

## A community- based study of the prevalence and risk factor for “*Schistosoma haematobium*” in Two Endemic Districts of Taiz Governorate, Yemen

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**Abstract:** Background: Schistosomiasis is still a major public health problem despite launching preventive chemotherapy campaigns (using Praziquantel) through yearly treatment of school-age children since 2008. Objective: To conclude: prevalence, contributing factors, intensity for *Schistosoma Haematobium* in Al-Shmaytin & Al-Mwaset districts-Taiz, Yemen. Methods: a cross-sectional study, data on age, sex, marital status, income, education, location, water contact, medical history (MH), urine test results (filtration method used to detect *S. haematobium* & concentration methods for the detection of infection intensities), were gathered using structured questionnaires between March & April 2021. Sample size calculated using appropriate formula. 298 individuals selected by systematic random sampling. Informed consent obtained. For statistical analysis, SPSS version 24 is used. For “*p*”-values, the statistical significance was set at 0.05. Results: *S. haematobium* was found in 17 of 273 respondents, with a prevalence of 6.2%, higher in Al-Shmaytin (9.2%) than in Al-Mwaset (3.5%), and a light-intensity 59%. Adjusted Odds Ratio (AOR) for the following variables (95% confidence interval (CI)): district 3.7 (12 cases from Al-Shmaytin 9.2%), age 1.0 (13 cases from 6-18 years 7.8%), sex 2.8 (13 cases from female 7.4%), marital 0.3 (15 cases from single 8%), educational status 1.3 (15 cases from Illiterate/Essential School 6%), swimming/bathing 2.0 (13 cases 8.6%), wear shoes 0.4 (15 cases from those who do not wear shoes 8.1%), urinate near water 1.7 (8 cases 9.8%), family member with disease 1.0 (5 cases 7.1%), dysuria 1.7 (8 cases 8.3%), and receiving anti-schistosomiasis drugs 0.9 (9 cases among those didn't receiving drugs 7%). All had low monthly incomes and no sanitation. Prevalent among: secondary school and higher (2, 8.7%), unaware of schistosomiasis (15, 7.4%), and unaware of prophylaxis (16, 7.1%). Conclusions: Hypo-endemic urinary schistosomiasis in study areas. Most patients from Alsafiah, females, 6-18 years, light-intensity, swimming/bathing, single, didn't receive Praziquantel®, urinated near water, had dysuria, didn't wear shoes, had diseased family members, lacked sanitation, were unaware of schistosomiasis and its prevention, lived near water sources, and had low monthly income.

**Keywords:** *S. haematobium*, epidemiology, questionnaire, hematuria, egg positive rate, infection intensity, water-contact pattern, factors, rural areas, Yemen.

### دراسة مبنية على المجتمع لانتشار البلهارسيا البولية وعوامل اختطارها في مديرتين موبوتين في محافظة تعز-اليمن

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**المستخلص:** الخلفية: لا يزال مرض البلهارسيا يشكل مشكلة كبيرة للصحة العامة على الرغم من تنفيذ حملات معالجة كيميائية وقائية (باستخدام علاج البرازيكوانتيل) من خلال المعالجة السنوية لأطفال المدارس منذ عام 2008. الأهداف: من أجل تحديد مدى انتشار، العوامل المساهمة وكثافة الإصابة بالبلهارسيا البولية في مديرتي الشماليتين والمواسط بمحافظة تعز-اليمن. المنهجية: دراسة مقطعية، حيث سيتم جمع بيانات عن العمر، الجنس، الحالة الاجتماعية، الدخل الشهري، المستوى التعليمي، مكان السكن، الاحتكاك بمصادر المياه، القصة المرضية، نتائج فحص البول (باستخدام طريقة الترشيح لاكتشاف البلهارسيا البولية وطريقة التركيز لتحديد كثافة الإصابة) باستخدام استبيان خلال الفترة بين مارس وأبريل 2021. حجم العينة تم حسابه باستخدام المعادلة المناسبة. اختيار 298 شخص بواسطة العينة العشوائية المنتظمة. تم الحصول على موافقة خطية من المشاركين. التحليل الإحصائي للنتائج باستخدام برنامج الحزمة الإحصائية للعلوم الاجتماعية (SPSS) النسخة 24. لمعرفة الأهمية الإحصائية فقد تم وضع قيمة P عند 0.05. النتائج: 273 مستجيب سلموا عينة البول، 17 منهم تبين انه مصاب بالبلهارسيا البولية، بمعدل انتشار بلغ 6.2%. وكان أكثر انتشارا في الشماليتين 9.2% مقارنة بالمواسط 3.5%. وكثافة إصابة خفيفة 59%. نسبة الاحتمالات المعدلة للمتغيرات التالية (فترة ثقة 95%): المديرية 3.7 (12 حالة من الشماليتين 9.2%)، العمر 1 (13 حالة ضمن الفئة العمرية 6-18 سنة 7.8%)، الجنس 2.8 (13 حالة من الاناث 7.4%)، الحالة الاجتماعية 0.3 (15 حالة من العازبين 8%)، المستوى التعليمي 1.3 (15 حالة من الاميين/التعليم الأساسي 6%)، السباحة/الاغتسال 2 (13 حالة 8.6%)، ليس الأحذية 0.4 (15 حالة من الذين لا يلبسون الأحذية 8.1%)، التبول بالقرب من الماء 1.7 (8 حالات 9.8%)، فرد من الاسرة مصاب بالمرض 1 (5 حالات 7.1%)، حرقة اثناء التبول 1.7 (8 حالات 8.3%)، وتقل علاج البلهارسيا 0.9 (9 حالات من الذين لم يتلقوا العلاج 7%)، كل المصابين لديهم دخل شهري منخفض وبدون صرف صحي. أكثر انتشارا في أوساط: طلاب الثانوية او اعلى (2، 8.7%)، لا يعرفون عن البلهارسيا (15، 7.4%)، لا يعرفون حول الوقاية من المرض (16، 7.1%)، الاستنتاجات: توطن متدني للبلهارسيا البولية في مناطق الدراسة. معظم المصابين من: وادي الصافية، اناث، 6-18 سنة، وكثافة إصابة خفيفة، يسبحون/يغتسلون، عازبين، لم يتلقوا علاج البلهارسيا، يتبولون بالقرب من الماء، يعانون من حرقة بالبول، لا يلبسون احذية، أحد افراد الأسرة مصاب بالمرض، ليس لديهم تصريف للمجاري، لا يعرفون عن البلهارسيا والوقاية منها، يسكنون بالقرب من مصادر المياه، ولديهم دخل شهري منخفض. الكلمات المفتاحية: البلهارسيا البولية، علم الأوبئة، كثافة العدوى، نمط ملامسة الماء، المناطق الريفية، اليمن.

## 1. Introduction:

Schistosomiasis is a parasite disease spread by snails that is caused by six species of blood trematodes from the genus *Schistosoma*: *S. haematobium*, *S. mansoni*, *S. japonicum*, *S. mekongi*, *S. intercalatum*, and *S. guineensis* (Colley et al., 2014). The first three species are primarily responsible for human schistosomiasis: *S. haematobium* causes urogenital schistosomiasis, while *S. mansoni* and *S. japonicum* produce intestinal schistosomiasis (Colley et al., 2014). Although schistosomiasis is a preventable neglected tropical disease (NTD), it is nonetheless common in developing and underdeveloped nations (Utzinger et al., 2009), especially in rural regions. Over 700 million people live in endemic nations, which account for nearly 204 million of its victims worldwide (World Health Organization (WHO), 2022). However, its impact on public health is typically underestimated because of its sneaky chronic nature and uneven distribution in endemic areas (WHO, 1993). Schistosomiasis primarily affects underprivileged areas with poor sanitation, contaminated water sources, and insufficient access to healthcare services (Watts, 2006). Schistosomiasis is spread when individuals contaminate freshwater sources with their excreta, which contain parasite eggs that develop in water. When the parasite's larvae, which are released by freshwater snails, penetrate the skin when in contact with contaminated water, people become infected. The trematode *S. haematobium*, which causes urogenital schistosomiasis as one of its symptoms, is spread by freshwater snails. Their larvae enter human skin, where they lay eggs in numerous locations within the human host (WHO, 2022). Hotspots develop in several remote places with insufficient resources for reporting, testing, or treatment because to snails' preference for stagnant water (Savioli, et al., 2017). Considered a disease of poverty, urogenital schistosomiasis primarily affects school-age children (SAC) (Kimberlin, et al., 2021; Sokolow, et al., 2016). Dysuria and hematuria occur in early and late disease; late disease manifestations also include proteinuria, renal colic, and renal failure; vaginal bleeding and dyspareunia in females and infertility in males; and hematuria, which appears 10–12 weeks after infection. In contrast to infections with *S. mansoni*, *S. japonicum*, and *S. mekongi*, transverse myelitis signs and symptoms like lumbar pain, lower limb radicular pain, and bladder dysfunction are more frequent (Olveda, et al., 2013).

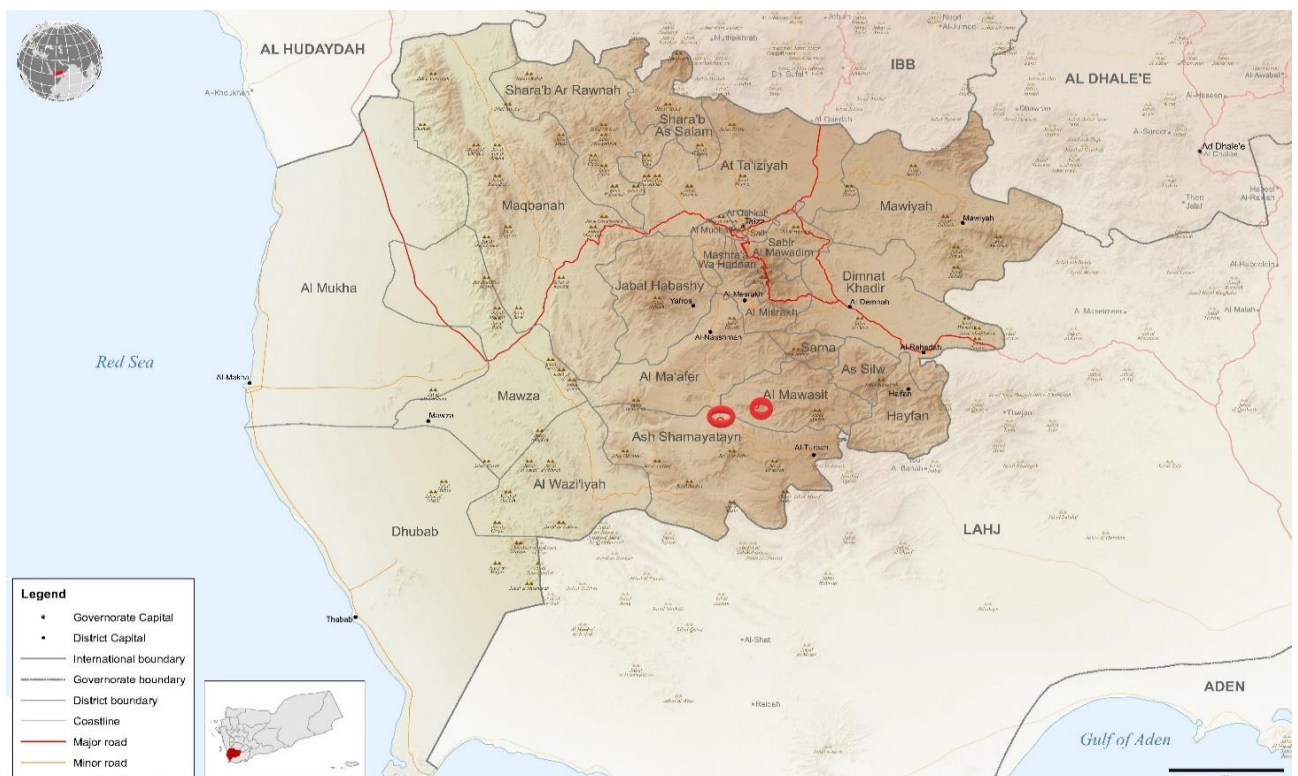
Furthermore, it contributes to sustaining poverty among the populations in endemic areas (Watts, 2006), through increasing morbidities and disabilities (increase absence of workers) or death, which aggravate the economic burden on families and country. To fulfill the Millennium Development Goals (MDGs) of the United Nations on sustainable poverty reduction in endemic countries, its elimination has therefore been a priority along with that of other NTDs (Hotez, 2007).

Yemen is one of the least developed countries in the world, ranking 183<sup>rd</sup> out of 191 countries and territories in the most current UN Human Development Index for 2022 (United Nations Development Programme (UNDP), 2022). Since 2015, armed hostilities have made the country one of the worst humanitarian catastrophes in the world. The output of the nation has fallen by 40% from its pre-conflict level, indicating a significant downturn in the economy (World Bank (WB), 2019). According to projections, more than 75 percent of people are estimated to be poor (UNDP, 2019). One of the nations with the highest prevalence of NTDs is Yemen (Hotez, 2012).

Schistosomiasis is still a major public health concern despite preventive chemotherapeutic campaigns to eliminate it by annual treatment of SAC since 2008 (Al-Eryani, 2014). The main public health intervention in the national control and elimination strategy is mass drug administration (MDA) using Praziquantel® (PZQ), with 14 campaigns conducted between 2010 and 2017 (National Schistosomiasis and Intestinal Parasites Control Programme (NSIPCP), 2017).

Yemen is endemic to both *S. mansoni* and *S. haematobium* (Oshish, 2011). Although schistosomiasis has decreased countrywide as a result of consistent and recurrent PZQ treatments, high-infection foci still exist (Abdulrab, et al. 2013; Alwabr, & Al-Moayed, 2016; Sady, et al., 2013). *S. haematobium*, was common in 1.7% (8/460) of the students that were investigated during study of students enrolled in Hajjah governorate schools (Raed, et al. 2019). In Abyan and Taiz governorates (nearly the same percentage in both), about 21.4% of schoolchildren were reported to have urinary schistosomiasis in 2009 (Ba'amer, 2009). The governorates of Hajjah and Taiz were reported to have the highest prevalence (Al-Shamiri, et al., 2011; and Nagi, 2005). Several regions of Yemen, including Taiz, Marib, Ibb, Hajjah, Sana'a, Sa'adah, the Central Highlands, Al-Mahweet, Aden, and Yahr, have reported cases of schistosomiasis (Al-Haddad, & Assabri, 1998; Azazy, & Al-Dullaimi, 1999; Hazza, et al., 1983; Nagi, & Molan, 1992; Schaap, et al., 1992). The Assahul Valley of the Ibb governorates has a 37% *Schistosoma* infection rate (Raja'a, et al., 2000). In Sahar District, Sa'adah Governorate, there was a low prevalence of schistosomiasis infection (5.6%): 3.3% for *S. haematobium* and 2.3% for *S. mansoni* (Raja'a, & Mubarak, 2006). Early in the 1950s, both forms of schistosomiasis were identified in humans and snails in Taiz (Kuntz, 1952). A recently released school-based national mapping survey found that *S. haematobium* and *S. mansoni* were both endemic in 31.6% and 54.2%, respectively, of the 332 districts in the nation (Johari, et al., 2022). In many endemic regions of the nation, it is unclear how the circumstances caused by armed conflicts and humanitarian crises affect the epidemiology of schistosomiasis. Determining the prevalence of urinary schistosomiasis and identifying its risk factors in two highly endemic districts of the Taiz Governorate were the goals of the current investigation. Taiz is situated at 13°34' 44" N latitude and 44°01' 19" E longitude, 256 kilometers south of Sana'a, in the southwest of the nation. with an estimated 3.4 million inhabitants overall (Central Statistical Organization (CSO), 2004), it is the most populous governorate in the country, of which approximately 77.5% are urban dwellers. The greatest water shortages cause locals to routinely access open water sources for drinking and household uses, such as streams, unprotected swimming pools, tanks, and cement cisterns and troughs. It is one of the governorates in the nation that is most impacted by the ongoing conflict and political unrest. In

addition, the government has constructed a lot of dams all around the nation for irrigation and groundwater recharge, exposing people to schistosomiasis. Al-Shmaytin and Al-Mwaset districts are included in Taiz Governorate, which is classed as having a moderate risk of schistosomiasis, with thresholds for each kind of schistosomiasis ranging from 10% to less than 50%. (Johari, et al., 2022). However, due to the ongoing conflict within the country, after the MDA campaign, the epidemiology of schistosomiasis in the study area was ambiguous.



Map (1): Taiz Governorate ( study areas) (A1\_Taizz\_Governorate\_Basemap\_with Elevation 2014)

## 2. Methods

### 2.1 Sample size calculation

The equation is:  $n = (Z^2 * P(1 - P)) / e^2$  (Wayne, 2013) and the minimum sample size calculation method (Montresor, et al. 2002), the number of study participants was determined,

where "n" is the number of samples, "Z" represents the value of the standard normal distribution that corresponds to the necessary level of confidence ( $Z = 1.96$  for 95% CI), "P" represents the projected proportion, which is 20.8% from a prior study (Nagi, 2005), and "e" represents the required degree of accuracy (0.05).

$$=(1.96^2 * 0.214(1-0.214)) / 0.05^2 = 259$$

We want this study to have a power of 80% and a type I error of 5% for associated factors in schistosomiasis prevalence in Al-Shmaytin and Al-Mwaset districts (including the comparison between the two districts).

At least 15% of the estimated estimates' value (or 39 persons) were added as a substitute for nonresponse and missing data during sampling in order to lower sampling error. As a result, we choose at least 298 of the 8,098 inhabitants who reside in the designated areas for interviews and analysis.

### 2.2 Research time and site

Between March 21 and April 10, 2021, Al-Shmaytin and Al-Mwaset districts in the southern Taiz governorate were the focus of this cross-sectional, community-based investigation.

### 2.3 Research subjects

Participants in the study, including male and female residents of the Alsafiah valley in Al-Shmaytin and the Ayfoa'a valley in Al-Mwaset, who voluntarily decided to participate and return the samples, were to be included after obtaining written informed consent. On the other hand,

people who declined to provide informed consent, did not return urine samples, or had psychiatric disorders were excluded from the study. 298 received urine containers, but only 273 (91.6%) submitted them for testing.

#### 2.4 Data gathering

A pre-designed questionnaire in face-to-face interviews was used to collect data on the sociodemographic, clinical, and risk factors for *S. haematobium*.

After providing participants with instructions on how to properly collect the samples, urine samples were taken in clean, screw-capped containers that were pre-labeled with the participant's name, age, and identification number as well as the date and time of collection.

#### 2.5 Urine analysis

The filtration method for urine samples was used to detect *S. haematobium* ova (Mott, et al. 1982). Concentration methods, such as sedimentation in glycerin solution or centrifugation in formalized ether, are needed for the detection of mild and light infections (Feldmeier, & Poggensee, 1993). A 12-mm polycarbonate filter (Millipore, UK) was syringed with ten milliliters of urine, and the filters were examined using a light compound microscope at 40x magnification. Light infections (1–49 eggs/10 ml urine) and high infections (>50 eggs/10 ml urine) were classified (Montesor, et al. 2002; and Saathoff, et al., 2004). The analysis was repeated for participant's urine who had visual blood in their urine, and his results were negative for *S. haematobium* in the first test.

#### 2.6 Ethics approval

The study proposal was approved by the Research Ethics Committee of the Faculty of Medicine and Health Sciences, University of Science and Technology, Yemen (MECA No.: (EAC/UST228)).

University of Science & Technology  
Faculty of Medicine & Health Sciences  
Research Ethics Committee



For Committee Use Only  
MECA No.: (EAC/UST228)

### MEDICAL ETHICAL COMMITTEE APPROVAL

This is to declare that the ethical committee of the medical research has reviewed the proposal titled:

**Community-based prevalence of urinary schistosomiasis and associated risk factors in two endemic districts of Taiz governorate, Yemen**

Presented by: **Abdullnasser Ahmed Mohamed Al-Kabab**

Faculty: **Medicine and Health Sciences, University of Science and Technology**

And found that it has fulfilled the guarantees and safeguards for the medical research ethics and that the proposal is in compliance with the policy of the committee.

Chair, Ethical Committee  
Prof. Dr. Husni A. Al-Goshae



### 2.7 Consent to participate

Before beginning the survey, all study participants provided written informed consent. The secrecy laws applied to all information. The goals and methodology of the study as well as the importance of parental approval for the inclusion of children were explained to the parents of the children. Praziquantel tablets (40 mg/kg body weight) were administered as the sole form of treatment to all affected participants.

### 2.8 Statistical analysis

The data was analyzed using IBM SPSS Statistics (IBM Corp., Armonk, NY, USA). Using univariate analysis, the correlations between sociodemographic characteristics, clinical characteristics, and risk factors and *S. haematobium* were investigated. The odds ratios (ORs) and 95% confidence intervals (CIs) for these associations were also reported. Multivariable logistic regression analysis was used to identify the independent predictors of urinary schistosomiasis for the factors identified as significant in univariate analysis, producing adjusted ORs (AORs) and their corresponding 95% CIs. For "*p*"-values, the threshold for statistical significance was set at 0.05.

## 3. Results

### 3.1 Characteristics of the research subjects

From the people who invited to take part in this study, only 273 met the inclusion criteria, supplied urine samples, and entered the study (response rate = 91.6%). According to figures 1 a & b, the majority of respondents (65.4%) were females between the ages of 6 and 18 (61.4%). They are primarily from the Alsafiah Valley (50.7%), while the Ayfoa'a Valley makes up 49.3% of them. The majority of them (95.5%) were unmarried, uneducated, or had only the most basic education (91.3%). All had low monthly earnings of less than 50,000 Yemeni Rials and students made up about 61.1% of the population. The majority of respondents (72.1%) did not have access to sanitation, and roughly 20.5% did not have a toilet at home. Only 12.1% of people lacked a reliable source of hot water, and 94% of them lived in valleys or close to streams or springs.

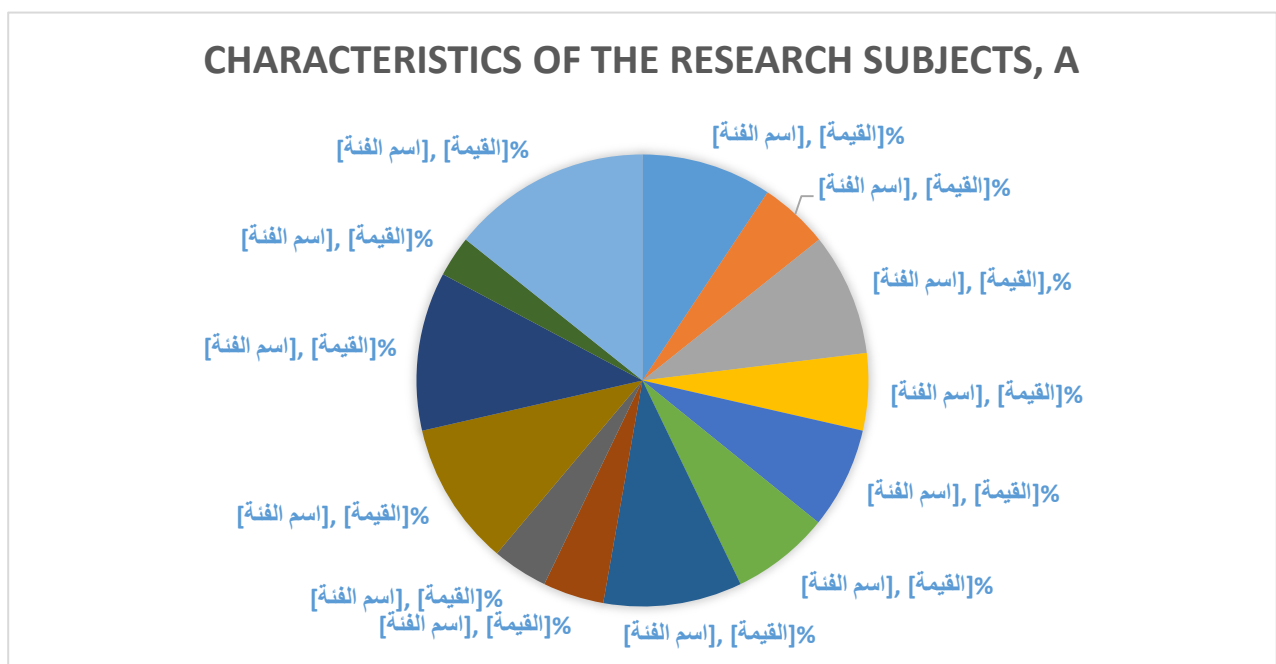


Figure (1a): Characteristics of the research subjects (The total number was 298)

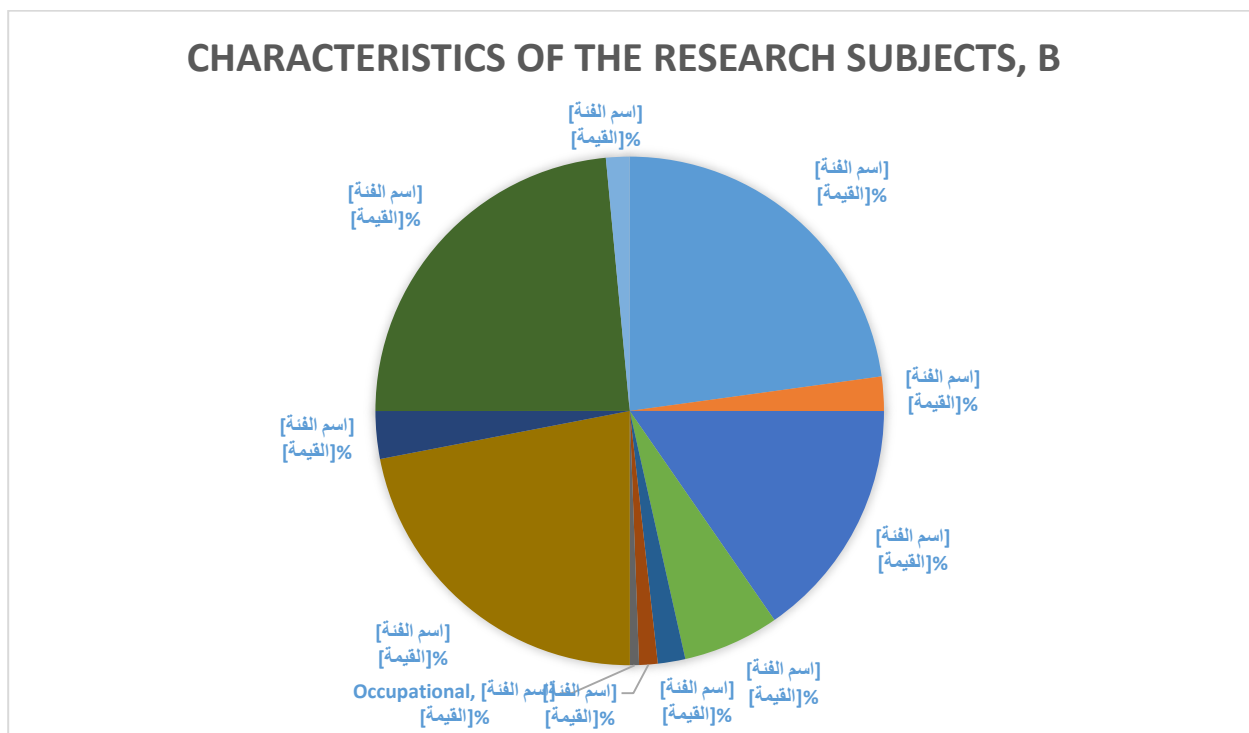


Figure (1b): Characteristics of the research subjects (The total number was 298)

### 3.2 *S. haematobium* prevalence and intensity

According to Figure 2, about 6.2% of people in Taiz governorate's rural villages had *S. haematobium*, with Al-Shmaytin district having a greater frequency than Al-Mwaset district (9.2% vs. 3.5%, respectively), which are statistically significant ( $p = 0.050$ ).

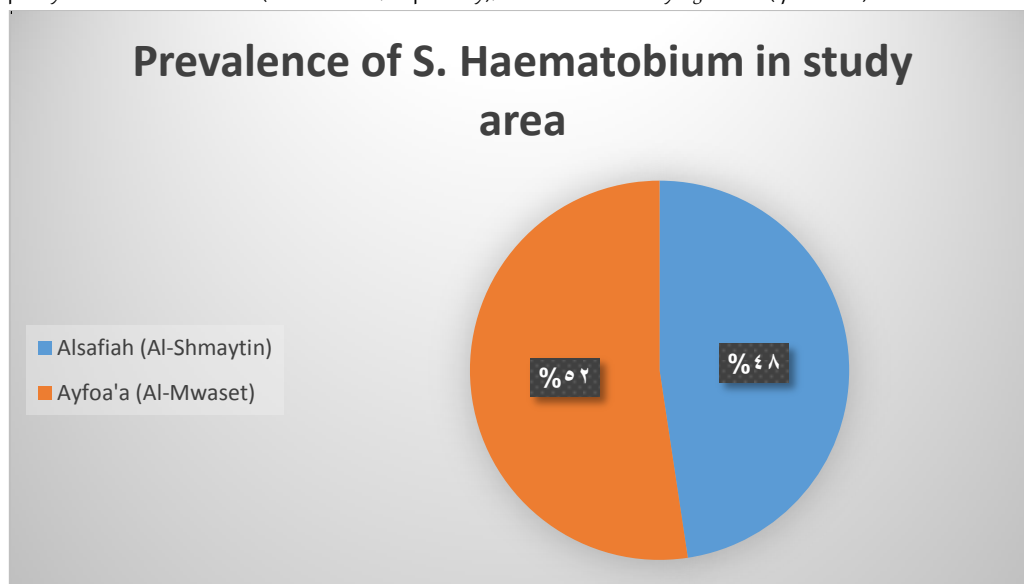


Figure 2: The prevalence of *S. haematobium* among the residents in the Taiz governorate's Al-Shmaytin and Al-Mwaset districts in 2021.

In the study district, the majority of *S. haematobium* infections (59%) were light - intensity, while (41%) were heavy/high - intensity. This is depicted in figure 1. About 52.41 eggs were found per 10 ml of urine in the EPG, which had a geometric mean egg count overall.

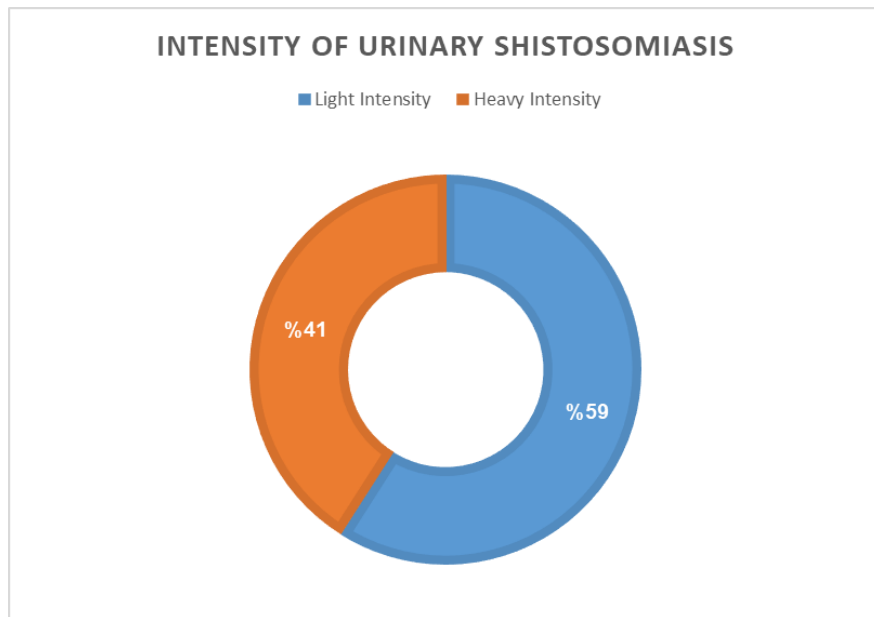


Figure (3): Intensity of urinary schistosomiasis among people in Al-Shmaytin district of Taiz governorate (2021)

3.3 S. haematobium intensity by district, sex and age

According to Graph 4, 50% of respondents from the Al Shmaytin district who contracted *S. haematobium* had light - intensity infections, and 50% had heavy- intensity infections. However, 80% of the responders from the Al Mwaset district who contracted *S. haematobium* had light - intensity infections, and 20% had heavy- intensity infections. In contrast, *S. haematobium* infections among males were equally light and heavy (50%). But among females, light infections made up the majority (61.5%), followed by heavy infections (38.5%). Similar outcomes for infections with *S. haematobium* among those aged 6 to 18 years showed that light -intensity infections predominated (61.5%), followed by heavy infections (38.5%). However, the infection among the age group of >18 years was of light and heavy- intensity (50%).

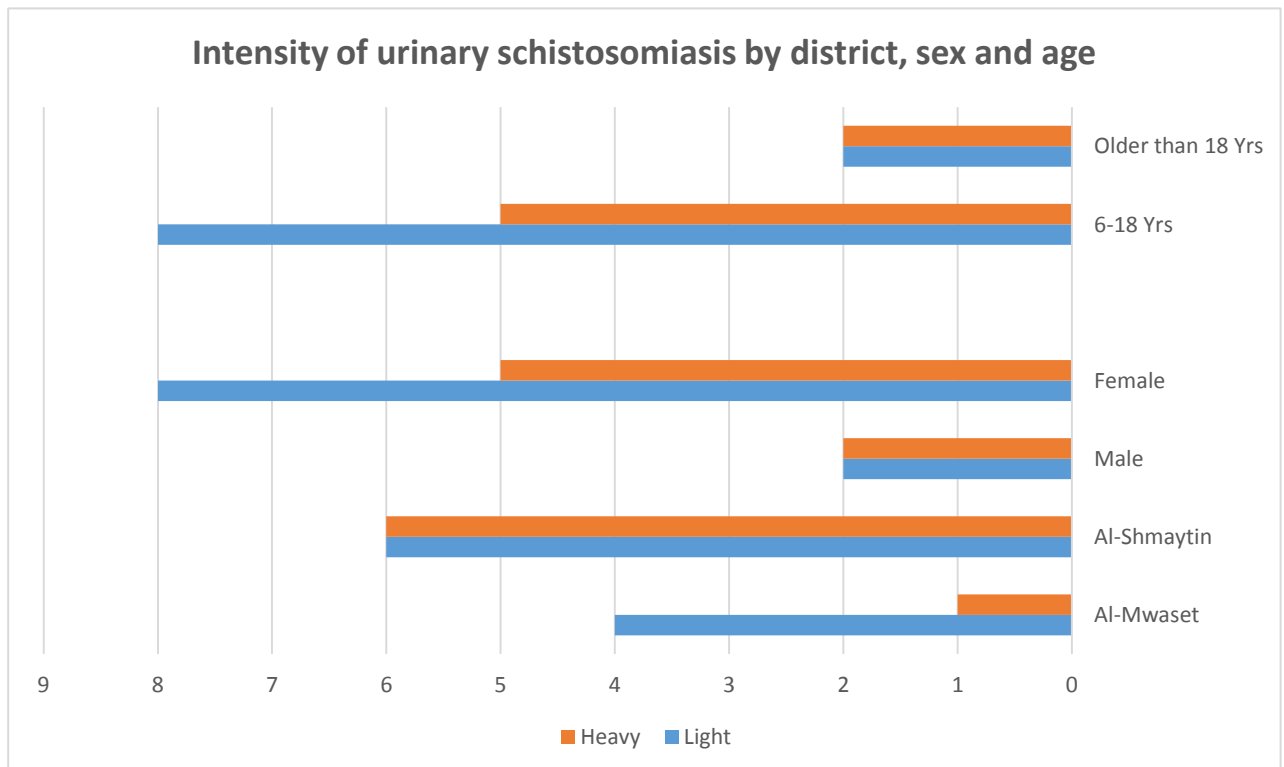


Figure (4): By district, sex, and age, the intensity of urinary schistosomiasis in the Al-Shmaytin and Al-Mwaset populations of the Taiz Governorate in 2021.

3.4 *S. haematobium* associated risk factors

According to figures 5 (a) and (b): *S. haematobium* was more common among female respondents (13/175, 7.4%) than among male respondents (4/98, 4.1%), which was not statistically significant ( $p = 0.272$ ). It was more common among respondents in the 6–18 age group (13/167, 7.8%) than the >18 age group (4/106, 3.8%), which was not statistically significant ( $p = 0.181$ ). Additionally, it was widespread among patients who were unmarried (15/187, 8.0%), which was not statistically significant ( $p = 0.070$ ). In Al-Shmaytin district respondents (12/130, 9.2%), which was statistically significant ( $p = 0.050$ ), secondary school respondents (2/23, 8.7%) which was not statistically significant ( $p = 0.609$ ), and those with low monthly earning (17/273, 6.2%), it was more common. Additionally, those without sanitation were more likely to have it (17/197, 8.6%), which was statistically significant ( $p = 0.008$ ), residing near water sources (17/258, 6.6%) which was not statistically significant ( $p = 0.305$ ), did not have pools or ponds near home (5/53, 9.4%) which was not statistically significant ( $p = 0.282$ ), did not have a dam near home (14/171, 8.2%) which was not statistically significant ( $p = 0.083$ ), did not have a water pump near home (10/128, 7.8%) which was not statistically significant ( $p = 0.308$ ), among those who used stream water for less than 3 years or did not use it (8/88, 9.1%) which was not statistically significant ( $p = 0.177$ ), did not engage in irrigation (16/230, 7.0%) which was not statistically significant ( $p = 0.739$ ), did not wash clothes in the valley (14/173, 8.1%) which was not statistically significant ( $p = 0.224$ ), bathing or swimming in water collections (13/152, 8.6%) which was not statistically significant ( $p = 0.170$ ), wore no shoes while in touch with water (15/185, 8.1%) which was not statistically significant ( $p = 0.166$ ), did not experience itching following water contact (11/141, 7.8%) which was not statistically significant ( $p = 0.474$ ), and urinated near water sources (8/82, 9.8%) which was not statistically significant ( $p = 0.195$ ).

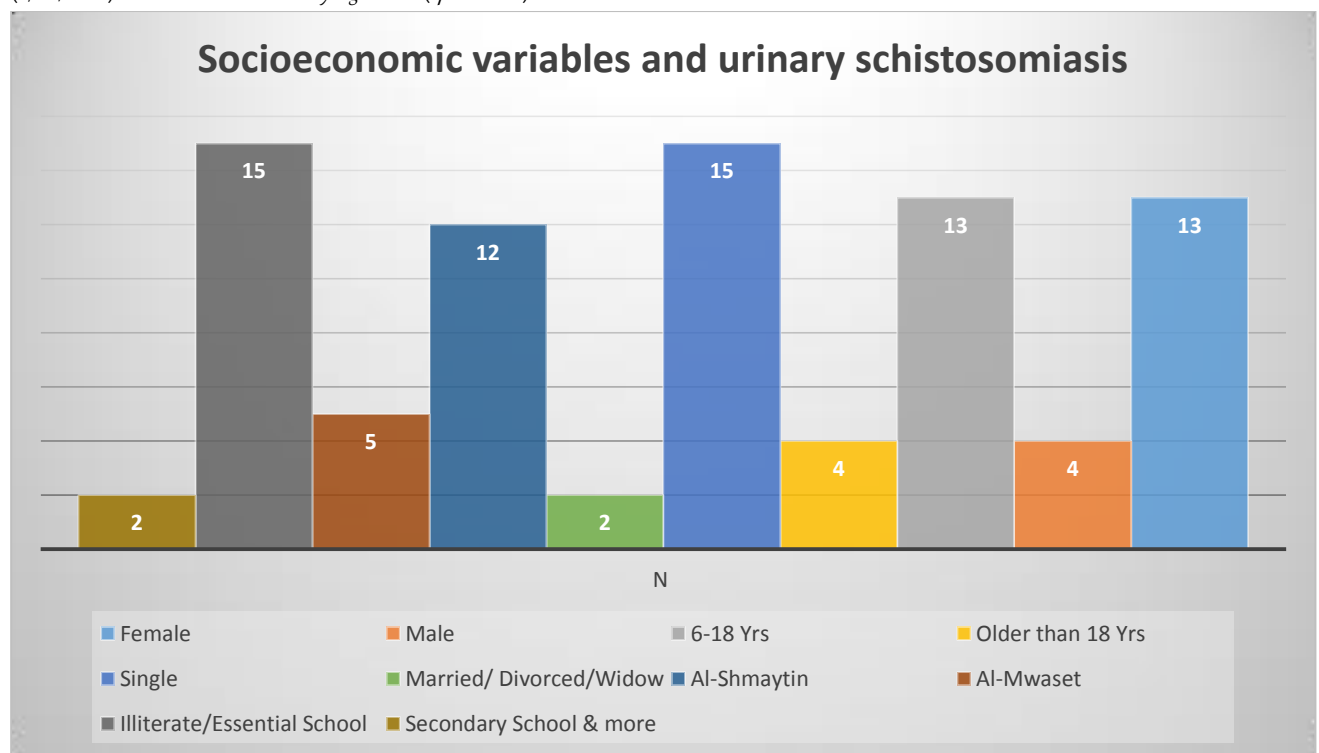


Figure (5 a): Urinary schistosomiasis and the socioeconomic variables that are linked to it in the Taiz governorate's Al-Shmaytin and Al-Mwaset districts in 2021.



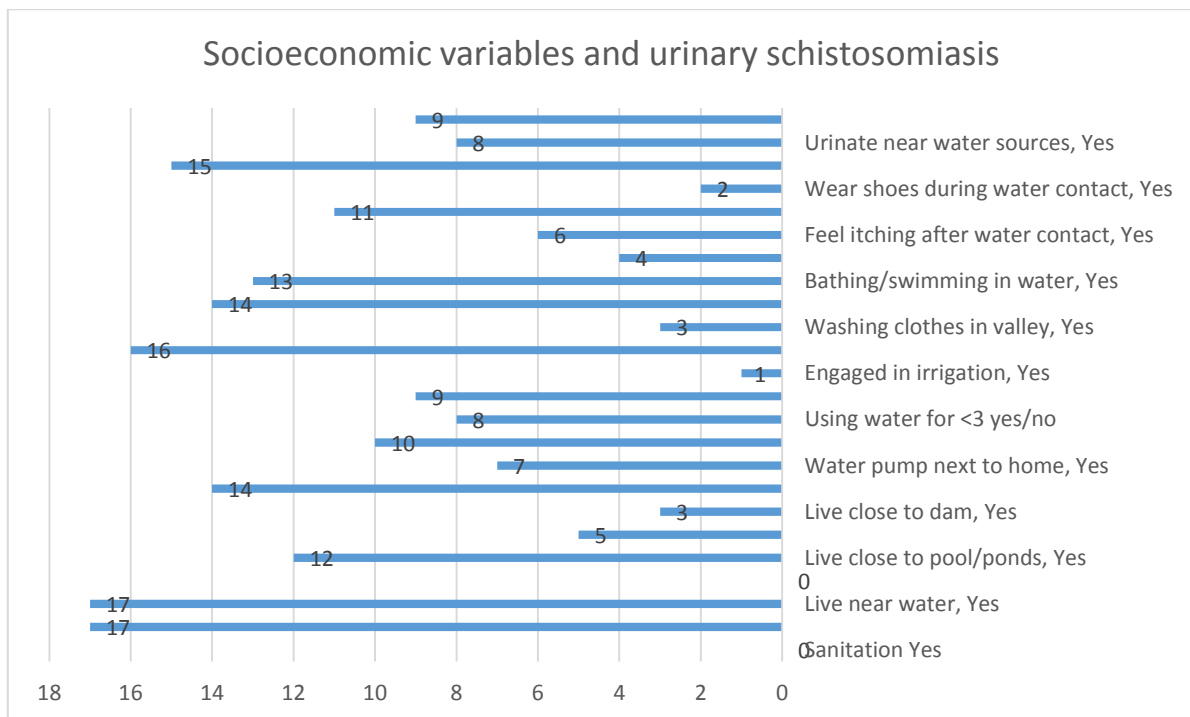


Figure (5 b): Urinary schistosomiasis and the socioeconomic variables that are linked to it in the Taiz governorate's Al-Shmaytin and Al-Mwaset districts in 202.

According to figure (6), individuals were more likely to have *S. haematobium* are those: who reported dysuria (8/96, 8.3%) which was not statistically significant ( $p = 0.289$ ), did not complain of painless terminal blood in urine (17/262, 6.5%) which was not statistically significant ( $p = 0.383$ ), did not complain of schistosomiasis previously (16/233, 6.9%) which was not statistically significant ( $p = 0.291$ ), had any member of their family complaining of schistosomiasis (5/70, 7.1%) which was not statistically significant ( $p = 0.713$ ), did not receive Praziquantel® drugs (9/128, 7.0%) which was not statistically significant ( $p = 0.695$ ), and did not know about the nature of schistosomiasis and its prevention (15/203, 7.4%), (16/225, 7.1%), respectively, which were not statistically significant ( $p = 0.176$ ,  $p = 0.191$ ).

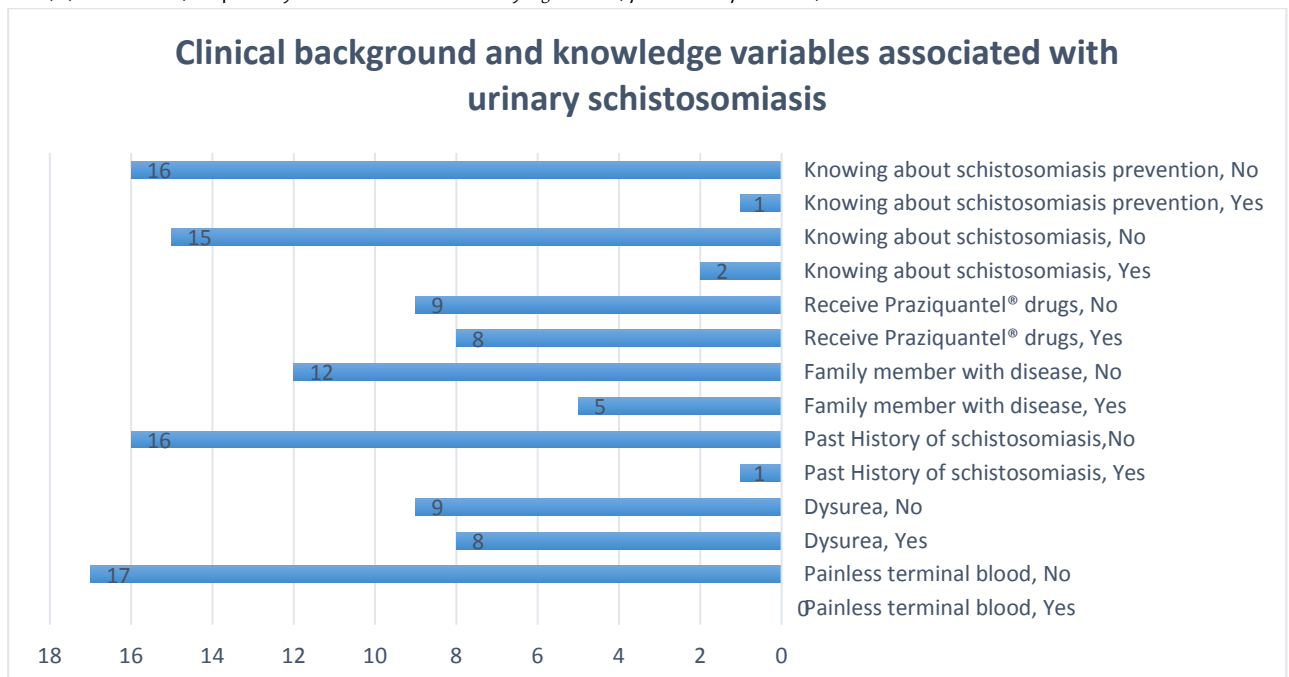


Figure (6): Clinical background and knowledge variables linked to urinary schistosomiasis among residents of Taiz governorate's Al-Shmaytin and Al-Mwaset districts in 2021

### 3.5 *S. haematobium* independent predictors (IPs)

The findings of the logistic regression analysis are presented in Figure 7. The contribution of each independent variable to the prediction or explanation of the outcome variable is shown in this table. The table displays the adjusted OR, 95% confidence interval (CI), and “*p*”-value (Sig.). It was statistically significant (“*p*”= 0.019) that the adjusted OR for district was 3.7 (95% CI: 1.24-11.16). Age adjusted odds ratios (AOR) were not statistically significant (“*p*”= 0.991), and the age AOR was 1.0 (95% CI: 0.13-7.54). 2.8 (95% CI: 0.84-9.17) was the adjusted OR for sex, which was not statistically significant (“*p*”= 0.095). 0.3 (95% CI: 0.03-2.98) was the adjusted OR for marital status, which was not statistically significant (“*p*”= 0.306). 1.3 (95% CI: 0.16–10.07) was the adjusted OR for educational status, which was not statistically significant (“*p*”= 0.828). It was not statistically significant (“*p*”= 0.293) but the adjusted OR for swimming or taking a bath in stream water was 2.0 (95% CI: 0.54-7.56). When people come into contact with water, the adjusted OR for those who wear shoes is 0.4 (95% CI: 0.08–2.23), which is not statistically significant (“*p*”= 0.304). Similar to the previous finding, the adjusted OR for those who urinated close to water sources was 1.7 (95% CI: 0.58-5.09), which was not statistically significant (“*p*”= 0.330). A family member who had *S. haematobium* was diagnosed with an adjusted OR of 1.0 (95% CI: 0.33-3.05), which was not statistically significant (“*p*”= 0.999). 1.7 (95% CI: 0.59-5.19) was the adjusted OR for those who reported pain when urinating, although this value was not statistically significant (“*p*”= 0.319). At 0.9 (95% CI: 0.29–2.55), the adjusted OR for individuals who received Praziquantel® medications was not statistically significant (“*p*”= 0.782).

Wald statistics indicated that the variable made the largest contribution to the model. Because it had the highest Wald value among the variables that were statistically significant, habitation in the Alsafiah Valley-Al-Shmaytin district was the most significant variable contributing to the model (the prevalence of *S. haematobium*).

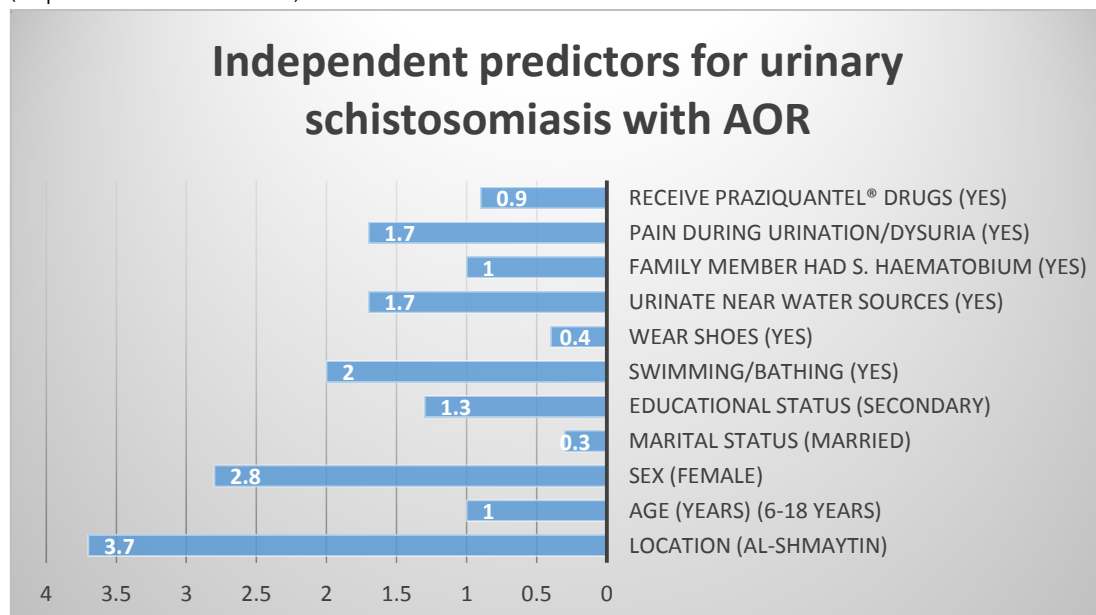


Figure (7) *S. haematobium* and independent predictors in residents of Taiz governorate's Al-Shmaytin and Al-Mwaset districts in 2021

## 4. Discussion

Most respondents were from Alsafiah Valley, and due to that, the population in this valley was higher than the population in Ayfoa'a Valley. People between the ages of 6 and 18 made up the majority of responses from both valleys, which may be related to the fact that this age group made up the majority of Yemenis (those over 60 made up only 4% of the country's population in 2009) (Ministry of Planning & International Cooperation (MoP&IC) 2008). People between the ages of 6 and 18 made up the majority of responses from both valleys, which may be related to the fact that this age group made up the majority of Yemenis (those over 60 made up only 4% of the country's population in 2009) (MoP&IC 2008). Female, as evidenced by the fact that responses to the questionnaire from females were more obliging. Due to the majority of research participants being between the ages of 6 and 18, this group was single. The same factor that caused the prior variable's result also contributed to this one, which related to essential school students. Having a meager income (less than 50,000 Yemeni rials). This result reflects the nation's economic situation and shows how economic status affects the prevalence of schistosomiasis in both valleys (more than 61% of Taiz governorate residents lived in poverty in 2008) (MoP&IC 2008). Furthermore, this outcome was expected given that the majority of Yemenis were jobless (more than 49% of Taiz governorate residents were unemployed in 2004) (MoP&IC 2008). Lacked sewage or sanitation. This outcome can be a result of the poor economic situation, which prevents the populace from having access to sanitation. Additionally, the government lacked the funds necessary to build public restrooms. A toilet in the house or having a fixed hot-water supply. The source of household water was the governmental or local network, which

was higher in Alsafiah than in the Ayfoa'a Valley. Household water did not save in the tanks before use. Living within the valley itself or within 300 meters or less of streams or springs. This is due to the fact that most Yemeni rural residents rely heavily on water for domestic purposes.

Clinical descriptions and case definitions for the WHO's recommended prevention and control measures for communicable diseases are provided by the International Statistical Classification of Diseases and Related Health Problems (WHO 2001 and 2009), *S. haematobium* prevalence in the study area (6.2%) was regarded as having a low risk of morbidity. Due to the reported parasitologically confirmed cases, which have a prevalence of less than 10% in the affected areas, and the requirement of prophylactic treatment, there was a low risk of morbidity (WB 2016). The majority of these villages in the research region had ponds and streams, where women and children mostly played, bathed, swam, washed clothes, and collected water for domestic use. The reported 17 cases could have been impacted by the area's inadequate access to clean drinking water and declining healthcare services. Because the current experiment was conducted in areas that were actively controlled, there was a low risk of morbidity. Between 2015 and 2021, three MDA campaigns were run to distribute drugs in the neighborhood utilizing temporary locations like schools, to which the low prevalence of *S. haematobium* infections could be attributed. Currently, urinary and intestinal schistosomiasis is estimated to be prevalent in all of Yemen's governorates, with prevalence rates ranging from 14% to 49% (Hotez 2012, and WHO, 2001). In a previous study, *S. haematobium* was less frequent than *S. mansoni* (7.4% versus 20.7%) in children from the Taiz governorate, which was similar to this study findings (Al-Samawi, & Aulqi, 2013). This outcome was in line with research done in Yemen, where it was discovered that almost one-third (31.6%) of districts were categorized as having a low (0.3%) or moderate (31.3%) risk for urogenital SCH infection (Johari et al., 2022). This was in line with another study conducted in Yemen, which stated that *S. haematobium* was prevalent in 1.7% (8/460) of the investigated students (Raed et al. 2019). In contrast, Taiz and Sana'a have the highest prevalence of *S. haematobium*, followed by Hodeida (36.0%, 36.0%, and 33.3%, respectively) (Sady et al., 2013). Similar contrasting results from research conducted outside Yemen found that sub-Saharan countries like Nigeria, as well as developing countries like Sudan (51.4%) (Abedaziz et al., 2012) and Mali (61.7%) (Landouré et al., 2012), have high prevalence rates of *S. haematobium*. According to the study's findings, a larger proportion of the infected community (59%), compared to 41% of those with a heavy- intensity of infection, had a light -intensity of infection. About 52.41 eggs were found in every 10 ml of urine, which was the overall geometric mean egg count in the EPG. This could be a result of drug resistance or malabsorption, or it could be because certain people in the community reject medication during mass administration therapy. Furthermore, this is easily explained by variations in community water interaction activities. This finding is in contrast to a study conducted in Nigeria, which revealed that the prevalence of genito-urinary schistosomiasis was 22.7% with a mean intensity of 25 eggs per 10 ml of urine (Atalabi et al., 2016). However, some genetic factors that are crucial in determining disease susceptibility may be responsible for this variation (Kouriba et al., 2005).

According to this research, the light and heavy- intensities of *S. haematobium* infections were equally prevalent in half of the respondents from the Al Shmaytin district. The majority of the respondents from the Al Mwaset district had light infections. This may be due to the fact that those infected in Al-Shmaytin district had more contact with water than those in Al-Mwaset district. Additionally, some of the villages in the research locations could not have water supply projects, which could account for this. Due to the resource's scarcity, the residents were exposed to the disease as a result of having to completely rely on streams.

Anyway, this study discovered that males with *S. haematobium* exhibited equal light and heavy -intensity, whereas light - intensity was common among females. This finding indicated that, compared to boys, girls had a considerably greater light - intensity of *S. haematobium*. These findings are similar to those of several studies conducted in other countries (Ahmed et al., 2012, & Garba et al., 2010). Additionally, this was consistent with a Nigerian study (Atalabi et al., 2016). In contrast to what we found regarding differences between males and females in the effects of tropical diseases (Vlassof, C., & Bonilla, E., 1994), another study noted that men have a slightly greater rate of light -intensity than women.

*S. haematobium* egg intensity by age revealed that those aged > 18 years had equal light and heavy - intensity of infection, while in younger children (6–18 years), light -intensity was higher than heavy - intensity of infection. It was not surprising that children had a high prevalence of light- intensity infection because, in regions where urinary schistosomiasis is endemic, this age group has a short duration of water contact activities. Contrary to this study findings, investigations carried out in regions of southeastern and northern Nigeria, where the disease was endemic, have also reported adolescents with a high - intensity of infection (Anosike et al., 2006, and Dabo et al., 2011).

In current study's conclusion showed that, compared to respondents from the Al Mwaset district, respondents from the Al Shmaytin district had a higher prevalence of *S. haematobium*. This might be caused by variations in water-contact activities. The relationship between *S. haematobium* infection and habitat was a significant.

The present investigation revealed a confident (risk) connection between *S. haematobium* and sex. Despite a strong correlation between *S. haematobium* and sex, females (mainly girls) have higher prevalence rates of infection than males. sex and *S. haematobium* infection .

Similar results were reported in other studies, which found that female infection rates were much higher than those of their male counterparts (Rudge et al., 2008, and Satayathum et al., 2006). But on the contrary, results from other studies suggested that males often had greater prevalence rates of schistosomiasis than females. This was explained by factors such as water contact practices or religious and cultural views (Deribe et al., El-Khoby et al., 2000, 2011, Raja'a et al., 2000). Men in Yemen had a 100% prevalence of urinary schistosomiasis, according to one

study (Ashwaq, 2020). A study conducted in southern Mauritania showed contrasting results, with males contracting the disease approximately 200% more likely to be infected than females (Gbalégba et al., 2017). Another study found that boys and girls showed similar *S. haematobium* prevalence (14.2% vs. 13.7%;  $p = 0.781$ ) (Etienne et al., 2019). In contrast, women were in charge of carrying water, washing laundry, and using these water sources to clean utensils, therefore they experienced a similar level of exposure to infectious phases. Yemen has one of the largest sex gaps in educational attainment worldwide, and educating women remains a significant problem (Hausmann et al., 2011). Research from rural areas of Southwest and South-South Nigeria and Kwazulu-Natal, South Africa, which discovered that females contracted infections at a higher rate than males, is supported by this study (Etim, 1995, Morgas-Thomassen et al., 2010, Sam-Wobo et al., 2011).

Children between the ages of 6 and 18 were shown to have the highest risk of contracting the condition, followed by those over the age of 18. Numerous earlier research studies (Agi & Awi-waadu, 2008, Ugbomoiko et al., 2010), that have shown the considerable prevalence of urinary schistosomiasis in children aged 7 to 16 years also indicated how activities like swimming, washing, fishing, and playing in infested water bodies contribute to the condition. While a study conducted in Sudan revealed that the highest frequency of positive cases was found among the age group of 12 to 15 years (91/154, 59.1%), no significant association between age distribution and positive results were found ( $p$ -value = 0.18) (Elsiddig et al., 2019). This result is in contrast to earlier researches from Yemen and other countries (Deribe, et al., 2011, Gryseels et al. 2006, Raja'a, et al., 2000, Ugbomoiko et al., 2010). This may be explained by the fact that young children move around too much at this age and may be more exposed to contaminated water while playing, swimming, fetching water for the house, or helping to bring water to the house because of severe water shortages. The children included in this study also reported engaging in diverse activities. There was a relative urinary schistosomiasis infection rate of 7.8% in the study area among children aged 6–18. These moms and children were transported in a bathtub to a creek. Younger kids run the danger of getting sick while learning to swim when they go to water areas with their bigger siblings.

The risk of a child being sick in the area was said to increase with swimming, not wearing shoes when using stream water, and water use for 1-3 years. This could be a result of the body being in contact during these activities for a longer amount of time. However, if young kids go with their mothers to water sources for fetching or other common home chores like washing, they could potentially catch the disease. Additionally, it has been noted that communities in close proximity to streams are at significant risk of infection. Additionally, parents may be less likely to educate their kids on protective measures due to the high rates of parental negligence and illiteracy in the area, which may have an impact on the pattern of transmission.

Additionally, singles and students in secondary school shared this. The same causes of infection were responsible for this in children aged 6 to 18.

According to this study, poverty has an impact on the prevalence of urinary schistosomiasis. This can be the outcome of communities having less access to health services. Schistosomiasis, which is typically linked to rural poverty, affects an estimated 170 million individuals in sub-Saharan Africa and an additional 30 million people in North Africa, Asia, and South America (Naris, 2000). According to a UNICEF report published in the middle of 2021 (UNICEF, 2021), the crisis in Yemen has forced almost two million children out of school, which means that two-thirds of Yemeni teachers have been working without pay for more than four years. Water sources can get contaminated by improper sanitation, as was evident in the research region, and household latrines can raise the risk of transmission. The findings of this study are in line with those of a research done in Zambia, which found that unclean water and inadequate sanitation facilities were to blame for the illness in more than 4 million school-aged children, the majority of whom lived in rural communities (Kalinda, et al., 2020). The same findings were made by another study, which claimed that the risk factors for the transmission of urogenital schistosomiasis included inadequate parental or guardian knowledge of the illness, unfavorable attitudes and inappropriate preventive measures, frequent contact with water, a lack of accessible, affordable clean water, poor sanitation at water bodies, and unhygienic practices (Mushi et al 2021).

It was widespread among residents who lived close to water sources, had used stream water for fewer than three years, bathed or swam in water collections, and did not wear shoes when in the water, all of which increased access to the infection source. These findings show that activities involving water have a part in *S. haematobium* prevalence. According to De Haan (De Haan, 2004), the connection between water and schistosomiasis was also emphasized. According to a study carried out in Uganda, exposure to contaminated water during regular agricultural, domestic, professional, and recreational activities was the predominant method of disease transmission (Kibira et al., 2019). *S. haematobium* was frequently found among people who urinated close to water sources, according to findings of this study. This describes how poor sanitation contributes to schistosomiasis infection, which causes people to urinate in public places, contaminating the environment. This is in line with the conclusions of an additional study (Coulibaly et al., 2013). *S. haematobium* was frequently found among people who reported experiencing pain while urinating (dysuria), according to this study. This outcome is consistent with research was done in Tanzania (Mushi et al 2021). In addition, the illness was more common in people who had family members who had schistosomiasis. This outcome is consistent with research was done in Nigeria (Dawaki et al., 2016). Among individuals who did not take Praziquantel®, *S. haematobium* was frequently found. The Mass Drug Administration (MDA) is the primary strategy for reducing urogenital schistosomiasis in places where it is endemic (Cribb et al., 2019). *S. haematobium* was more common in people who were ignorant of schistosomiasis or who did not know how to prevent it. This shows how

knowledge affects *S. haematobium* prevalence. Schistosomiasis may be difficult to eradicate in Yemen's rural areas due to the population's lack of awareness of the disease's causes, transmission, symptoms, and prevention. The results of this study were in line with one study's findings that the disease's etiology and prevention were poorly understood, despite the fact that participants' general awareness of the danger of schistosomiasis was high (Mazani et al 2021). Poor awareness of symptoms and indications was also noted among rural Yemeni people in Mawea (Sady et al., 2015). To significantly reduce the transmission and morbidity of schistosomiasis in these communities, health education in schools and communities was crucial in addition to the current MDA (WB, 2016).

The frequency of *S. haematobium* in communities, particularly among youngsters, was shown to have a low risk of morbidity in both valleys, according to WHO categorization (WB, 2016).

They have been discussed using the modified OR in order to extract the key elements (predictors) from the aforementioned factors: Alsafiah valley from Al-Shmaytin district was 3.6 times more likely to have *S. haematobium* than Ayfoa'a valley from Al-Mwaset district. People aged 6 to 18 were 1.6 times more likely to get *S. haematobium* than people over the age of 18. Which are the same for a study conducted in Sudan (Elsiddig et al., 2019). This result is in contrast to earlier researches from Yemen and other countries (Deribe, et al., 2011, Gryseels et. al. 2006, Raja'a, et al., 2000, Ugbomoiko et al., 2010). Similarly, females were 2.5 times more likely than males to contract *S. haematobium*. This result is similar to other study (Rudge et al., 2008, and Satayathum et al., 2006). But on the contrary, to study conducted in Yemen (Ashwaq, 2020). The single people were 4.4 times more likely to get *S. haematobium* than married, divorced, or widowed people. Those who bathed or swam in stream water had a 2.2-fold higher risk of getting *S. haematobium* than those who did not. Individuals who did not wear shoes were 3.2 times more likely to get *S. haematobium* than those who did. Individuals who urinated close to water sources were 2.1 times more likely to acquire *S. haematobium* than those who did not. The previous three factors were discovered by another study (Mushi et al 2021). Individuals with any family member who had *S. haematobium* were 1.4 times more likely to have it compared to those who did not. Individuals who experienced dysuria—pain during urination—were 2.6 times more likely to acquire *S. haematobium* than those who did not. This result in line with another study (Mushi et al 2021). Finally, those who did not get Praziquantel® medications had a 1.1 times higher risk of contracting *S. haematobium* than those who had. The same result was shown by one study (Cribb et al., 2019).

The Wald statistics indicated that the variable had the most impact on the model. Given that it had the highest Wald value among the factors that were statistically significant, residence (Al-Shmaytin district) was the most significant variable that affected the model's prediction of *S. haematobium* prevalence.

## 5. Conclusion

In this study, the Alsafiah and Ayfoa'a valleys of the Al-Shmaytin and Al-Mwaset districts show hypoendemicity (low risk morbidity) of urinary schistosomiasis, highlighting the importance of current control strategies, which include implementing integrated, targeted, efficient, and effective schistosomiasis control measures (primarily MDA). According to this study, the Alsafiah Valley produced the majority of the respondents who tested positive for *S. haematobium*. The current study discovered that *S. haematobium* was more prevalent in females (mostly girls) than in males. Children between the ages of 6 and 18 had the highest prevalence. A larger percentage of the infected community had a light-intensity of infection. Females and children aged 6–18 had a considerably greater light-intensity of *S. haematobium*. The highest prevalence of urinary schistosomiasis was among those who went swimming, was single, attended secondary school or more, did not receive anti-bilharzia drugs, urinated close to water sources, lacked sanitation, did not wear shoes when using stream water, were unaware of schistosomiasis and its prevention, lived near stream water sources, had low monthly incomes, and had any family member complaining of the disease. This study also shows the necessity for additional research about *S. haematobium* prevalence in other highly endemic regions. To prevent the infection from spreading to other parts of the governorate, regional control programs were crucial. Public health officials should use screening additional family members and treating sick people to fight this infection in these communities. The introduction of proper sanitation was essential among these communities in order to reduce the transmission and morbidity brought on by schistosomiasis, in addition to the periodic distribution of drugs, health education regarding good personal hygiene and good sanitary practices, and the provision of clean and safe drinking water.

## 6. Recommendations

The following steps were suggested based on the aforementioned findings: (i) Praziquantel®-based treatment programs as well as thorough epidemiological studies should be performed throughout the whole Taiz governorate, including the Al-Shmaytin area. (ii) There should be a safe water supply available and recreational water bodies built in the settlements to prevent contact with water bodies that are already infested. (iii) It's important to identify and manage the governorate's and valley's snail vectors. (iv) Health education: an initiative to promote and reinforce healthy behavior with full community and individual engagement. (v) To optimize the benefits of routine chemotherapy, it was crucial to promote long-lasting advancements in cleanliness and hygiene. (vi) Urinary schistosomiasis control initiatives should be carried out in conjunction with campaigns

against some endemic diseases such as onchocerciasis, outreach initiatives, cholera, and malaria. (vii) To help concentrate control efforts in the endemic regions, future studies should use geographic information systems to locate the precise locations of the affected areas.

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#### 8. Conflict of interest declaration

The authors declare no conflict of interest.

#### 9. Data availability

Further data is available from the corresponding author on reasonable request.

#### 10. Funding

This study was funded by the corresponding author.

#### 11. Authorship

The original essay was written, examined, and discussed by Abdunnasser A. Al-Kabab. amending the content in accordance with supervisors' comments .

Einas I. EL Sheikh oversaw, offered suggestions, and revised the article.

Abdulla A. Al-Mikhlaflay oversaw, offered suggestions, and revised the article.

## 12. Abbreviations list:

Abbreviations	Explanation	Abbreviations	Explanation
AORs	Adjusted odds ratios	NSIPCP	National Schistosomiasis and Intestinal Parasites Control Programme
CI	Confidence interval	NTDs	neglected tropical diseases
CSO	Central Statistical Organization	ORs	Odds ratios
EPG	egg per gram	P	Proportion
IPs	Independent predictors	PZQ	Praziquantel
kg	kilogram	S.	Schistosoma
MDA	Mass drug administration	SAC	School-Age Children
MDGs	Millennium Development Goals	SPSS	Statistical Package for the Social Sciences
MECA	Medical Ethical Committee Approval	UNDP	United Nations Development Programme
mg	Milligram	USA	United State of America
MH	Medical history	UST	University of Sciences & Technology
MoP&IC	Ministry of Planning & International Cooperation	WB	World Bank
n	number	WHO	World Health Organization

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