in different regions of the genomes of these two schistosome parasites, so there is no chance of cross-amplification.

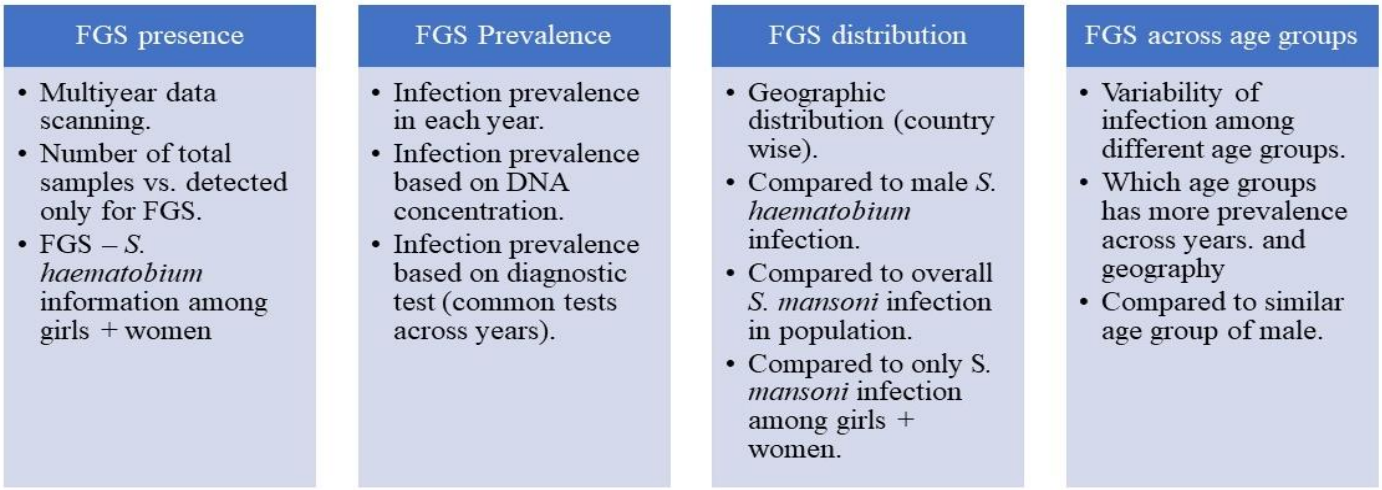

Figure 1. The model of FGS data analysis determines the prevalence and burden in different geographic locations over multiple years.

2.2.2. FGS Prevalence Based on Parasite DNA Concentration in Urine

The overall infection prevalence was assessed for each year across three countries: Ghana (2013), Zambia (2016 and 2017), and Tanzania (2018). The infection prevalence was defined as the number of positive samples out of the total number of samples evaluated each year. The extracted DNA from filtered urine samples (used to assess FGS prevalence) for each year was categorized into three groups, as follows: high DNA load (>10 ng/μL), medium DNA load (4–10 ng/μL), and low DNA load (0.5–3 ng/μL). The categories corresponded to the infection levels present among the participants in the three countries. All the duplicates and missing samples were discarded. The prevalence of FGS was also determined by comparing the different diagnostic tests, such as hematuria, urine filtration, and PCR, for each year for the three countries.

2.2.3. Geographical and Gender-Based Distribution of FGS

The country-wise distribution of FGS was determined based on the *S. haematobium* infection of the collected urine samples from three countries over four years. The same approach was taken with males to evaluate the *S. haematobium* infection that causes Male Genital Schistosomiasis (MGS). The distribution of FGS was compared against *S. mansoni* infection only in girls and women and the overall *S. mansoni* infection over four years in three countries. For Ghana, samples were collected from Tomefa, a community in the Weija Lake area of the GA South district of the Greater Accra region. For Zambia, samples were collected from the Chongwe district in Lusaka Province and the Siavonga district along the shores of Lake Kariba, which is endemic for both Schistosome species. For Tanzania, samples were collected from the Kayenze villages where schistosomiasis infection was prevalent. In Africa, two major human-infecting species, *S. mansoni* and *S. haematobium*, are often sympatric; concurrent infection is debilitating [19]. Because the former is intestinal, and the latter is a urogenital parasite, their pathophysiological outcome is completely different. So, identifying both species from co-infected individuals is important for surveillance, pathology, and monitoring.

2.2.4. FGS Age Distribution

Data for each year were categorized into four age groups: Group A (1–10 years, children and juveniles), Group B (11–20 years, pre-teens to young adults), Group C (21–30 years, young adults to mature adults), and Group D (>31 years, mid-ages). The FGS infection prevalence for all four age groups was determined, along with the highest infection for the age group across years and countries. Also, we evaluated the infection variability amongst different age groups across years and geography and compared this against similar age groups in males.

2.3. Statistical Analysis

We performed a quantitative assessment to evaluate FGS presence, prevalence, distribution, and burden across age groups for four years from three countries. The above-mentioned statistical analysis was carried out by comparing positive and negative infections detected by PCR for *S. haematobium*. The disease prevalence was determined based on the number of positive cases found by each diagnostic test against the total number of samples evaluated. The data and analysis were processed through Microsoft Excel and JMP 12 (JMP® v12, SAS Institute Inc., Cary, NC, USA) and converted to numerical values (1 = positive and 0 = negative) for statistical analysis. Excel and JMP analyses were performed blindly and then compared for accuracy.

3. Results

3.1. Overall FGS Prevalence

For Ghana in 2013, the prevalence of FGS was 79.5% (31 out of 39 females were positive). For Zambia in 2016 and 2017, the figures were 57.5% (46 out of 80 females were positive) and 75% (45 out of 60 females were positive), whereas, in Tanzania in 2018, the prevalence was 61.4% (43 out of 70 females were positive, Table 1).

Table 1. Prevalence of Female Genital Schistosomiasis (FGS) among the total samples collected in Ghana, Zambia, and Tanzania.

Data Source	Total Samples	Total Females	Positive Females (*S. haematobium* Prevalence *)	Negative Females (*S. haematobium* Prevalence *)
Ghana 2013	90	39 (43%)	31 (79.5%)	8 (20.5%)
Zambia 2016	133	80 (60%)	46 (57.5%)	34 (42.5%)
Zambia 2017	110	60 (54.5%)	45 (75%)	15 (25%)
Tanzania 2018	104	70 (67.3%)	43 (61.4%)	27 (38.6%)

* Disease prevalence = proportion of positive infections by each test out of a total number of samples evaluated.

Out of the total samples, all the duplicates and missing samples were discarded. Positive samples are based on PCR testing.

3.2. FGS Prevalence Based on Parasite DNA Concentration

Data for each year were categorized as follows based on the concentration of extracted DNA collected from filtered urine samples of PCR-positive individuals to assess FGS prevalence: high DNA load (>10 ng/μL), medium DNA load (4–10 ng/μL), and low DNA load (0.5–3 ng/μL). The highest positivity rate was found in the low DNA load over three years, as follows: in Zambia (2016), 42 (91.30%) females were positive; in Zambia (2017), 40 (88.89%) females were positive; and in Tanzania (2018), 41 (95.35%) females were positive. Based on a medium DNA load, the positivity rate ranged between 0 and 16 (0–51.61%). For a high DNA load, the positivity rate ranged between 2 and 6 (4.44–19.35%, Table 2).

Table 2. Prevalence of FGS based on the DNA concentrations of PCR-positive individuals in Ghana, Zambia, and Tanzania.

DNA Concentration (ng/µL)	DNA Concentration	Total Females in Ghana 2013	Total Females in Zambia 2016	Total Females in Zambia 2017	Total Females in Tanzania 2018
Gr. A (0.5–3)	Low	9 (29.04%)	42 (91.30%)	40 (88.89%)	41 (95.35%)
Gr. B (4–10)	Medium	16 (51.61%)	4 (8.70%)	3 (6.67%)	0 (0%)
Gr. C (10–above)	High	6 (19.35%)	0 (0%)	2 (4.44%)	2 (4.65%)

Duplicated/missing samples were discarded.

3.3. FGS Geographical Distribution Based on Diagnostic Testing

The FGS prevalence based on PCR detection ranged from 57.5% (Zambia in 2016) upwards to 79.5% (Ghana in 2013) and others in between (Table 3). PCR consistently detected *S. haematobium*-specific DNA (4–15 times) in extracted DNA from urine samples collected from different endemic countries compared to traditional diagnostic tests, such as hematuria and urine filtration.

Table 3. Infection prevalence of FGS based on hematuria, urine filtration, and the PCR diagnostic test. -- = absence of positive or negative samples.

Data Source	Hematuria		Urine Filtration		PCR	
	Positive	Negative	Positive	Negative	Positive	Negative
Ghana 2013	8 (18.6%)	35 (81.4%)	--	--	31 (79.5%)	8 (20.5%)
Zambia 2016	3 (3.7%)	79 (96.3%)	0	82 (100%)	46 (57.5%)	34 (42.5%)
Zambia 2017	7 (11.7%)	53 (88.3%)	3 (5%)	57 (95%)	45 (75%)	15 (25%)
Tanzania 2018	--	--	--	--	43 (61.4%)	27 (38.6%)

3.4. FGS Distribution Comparison Based on Gender

S. haematobium (the causative agent of FGS) infections were comparatively higher among females than in males in Zambia (2016: 35% vs. 24.4%, and 2017: 41% vs. 33.6%) and Tanzania (2018: 41.4% vs. 23.1%) (Table 4). Similarly, females had higher *S. mansoni* infections over three years (Zambia 2016 and 2017, and Tanzania 2018) than males with *S. mansoni* infections. Co-occurrence (*S. haematobium* and *S. mansoni*) among females and males remained somewhat similar throughout the years in the three countries (Table 4).

Table 4. Comparison among females and males detected as positive for *S. haematobium*, *S. mansoni*, and dual infections. Male = M, Female = F.

Location	Total Female	Total Male	Female			Male		
			S. haematobium	*S. mansoni*	Co-Occurrence	*S. haematobium*	*S. mansoni*	Co-Occurrence
Ghana 2013	39	47	31 (36%)	33 (38%)	27 (69%)	39 (45%)	41 (47.7%)	35 (74.5%)
Zambia 2016	80	51	46 (35%)	61 (46.6%)	33 (41.3%)	32 (24.4%)	34 (26%)	20(39%)
Zambia 2017	60	50	45 (41%)	47 (42.8%)	47 (78%)	37 (33.6%)	38 (34.6%)	31 (62%)
Tanzania 2018	70	34	43 (41.4%)	54 (52%)	37 (52.9%)	24 (23.1%)	28 (27%)	23 (67.7%)

It is found to be predominant among the age group of 11–20 years.

3.5. FGS Distribution Based on Age Group

The FGS infection level had been consistently higher among pre-teens to young adults (11–20 years) for three years (2013, 2016, and 2017) in two countries (Ghana and Zambia) (Table 5). The infection level was higher for mid-ages (>31 years) for only Tanzania in

2018 (Table 5). The second highest infection level was found among children and juveniles (1–10 years) (Table 5).

Table 5. Prevalence of Female Genital Schistosomiasis (FGS) among different female age groups. -- = absence of positive or negative samples.

Location	Total Females	*S. haematobium* Positive			
		Gr. A (0–10 years)	Gr. B (11–20 years)	Gr. C (21–30 years)	Gr. D (>31 years)
Ghana 2013	39	9 (23.1%)	22 (56.4%)	--	--
Zambia 2016	80	18 (22.5%)	28 (35%)	--	--
Zambia 2017	60	13 (21.7%)	32 (53.3%)	--	--
Tanzania 2018	70	--	4 (5.7%)	8 (11.4%)	31 (44.3%)

4. Discussion

The outcome of this study highlights that FGS has been predominant in females in different endemic countries over the years, with a high overall prevalence in certain age groups and when compared to males. The findings are crucial as awareness and knowledge of FGS are largely absent in communities and healthcare workforces in endemic countries [2]. The analytical outcome highlights that FGS is predominant in females among the evaluated urine samples in Ghana (2013), Zambia (2016 and 2017), and Tanzania (2018), and the prevalence ranges from 57.5% to 79.5% (Table 1). This is a prelude to underestimating the true prevalence of FGS as it is currently based on a small number of studies [5,20].

Cell-free *S. haematobium*-specific DNA detection via Polymerase Chain Reaction (PCR) consistently detected more infections (4–15 times) than traditional diagnostic tests, such as hematuria and urine filtration for urine samples collected from different endemic countries over the years (Table 3). The presence of *S. haematobium*-specific DNA in urine is an indication of an active infection that clears within two weeks of Mass Drug Administration (MDA [21]). The level of DNA extracted from the urine of PCR-positive individuals is reflective of the infection level and mirrors the high (10 and above ng/µL), medium (4–10 ng/µL), and low infection (0.5–3 ng/µL) levels. PCR has shown its effectiveness as most of the positive infections detected occurred in low-level infections (Table 2). Sensitive and effective diagnostics are paramount for gaining a true sense of the prevalence and extent of FGS in endemic areas, as it is currently substantially under-reported [5,22,23].

Infections related to *S. haematobium* were relatively higher among females compared to males in three years for two different countries, except for Ghana (Table 4). Co-occurrence along with *S. mansoni* was higher only for Zambia across two years and lower for Ghana and Tanzania when compared to males (Table 4). FGS infection was consistently higher within the age group of pre-teens to young adults (11–20-yer-olds) in Ghana and Zambia for three years, except for Tanzania (Table 5). Interestingly, children (1–10-year-olds) had the second highest infection level for Ghana and Zambia (Table 5). Girls and women are susceptible to schistosomiasis from a young age in endemic areas, and it affects women of all age groups [5,24]. Recurrent infection occurs throughout the life of these women in endemic areas due to repeated exposure to infested water bodies [5]. In addition, 30–75% of girls and women with urinary schistosomiasis develop FGS [24,25]. So, it is important to detect FGS infection at an early stage of life, such as in children and young adults, as this is the age impacted most by *S. haematobium* infection [5]. Moreover, FGS infection leads to adverse reproductive health outcomes, organ dysfunction, and reproductive morbidity [20].

This study has its shortcomings. It was a retrospective study based on urine samples collected previously and evaluated via PCR for *S. haematobium* detection. The sample size per country could be a limiting factor, although the general findings were similar to previous findings [5,20]. Only urine samples were part of this study; vaginal swabs or colposcopy pictures of lesions were absent in the three countries, usually used to validate

the pathological signs of FGS. However, cell-free repeat species-specific DNA detection for *S. haematobium* from urine has been successful in previous studies [26,27].

This study helped to explore the true burden of FGS for broader geographical areas, which will help to develop strategies to control FGS and improve current intervention measurements. FGS is largely neglected, overlooked, and not researched to determine the true prevalence, geographic distribution, and age group infection variation for *S. haematobium* endemic countries. Future priorities will be aimed at improving awareness and addressing the lack of knowledge by providing accurate data, using highly sensitive molecular diagnostics along with vaginal swabs, and developing an integrated control approach within broader Schistosomiasis control programs. These measures will be important for the detection, control, and elimination of FGS from endemic countries.

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Institutional Review Board Statement: This study was based on retrospective data analysis. All utilized data for this study were collected as part of other studies and data were generated as per the guidelines set by the Marquette University IRB during those studies. For the current study, we just utilized the existing data and conducted the new analysis. No new human samples were collected or evaluated as part of this study. Hence, approval from the Marquette University IRB was not required to perform the tasks of this study.

Informed Consent Statement: Not applicable.

Data Availability Statement: The raw data supporting the conclusions of this article will be made available by the authors upon request.

Conflicts of Interest: The authors declare that this research was conducted in the absence of any commercial or financial relationships that could be construed as potential conflicts of interest.

References

1. Colley, D.G.; Bustinduy, A.L.; Secor, W.E.; King, C.H. Human schistosomiasis. *Lancet* **2014**, *383*, 2253–2264. [CrossRef] [PubMed]
2. Ndubani, R.; Lamberti, O.; Kildemoes, A.; Hoekstra, P.; Fitzpatrick, J.; Kelly, H.; Vwalika, B.; Randrianasolo, B.; Sturt, A.; Kayuni, S.; et al. The first BILGENSA Research Network workshop in Zambia: Identifying research priorities, challenges and needs in genital bilharzia in Southern Africa. *Wellcome Open Res.* **2024**, *9*, 1–16. [CrossRef] [PubMed]
3. Kjetland, E.F.; Hegertun, I.E.; Baay, M.F.; Onsrud, M.; Ndhlovu, P.D.; Taylor, M. Genital schistosomiasis and its unacknowledged role on HIV transmission in the STD intervention studies. *Int. J. STD AIDS* **2014**, *25*, 705–715. [CrossRef] [PubMed]
4. Poggensee, G.; Feldmeier, H.; Krantz, I. Schistosomiasis of the female genital tract: Public health aspects. *Parasitol. Today* **1999**, *15*, 378–381. [CrossRef] [PubMed]
5. Bustinduy, A.L.; Randriansolo, B.; Sturt, A.S.; Kayuni, S.A.; Leustcher, P.D.C.; Webster, B.L.; Van Lieshout, L.; Stothard, J.R.; Feldmeier, H.; Gyapong, M. An update on female and male genital schistosomiasis and a call to integrate efforts to escalate diagnosis, treatment and awareness in endemic and non-endemic settings: The time is now. *Adv. Parasitol.* **2022**, *115*, 1–44. [CrossRef] [PubMed]
6. Downs, J.A.; Kabangila, R.; Verweij, J.J.; Jaka, H.; Peck, R.N.; Kalluvya, S.E.; Changalucha, J.M.; Johnson, W.D.; van Lieshout, L.; Fitzgerald, D.W. Detectable urogenital schistosome DNA and cervical abnormalities 6 months after single-dose praziquantel in women with Schistosoma haematobium infection. *Trop. Med. Int. Health* **2013**, *18*, 1090–1096. [CrossRef] [PubMed]
7. Wall, K.M.; Kilembe, W.; Vwalika, B.; Dinh, C.; Livingston, P.; Lee, Y.M.; Lakhi, S.; Boeras, D.; Naw, H.K.; Brill, I.; et al. Schistosomiasis is associated with incident HIV transmission and death in Zambia. *PLoS Negl. Trop. Dis.* **2018**, *12*, e0006902. [CrossRef]
8. Kjetland, E.F.; Kurewa, E.N.; Mduluza, T.; Midzi, N.; Gomo, E.; Friis, H.; Gundersen, S.G.; Ndhlovu, P.D. The first community-based report on the effect of genital *Schistosoma haematobium* infection on female fertility. *Fertil. Steril.* **2010**, *94*, 1551–1553. [CrossRef] [PubMed]
9. Actor, J.K.; Shirai, M.; Kullberg, M.C.; Buller, R.M.; Sher, A.; Berzofsky, J.A. Helminth infection results in decreased virus-specific CD8+ cytotoxic T-cell and Th1 cytokine responses as well as delayed virus clearance. *Proc. Natl. Acad. Sci. USA* **1993**, *90*, 948–952. [CrossRef] [PubMed]

10. Shaker, O.G.; Hammam, O.A.; Wishahi, M.M. Is there a correlation between HPV and urinary bladder carcinoma? *Biomed. Pharmacother.* **2013**, *67*, 183–191. [CrossRef] [PubMed]
11. Feldmeier, H.; Krantz, I.; Poggensee, G. Female genital schistosomiasis as a risk-factor for the transmission of HIV. *Int. J. STD AIDS* **1994**, *5*, 368–372. [CrossRef]
12. Mbabazi, P.S.; Andan, O.; Fitzgerald, D.W.; Chitsulo, L.; Engels, D.; Downs, J.A. Examining the relationship between urogenital schistosomiasis and HIV infection. *PLoS Negl. Trop. Dis.* **2011**, *5*, e1396. [CrossRef]
13. World Health Organization. *Basic Laboratory Methods in Medical Parasitology*; World Health Organization: Geneva, Switzerland, 1993.
14. Mazigo, H.D.; Samson, A.; Lambert, V.J.; Kosia, A.L.; Ngoma, D.D.; Murphy, R.; Matungwa, D.J. "We know about schistosomiasis but we know nothing about FGS": A qualitative assessment of knowledge gaps about female genital schistosomiasis among communities living in *Schistosoma haematobium* endemic districts of Zanzibar and Northwestern Tanzania. *PLoS Negl. Trop. Dis.* **2021**, *15*, e0009789. [CrossRef] [PubMed]
15. Mosunjac, M.B.; Tadros, T.; Beach, R.; Majmudar, B. Cervical schistosomiasis, human papilloma virus (HPV), and human immunodeficiency virus (HIV): A dangerous coexistence or coincidence? *Gynecol. Oncol.* **2003**, *90*, 211–214. [CrossRef]
16. Osakunor, D.N.M.; Mduluza, T.; Midzi, N.; Chase-Topping, M.; Mutsaka-Makuvaza, M.J.; Chimponda, T.; Eyoh, E.; Mduluza, T.; Pfavayi, L.T.; Wami, W.M.; et al. Dynamics of paediatric urogenital schistosome infection, morbidity and treatment: A longitudinal study among preschool children in Zimbabwe. *BMJ Glob. Health* **2018**, *3*, e000661. [CrossRef] [PubMed]
17. Bosompem, K.M.; Bentum, I.A.; Otchere, J.; Anyan, W.K.; Brown, C.A.; Osada, Y.; Takeo, S.; Kojima, S.; Ohta, N. Infant schistosomiasis in Ghana: A survey in an irrigation community. *Trop. Med. Int. Health* **2004**, *9*, 917–922. [CrossRef] [PubMed]
18. Exum, N.G.; Kibira, S.P.S.; Ssenyonga, R.; Nobili, J.; Shannon, A.K.; Ssempebwa, J.C.; Tukahebwa, E.M.; Radloff, S.; Schwab, K.J.; Makumbi, F.E. The prevalence of schistosomiasis in Uganda: A nationally representative population estimate to inform control programs and water and sanitation interventions. *PLoS Negl. Trop. Dis.* **2019**, *13*, e0007617. [CrossRef]
19. King, C.H.; Dangerfield-Cha, M. The unacknowledged impact of chronic schistosomiasis. *Chronic Illn.* **2008**, *4*, 65–79. [CrossRef]
20. Kayuni, S.; Lampiao, F.; Makaula, P.; Juziwelo, L.; Lacourse, E.J.; Reinhard-Rupp, J.; Leutscher, P.D.C.; Stothard, J.R. A systematic review with epidemiological update of male genital schistosomiasis (MGS): A call for integrated case management across the health system in sub-Saharan Africa. *Parasite Epidemiol. Control* **2019**, *4*, e00077. [CrossRef] [PubMed]
21. Ibironke, O.; Koukounari, A.; Asaolu, S.; Moustaki, I.; Shiff, C. Validation of a new test for *Schistosoma haematobium* based on detection of Dra1 DNA fragments in urine: Evaluation through latent class analysis. *PLoS Negl. Trop. Dis.* **2012**, *6*, e1464. [CrossRef] [PubMed]
22. Pillay, P.; Downs, J.A.; Changalucha, J.M.; Brienen, E.A.T.; Ramarokoto, C.E.; Leutscher, P.D.C.; Vennervald, B.J.; Taylor, M.; Kjetland, E.F.; Van Lieshout, L. Detection of Schistosoma DNA in genital specimens and urine: A comparison between five female African study populations originating from *S. haematobium* and/or *S. mansoni* endemic areas. *Acta Trop.* **2020**, *204*, 105363. [CrossRef]
23. Sturt, A.S.; Webb, E.L.; Phiri, C.R.; Mweene, T.; Chola, N.; van Dam, G.J.; Corstjens, P.L.A.M.; Wessels, E.; Stothard, J.R.; Hayes, R.; et al. Genital self-sampling compared with cervicovaginal lavage for the diagnosis of female genital schistosomiasis in Zambian women: The BILHIV study. *PLoS Negl. Trop. Dis.* **2020**, *14*, e0008337. [CrossRef] [PubMed]
24. Kjetland, E.F.; Hove, R.J.; Gomo, E.; Midzi, N.; Gwanzura, L.; Mason, P.; Friis, H.; Verweij, J.J.; Gundersen, S.G.; Ndhlovu, P.D.; et al. Schistosomiasis PCR in vaginal lavage as an indicator of genital Schistosoma haematobium infection in rural Zimbabwean women. *Am. J. Trop. Med. Hyg.* **2009**, *81*, 1050–1055. [CrossRef]
25. Rafferty, H.; Sturt, A.S.; Phiri, C.R.; Webb, E.L.; Mudenda, M.; Mapani, J.; Corstjens, P.L.A.M.; van Dam, G.J.; Schaap, A.; Ayles, H.; et al. Association between cervical dysplasia and female genital schistosomiasis diagnosed by genital PCR in Zambian women. *BMC Infect. Dis.* **2021**, *21*, 691. [CrossRef] [PubMed]
26. Lodh, N.; Mwansa, J.C.L.; Mutengo, M.M.; Shiff, C.J. Diagnosis of *Schistosoma mansoni* without the Stool: Comparison of Three Diagnostic Tests to Detect *Schistosoma mansoni* Infection from Filtered Urine in Zambia. *Am. J. Trop. Med. Hyg.* **2013**, *89*, 46–50. [CrossRef] [PubMed]
27. Lodh, N.; Naples, J.M.; Bosompem, K.M.; Quartey, J.; Shiff, C.J. Detection of Parasite-Specific DNA in Urine Sediment Obtained by Filtration Differentiates between Single and Mixed Infections of *Schistosoma mansoni* and *S. haematobium* from Endemic Areas in Ghana. *PLoS ONE* **2014**, *9*, e91144. [CrossRef] [PubMed]

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