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Mapping of Schistosomiasis and Soil-transmitted helminths in Yemen, and the push for elimination

CID: 00636012

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List of Abbreviations

ALB	Albendazole
CI	Confidence Interval
CWW	Children Without Worms
GPS	Global Positioning System
GSK	GlaxoSmithKline
HIV	Human Immunodeficiency Virus
HPV	Human Papilloma Virus
IQR	Inter-quartile Range
J&J	Johnson & Johnson
MBD	Mebendazole
MDA	Mass Drug Administration
MENA	Middle East and North Africa
MoPHP	Ministry of Public Health and Population
NSCP	National Schistosomiasis Control Project
NTD	Neglected Tropical Diseases
PCT	Preventive Chemotherapy and Transmission Control
PM	Prevalence Mapping
PSU	Primary Sampling Unit
PZQ	Praziquantel
GIS	Geographic Information Systems
SCH	Schistosomiasis
SCI	Schistosomiasis Control Initiative
STH	Soil-transmitted Helminths (intestinal worms)

UN	United Nations
UNICEF	United Nations Children’s Fund
WASH	Water, Sanitation and Hygiene
WHO	World Health Organization
YNHDS	Yemen National Health and Demographic Survey

Abstract

Background

Schistosomiasis (SCH), both intestinal and urogenital forms, and soil-transmitted helminthiases (STH) are the most prevalent neglected tropical diseases (NTDs) in the Republic of Yemen. In 2010, a 6-year nationwide control programme commenced to control infection of both NTDs via preventive chemotherapy. After 2-3 rounds of treatment a prevalence re-mapping survey was conducted to map the distribution of infection and provide an overview of the programme's impact on NTD prevalence from baseline levels in 2010, as well as set the control approach for upcoming years of the programme. The opportunity was also taken to leverage this survey platform to provide the first nationwide estimate of anaemia prevalence amongst school-aged children in Yemen.

Aims

The aim of the study was to determine the prevalence and distribution of SCH and STH in Yemen after three years of treatment, and whether the programme can transition from morbidity control to elimination as a public health problem upon its scheduled completion in 2015. Results were compared to those from baseline prevalence mapping to re-categorise districts based on disease prevalence.

Methods

Twenty-five teams tested 80,432 school-aged children from 2,585 schools across 332 districts in all 22 governorates. Stool, urine and blood samples were collected and tested using the Kato-katz method (for intestinal helminths), hemastix dipsticks and urine filtration (urogenital SCH), and HemoCue® (haemoglobin concentration). Data were analysed on Microsoft Excel and prevalence calculated. Infected districts were classified according to baseline cut-off values for SCH and WHO recommended categories for STH and anaemia. Robust 95% confidence intervals and prevalence maps were generated using the statistical software R and QGIS respectively.

Results

Overall prevalence of any SCH infection was 3.2% (range 0-38.9% by district); 0.71% (0-10.2% by district) for *S. haematobium* and 2.5% (0-35.7% by district) for *S. mansoni*. No districts were classified as high risk for SCH, with 211 out 332 infected mostly in western regions where a majority of the population are based. Sixty-four fewer districts were infected compared to baseline districts. STH was more prevalent than SCH (8.8%, range

0-60.3% by district) with females having higher prevalence (10.2%) than males (7.8%). *Ascaris* was by far the most prevalent STH by district. Co-endemicity of SCH and STH as well as co-infections with both species of SCH was found nationwide. Anaemia prevalence was widespread (30.4%) with ¼ districts under severe public health significance and only 12 districts with no anaemia.

Conclusions

Integrated mapping of the NTDs is an important tool for the control of morbidity and elimination in geographical areas where there exists a widespread overlap of disease distribution. This report highlights the success of the national control programme in Yemen and important issues that need to be addressed, especially the alarmingly high prevalence of anaemia nationwide. The programme is already on track to achieve elimination as a public health problem in the majority of districts. Community awareness and improved living conditions need to be included alongside preventive chemotherapy as the programme transitions from control of disease morbidity to elimination of SCH and STH in Yemen.

1 Introduction

1.1 Schistosomiasis

Schistosomiasis (SCH) or bilharzia is an acute and chronic neglected tropical disease (NTD) that infects over 200 million people worldwide. The parasitic disease, caused by blood flukes of the genus *Schistosoma,* predominantly affects those living in poor, rural areas in the developing world (1). *Schistosoma* is a digenetic blood trematode consisting of two major forms – intestinal and urogenital, of which there are five main species that infect humans. The different species of SCH and their corresponding distribution worldwide is listed in Table 1 below.

Table 1: Type, species and global distribution of SCH[a]

Type of SCH	Species	Distribution/Location
Urogenital	*Schistosoma haematobium*	the Middle East, Africa
Intestinal	*Schistosoma mansoni*	the Middle East, Africa, the Caribbean, Brazil, Venezuela and Suriname
	Schistosoma japonicum	Indonesia, China, the Philippines
	Schistosoma mekongi	the Lao People's Democratic Republic and several districts within Cambodia
	Schistosoma guineensis, S. intercalatum	Central Africa (rain forest areas)

[a]Source: WHO, 2014 (1).

Of the five species that cause the disease, *S. haematobium* and *S. mansoni* are two highly prevalent species found in the Middle East, including the Republic of Yemen. Along with the soil-transmitted helminths (STH or also known as intestinal worms) SCH represents over 40% of the disease burden arising from all the tropical diseases, aside from malaria (2). Humans are infected by the larvae or cercariae of SCH which are released by freshwater snails, the intermediate hosts. Snails of the genus *Bulinus* and *Biomphalaria,* of which the former is more widely distributed in Yemen, serve as the intermediate hosts for *S. haematobium* and *S. mansoni* respectively (3, 4). The cercariae penetrate the skin, enter the body and develop into adult worms within the blood vessels. Adult *Schistosoma* worms release eggs that travel to the intestine or bladder depending on the species. The

eggs often become trapped within these organs, triggering the immune response and resulting morbidity. Eventually, the rest of the eggs leave the body of the infected individual within stools or urine (Figure 1) (5).

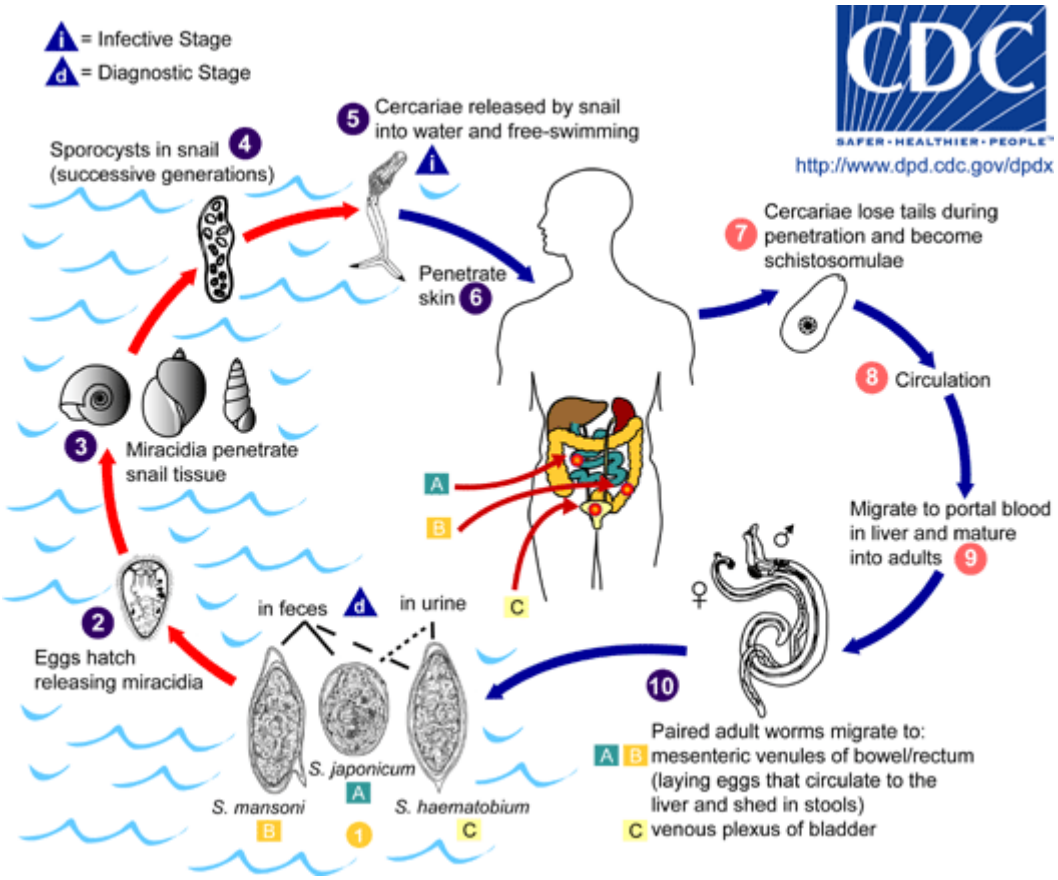


Figure 1: Life cycle of schistosomiasis (5)

Hence, humans often become infected when they come into contact with water in which infected individuals defecate or urinate. The parasites subsequently develop in intermediate snail hosts commonly found near the shores of shallow, slow-moving or stagnant water. Such water sources include lakes, ponds and irrigation systems located near residential areas of rural communities (6). This places agriculture and fishing populations with regular water contact as well as those with poor water supply or sanitation coverage at increased risk (7). Amongst these populations, children are at particularly high risk due to lower immunity levels (if occurring) and frequent water contact (8, 9). Therefore, school-aged children between 5 and 15 years old often suffer from the highest intensities of infection and are important sources of disease transmission (10, 11). In Yemen, over half of the population of nearly 25 million people live in poverty (12) with more than 60% residing in rural areas (13). The high prevalence of SCH in Yemen has raised further

concerns over the extent of poor water and sanitation, inadequate living conditions and resulting negative effects on population health with widespread infection.

S. haematobium, or urogenital, infection is typically associated with the characteristic blood in urine (haematuria) due to bladder and ureter fibrosis. In severe cases infection can lead to bladder cancer and, in women, genital tract damage and vaginal bleeding. Known as female genital SCH, such damage can, in turn, lead to increased susceptibility to sexually-transmitted diseases such as human papilloma virus (HPV) and human immunodeficiency virus (HIV) infection (14). Intestinal SCH caused by *S. mansoni*, on the other hand, leads to blood in the faeces, diarrhoea and abdominal pain as a result of hepatic and intestinal fibrosis (11). Organomegaly is common in chronic cases, in particular liver and spleen enlargement (15). Both types lead to a variety of debilitating symptoms; in school-aged children, SCH may result in anaemia, stunting and poor cognitive development (16, 17). In Yemen it was estimated that over 3 million people were infected with over 600,000 individuals suffering from clinical morbidity prior to the commencement of any large-scale control programme (18).

SCH is second only to malaria in terms of public health impact worldwide (15) and is one of the most significant public health problems in Yemen, where it is endemic (19). Thus, in 2010 a 6-year nationwide control programme commenced in Yemen in an effort to decrease the prevalence and intensity of both intestinal and urogenital SCH infection. This campaign is run by the Yemen Ministry of Public Health and Population (MoPHP), funded by the World Bank and involves collaborative partnerships with the World Health Organization (WHO) and the Schistosomiasis Control Initiative (SCI) (20).

1.2 The Schistosomiasis Control Initiative

The SCI was established in 2002 to provide assistance to countries in sub-Saharan Africa (Figure 2) to develop national SCH control programmes that are sustainable and effective (11). Such programmes focus on the control and eventual elimination of SCH and STH via preventive chemotherapy using the anthelminthic drugs praziquantel (PZQ) and albendazole (ALB) or mebendazole (MBD) respectively. The drugs, which were initially purchased, have subsequently been donated by several pharmaceutical companies. In 2007, Merck KGaA pledged to donate 200 million tablets of PZQ over 10 years via the WHO. Since then, the company has decided to continue the donation indefinitely,

expanding the drug supply from 25 million to 250 million tablets annually. This donation will allow the treatment of approximately 100 million children every year for SCH in Africa (21). Supply of the drug currently does not cover Yemen, but it is optimistic that coverage will be expanded beyond Africa to include middle-eastern countries in the future. ALB is currently donated by GlaxoSmithKline (GSK) against STH and lymphatic filariasis (22) via the WHO. For the treatment of intestinal worms, MBD, the alternative to ALB, is donated by Johnson & Johnson (J&J) through the collaborative health programme Children Without Worms (CWW) (23). Preventive chemotherapy is the main treatment strategy recommended by the WHO against these helminth infections (2), which can be treated safely and at a cost of only US$0.51 per person annually in Yemen with the aforementioned tablets (24).

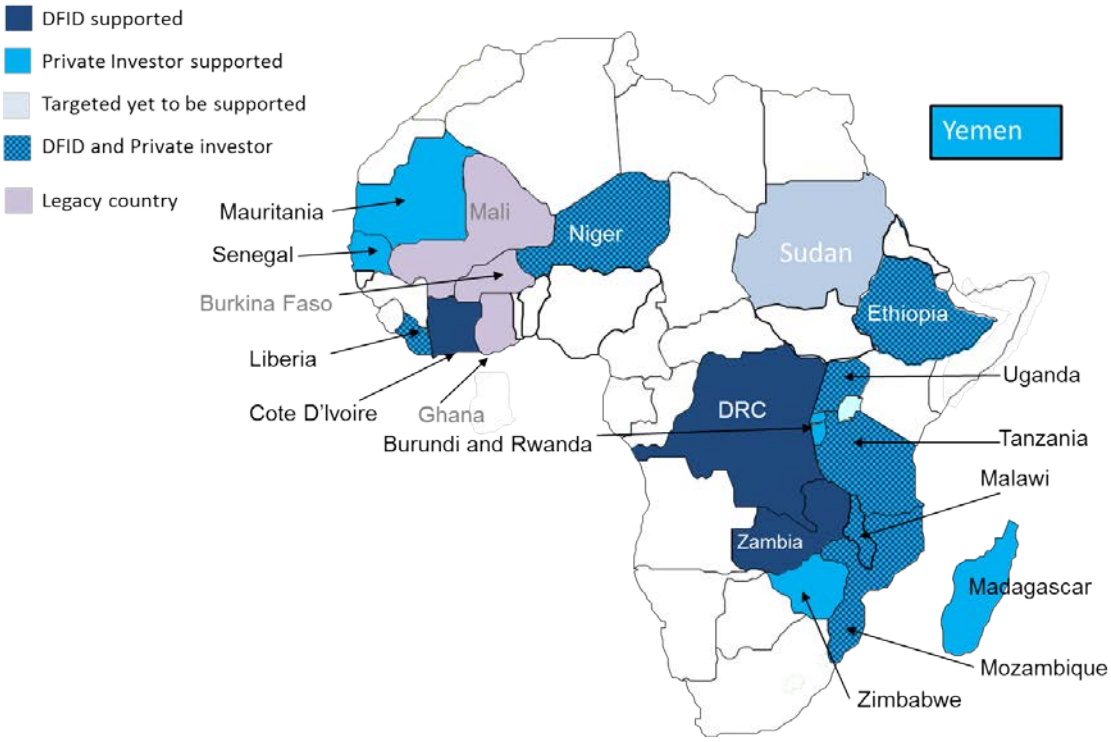


Figure 2: 'Map of SCI supported countries and sources of funding 2014' ((25):p.3)

The SCI has adopted the integration of STH control with that of SCH as both NTDs come hand-in-hand. Co-infections with STHs such as hookworm, *Ascaris lumbricoides* and *Trichuris trichuria* (26) are highly common. Hence, co-administration of a deworming dose of 400mg of ALB or 500mg of MBD with 40 mg/kg of PZQ (using a PZQ dose-pole of height as proxy for weight, Appendix 1) is cost-effective as logistical and technical resources are combined. Furthermore, integrated delivery of the drugs contributes to

increased treatment coverage (27). To date, the organisation has facilitated the delivery of over 120 million treatments for SCH and STH (Figure 3) (28).

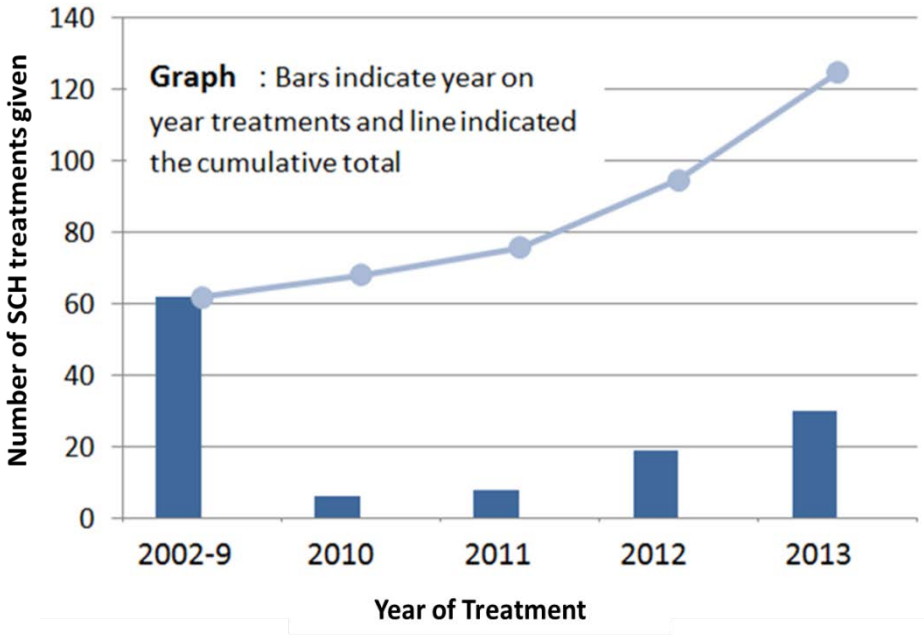


Figure 3: 'SCI's contribution to the global effort – the number of SCH treatments given annually from 2002-2013' ((28):p.4)

Apart from providing technical assistance to set up national control programmes, the SCI, based at Imperial College London, works to promote sustained access to necessary drugs and high quality case management in each country's national health system. To assess the progress of each programme, monitoring and evaluation (M&E) activities are developed to determine any reduction in infection markers and consequent improvements in health status (29). In Yemen, the SCI has been assisting the MoPHP in its control efforts under the Yemen National Schistosomiasis Control Programme (NSCP) (20). In keeping with the principle that all programmes developed (11) are 'country owned and run' (p. 1720), the SCI has built upon the programme's previous experience with sub-national control, M&E and disease mapping to tackle infections nationwide.

1.3 Yemen National Schistosomiasis Control Programme

Prior to the NSCP's official founding in 2008, sub-national control of SCH has been conducted via schools since 2002 with support from the WHO. In 2008, the NSCP

implemented school-based preventive chemotherapy at a sub-national scale using a US$2 million World Bank grant, where over 2 million school-aged children living in the highest endemicity areas were successfully treated. Coverage was then expanded by combining the school-based approach with the community-based approach to include females, non-enrolled children and at-risk adults. The school-based approach was effective in reaching enrolled children, but as these other risk groups may likely be infected, contributing to the spread of SCH, a school and community-based approach was implemented. Besides schools, PZQ and ALB were distributed at nearby health facilities and temporary sites at public areas such as mosques and markets. This strategy was utilised in a pilot project in 2009, where 686,000 individuals from 10 districts with high endemicity were treated. Overall, the pilot project successfully treated over 70% of adults and achieved a 40% increase in coverage of non-enrolled children compared to the 2008 campaign – providing evidence that community-based treatment was effective in reaching these target groups (20). Outcomes of the pilot project were then used to identify aspects for improvement for the planning of the main treatment campaign in 2010.

To date the NSCP has successfully treated approximately 10 million people nationwide, using more than 45 million tablets of PZQ and 18 million tablets of ALB or MEB (24, 30) under the Yemen Schistosomiasis Control Project. The 6-year campaign launched in 2010 and is supported by a US$25 million grant from the World Bank. The MoPHP runs the programme along with partnerships with the WHO and SCI. The programme aims to eliminate morbidity as a result of SCH and STH infection in Yemen via mass drug administration (MDA) of PZQ and ALB to all those who are at risk from 2010 to 2015 inclusive (20).

After extensive planning and preparation the main treatment campaign, covering not only high prevalence areas but all those that were endemic or suspected endemic for SCH, began in December 2010. The programme had to be suspended between April 2011 and May 2012 because of civil and political unrest, but consequently resumed to complete two to three rounds of treatment for a total of 3 years of activities by November 2013 (24). The most successful operational period was between March and May 2013, where approximately 9.6 million individuals in 263 out of the country’s 333 districts were treated for SCH and STH. This was achieved by carrying out two separate, intensive campaigns spanning four days each with 30,000 health officials and community members distributing PZQ and ALB. In total, 34 million tablets were handed out to adults and children (Figure 4) at the end of the campaign (31). Such extensive coverage and successful administration of

the drugs can be owed to strong political support and advocacy, strategic planning, extensive training, social mobilisation, organised drug distribution and proper M&E throughout the three years of the project.

Figure 4: 'Schoolgirls receiving school-based treatment as part of the Yemen NSCP in 2013' (30)

1.4 Prevalence Mapping

1.4.1 Introduction to Mapping

Every successful disease control programme requires the comprehensive mapping of disease distribution at baseline prior to the commencement of the programme, at suitable intervals throughout the programme to monitor progress and upon completion of the programme. As recommended by the WHO (10), mapping surveys are carried out throughout the country to collect necessary information that can then be used to produce maps of disease distribution, risk and prevalence and to inform the treatment approach for the upcoming years of the disease programme. Each mapping survey serves an important purpose at each stage and is crucial to inform programme managers of the status of disease control and the most suitable treatment approach moving forward.

1.4.2 Baseline Prevalence Mapping

Before the main treatment campaign in Yemen was launched in 2010, a baseline prevalence mapping (PM) survey was conducted. The small-scale survey validated previous mapping exercises that were conducted in 2004-2006, prior to the 2009 pilot

project, as well as filled in any gaps in knowledge for unmapped areas in the country. A baseline survey was crucial in preparation for the 2010 campaign as the treatment area was expanded from previous campaigns to include districts that were determined to be endemic or suspected endemic for SCH in Yemen (32).

Furthermore, SCH is known to be highly focal in its geographical distribution. This NTD is dependent on the contamination of freshwater bodies with infected urine or faeces, the presence of competent snail vectors and contact of the human host with infested water (33). Extensive surveys and maps are therefore essential in planning the control programme effectively, ensuring the best utilisation of available human, drug and logistical resources. The reliable information obtained helps to identify areas that would gain the most benefit from the MDA (34) and prevent wastage of resources. In the long run, unnecessary selection pressures on targeted parasites can be avoided. With that, the unwanted development of drug resistance, which would make control efforts more costly and difficult than it should be, can be prevented (35).

The baseline PM survey used parasitological risk mapping as its main strategy. Similar exercises have been conducted successfully in many countries such as Ghana and the United Republic of Tanzania (36). Parasitological data was collected for *S. mansoni* and *S. haematobium* as well as for the STHs from a representative sample of children from 120 schools within 9 governorates. This data was then combined with relevant ecological information (rainfall, temperature, population distribution, land cover and altitude) and data from previous mapping exercises to produce a prevalence risk map (Figure 5).

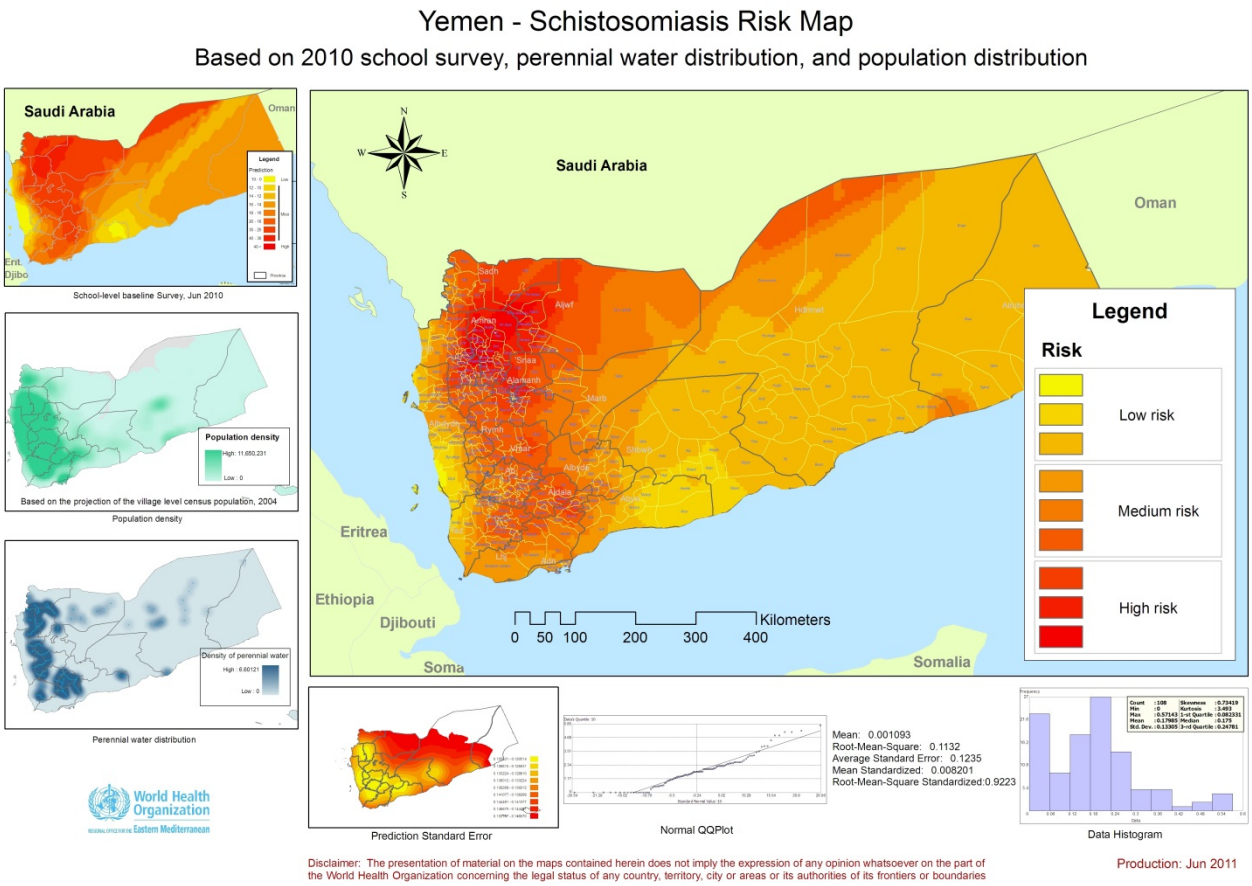


Figure 5: Results of the baseline prevalence mapping survey of Yemen in 2010 (French, M. *pers. comm*. (37))

Overall, 51 districts were classified as high-endemic, 183 meso-endemic and 41 low-endemic for a total of 275 infected districts out of 333 districts in Yemen (24, 38). MDA for SCH in the main treatment campaign was then guided based on each district's endemicity as described in Table 2 below. The cut-offs used for SCH endemicity in the campaign were narrower than those recommended by the WHO, where high prevalence of SCH is considered to be ≥50% of any SCH infection (27), hence extending treatment to a wider population. For the STHs, the WHO prevalence categories (High-risk ≥50%, Moderate-risk 20-50% and Low-risk <20%) were utilised (38).

Table 2: Classification of districts and corresponding treatment approach for schistosomiasis at school and community level in Yemen[a]

Category	Prevalence of infection with any form of schistosomiasis[b]	School-based treatment	Community-based treatment
High-endemic	≥40%	Years 1 - 6	Years 1, 2, 4
Meso-endemic	≥10% and <40%	Years 1, 2, 4, 6	Year 1
Low-endemic	<10%	Years 2, 5	Not done
Suspected-endemic	Districts that have not been surveyed, but where cases of schistosomiasis have been reported by the national surveillance system and may be reclassified upon assessment of the prevalence of infection	Years 1, 2, 4, 6	Year 1

[a]Source: Oshish et al, 2011 ((20):p.4) and The World Bank, 2009 (39).
[b]District classifications used by the NSCP for the main treatment campaign that commenced in 2010.

1.4.3 Prevalence Re-mapping

Re-mapping surveys, alongside M&E activities, play an important role in categorising districts and mapping the distribution of infection after multiple rounds of MDA. The exercise provides information on whether any areas have not had the expected response to treatment and thus whether changes to treatment approach are required. At the end of a treatment programme the data obtained also allows the determination of whether the country can look towards more ambitious disease control targets – potentially transitioning from control of morbidity to elimination of the disease as a public health problem and, eventually, the elimination of transmission altogether.

However unlike standard PM surveys, guidelines for prevalence re-mapping and the utilisation of its results are far less clear. In Yemen, a nationwide re-mapping survey was conducted from February to May 2014 in all 333 districts following three years of implementation of the main treatment campaign. This survey served the purpose of helping to inform the control approach for the remaining years of the programme; collecting data on both urogenital and intestinal SCH, the STHs as well as haemoglobin concentration amongst the school-aged population. With an integrated survey methodology, this exercise was the first nationwide assessment of anaemia prevalence amongst school-aged children in Yemen. This information complements data collected in

the Yemen National Health and Demographic Survey (YNHDS) 2013 (40) which conducted haemoglobin testing for children aged between 6 and 59 months and women between 15 and 49 years old. Anaemia is a known sequelae of various infections, including SCH, STH and malaria (41). Thus, such information will be invaluable to public health programmes running in the country given that the rate of undernutrition (stunting and wasting) is estimated to be one of the highest in the world. According to the YNHDS, nearly half (47%) of all children aged below five years old in Yemen are stunted, with consistently higher numbers in rural populations (40).

A national project such as this may help provide a stepping stone towards the formulation of guidelines for re-mapping surveys. This would also set an example of how the information collected can be used, analysed and interpreted effectively to provide a detailed and accurate overview of the status of control programmes and the spatial distribution of NTDs in other countries. The results from this survey will thus, as mentioned previously, provide a clear overview of the impact of the programme on the prevalence of SCH and STH in the country and whether it has achieved its main aim to eliminate morbidity as a result of these NTDs. Regional elimination of SCH in the WHO Eastern Mediterranean Region, which includes Yemen, has been set for 2015 under the WHO roadmap for the control, elimination and eradication of NTDs (42). The roadmap also looks towards achieving the elimination of SCH as a public health problem by 2020 in several countries in Africa, and worldwide by 2025. If the NSCP programme has been successful in achieving its primary aim of morbidity control, Yemen will be well on track towards elimination of SCH as a public health problem.

Therefore, this study aims to determine the prevalence and distribution of SCH and STH in Yemen after three years of the NSCP campaign, and whether the programme can transition from control of morbidity to elimination as a public health problem upon its slated completion in 2015. The objectives of the study are as follows.

- Analysis of survey data to estimate district-level infection.
- Determination of the distribution of anaemia amongst school-aged children.
- Production of prevalence maps at district and governorate level.
- Comparison of re-mapping results with baseline prevalence mapping results in 2010.
- Comparison of infection distribution with relevant ecological covariates where available.

2 Methods

2.1 Prevalence Re-mapping survey

Twenty five teams conducted the survey in 2,664 schools within 333 districts nationwide in the Republic of Yemen from February to May 2014. This exercise was carried out by the MoPHP and the SCI with technical assistance from Sana'a University and financial support by the World Bank. Yemen is the second largest country in the Arabian peninsula covering an area of 527,968 sq km (43). In Yemen the first administrative unit is the governorate (*muhafazat*), of which there are 22*,* which are then further subdivided into 333 districts (*muderiah*). Teams had to navigate through difficult terrain in order to reach selected schools and faced constant lack of security, making this survey a particularly challenging and time-consuming exercise.

2.1.1 Mapping strategy

Schistosomiasis and Soil-transmitted helminths

One of the main objectives of the survey was to re-categorise the districts according to the prevalence of the major forms of SCH (*S. mansoni* and *S. haematobium)* following two to three rounds of treatment. Data was also collected on the three STHs (*Ascaris, Trichuris* and hookworm) for the classification of districts based on STH prevalence. The data collected will allow comparison with baseline mapping data to determine changes in prevalence of infection and serve as a guide towards the control approach for the remaining two years of the control programme.

At baseline, SCH was known or suspected to be endemic in 275 districts in Yemen and STH infection was suspected in all districts. Thus, full-scale re-mapping was conducted for both SCH and STH in all districts, following WHO recommended mapping guidelines. Based on the guidelines, 200-250 school-aged children should be sampled in each ecologically homogenous area. In the case of Yemen, the most appropriate ecological zone, comprising of an area with similar characteristics suitable for SCH transmission, is the district level. The district was considered the 'implementation unit' at which it was logistically feasible to alter treatment strategies effectively (44). The prevalence categories employed to classify the districts in this survey are detailed in Tables 3 and 4 below.

Table 3: Classification of districts according to risk category for schistosomiasis in Yemen

Category	Prevalence of infection with any form of schistosomiasis	
	Standard thresholds[a]	New thresholds[b]
High-risk	≥40%	≥30%
Moderate-risk	≥10% and <40%	≥10 and <30%
Low-risk	<10%	<10%

[a]Standard cut-off values as was used in the baseline prevalence mapping survey (39).
[b]Thresholds were lowered to further decrease prevalence and intensity of infection and expand treatment towards elimination of the NTDs. This takes into account that infection recrudescence may occur if treatment is reduced, considering that infection levels in these areas have previously been suppressed by treatment.

Table 4: Classification of districts according to risk category for STHs in Yemen following WHO recommendations

Category[a]	Cumulative prevalence of STH	Percentage of moderate/heavy intensity infections
High-risk	≥50%	≥10%
Moderate-risk	≥20% and <50%	<10%
Low-risk	<20%	<10%

[a]Categories and cut-off values listed based on WHO guidelines (10, 38).

Anaemia

Alongside SCH and STH, testing for haemoglobin levels was integrated into this survey to provide the first estimate of national anaemia prevalence amongst school-aged children in Yemen. Collected data on haemoglobin levels were classified following WHO recommendations under mild, moderate and severe anaemia categories as shown in Table 5 under relevant age groups.

Table 5: Classification of anaemia severity at sea level based on measured haemoglobin concentrations by age group

Age group		Non-Anaemia[a] (g/L)	Anaemia[a] (g/L)		
			Mild	Moderate	Severe
6-59 months		≥110	100-109	70-99	<70
5-11 years		≥115	110-114	80-109	<80
12-14 years		≥120	110-119		
≥15 years	Girls[b]	≥120	110-119		
	Boys	≥130	110-129		

[a]WHO recommended anaemia cut-offs for measured haemoglobin levels (45-47).
[b]Girls in this case constitutes non-pregnant females aged 15 years and above.

In addition, haemoglobin concentrations were adjusted by the altitude of the locations at which samples were collected to avoid underestimation of the prevalence of anaemia. Communities living at high altitudes (>1000m above sea level) are known to have generally higher haemoglobin concentrations than those living at lower altitudes (46). Details on the adjustments to haemoglobin concentrations by altitude are shown in Table 6 below.

Table 6: Adjustments to measured haemoglobin concentrations according to altitude in metres above sea level

Altitude (m above sea level)	Adjustment[a] (g/L)
<1000	0
1000	-2
1500	-5
2000	-8
2500	-13
3000	-19

[a]WHO recommended adjustments to measured haemoglobin concentrations in individuals living at altitudes >1000m above sea level (45).

For anaemia prevalence, districts were classified under Mild, Moderate or Severe public health significance as outlined by the WHO (Table 7) (45).

Table 7: Public health significance of anaemia by WHO recommended categories and corresponding prevalence ranges

Category	Prevalence[a] (%)
No anaemia	≤4.9
Mild	5.0-19.9
Moderate	20.0-39.9
Severe	≥40

[a]WHO guidelines by categories of public health significance for prevalence rates obtained via estimation of haemoglobin concentrations in populations (45).

Prevalence maps

Final prevalence maps on the prevalence of *S. mansoni, S. haematobium*, the three STHs and at least mild, moderate and severe anaemia by district and governorate level were developed based on calculated prevalence and district classifications. In addition, for each condition districts were further classified by the upper boundary of the 95% confidence intervals calculated per district. Hence, districts that have borderline prevalence rates or upper limits that overlap the cut-offs stated above can be distinguished from the rest, and may require more attention in the interests of the control programme.

2.1.2 Survey methods

Before teams were despatched for sample collection, a governorates meeting was held by the MoPHP. This meeting was led by the General Director for Disease Control and Surveillance alongside the Yemen SCI Program Manager and the Sana'a University Team. During the meeting, the SCI and University teams presented details regarding the technical characteristics of the prevalence re-mapping survey. Consequently, the administrative aspects of the survey and necessary support required in the field from governorate and district health and education officials were successfully discussed (48).

Selection of sample population

Overall planning and collection methods were carried out following WHO guidelines for helminth control programmes (49). The survey was conducted in primary schools throughout Yemen, targeting school children between 10-14 years of age. The list of all schools in each sub-district (*uzla*) and district, including details on the number of students present in each school were obtained from the MoPHP (38). This list is the 'sampling frame' from which a representative number of schools were selected for inclusion in the survey. To ensure a sufficiently representative number of samples were collected in each district, a statistically-derived sample size was calculated by the SCI at Imperial College London. Twelve schools were selected based on weighted purposive sampling from which 8 were sampled per district. The 8 schools were chosen according to criteria such as sufficient numbers of male and female students for sampling, presence of latrines for water supply, and provided schools were functioning and representative for the particular district. In each school, 35 children were chosen for sampling by the teams to give a total of 280 children per district, and a grand total of 93,240 children in all (38).

Data collection

Twenty five teams consisting of 5 parasitological technicians each were recruited and trained by the Sana'a University team to cover the 333 specially assigned districts within 22 governorates. The targeted districts were allocated to each team according to location and feasibility (Appendix 2). Prior to commencement of the survey teams were briefed on precautionary measures, the appropriate methodology for selecting students for sampling and accurate data input on paper case report forms (example in Appendix 3). In addition, training was conducted on the various diagnostic tests used for sample collection. Teams were to travel to assigned schools with the necessary resources and equipment for data collection.

Upon arrival at each school, teams selected boys and girls between the ages of 10 and 14. The students were selected at random if there were more than the required number of students to meet the set sample size. With consent, each student was provided with empty stool and urine containers and instructed on how to collect a sufficient amount of urine and stool. Every student was registered and their samples collected by team members, with each member assigned separate tasks, under the team leader's supervision (details in Appendix 4).

Firstly, the presence of *S. mansoni* and the STHs (*Ascaris, Trichuris* and hookworm) were tested by two team members using the Kato-katz method to process stool samples and to detect eggs. A single team member was tasked with testing for *S. haematobium* using urine filtration, considered the diagnostic gold standard, as well as with haematuria reagent strips (Hemastix dip-sticks). Although Hemastix allows testing of *S. haematobium* prevalence with similar sensitivity and at lower cost (50, 51), specificity is lower as a result of likely contamination of samples with blood from menstruation or other forms of infection. Thus a two-step method was employed for the purposes of this survey. Besides testing for the parasites, haemoglobin concentration was estimated by the fourth team member using HemoCue® (46), a rapid diagnostic test, to determine anaemia severity and the subsequent prevalence in the population. The coordinates and altitude of the sampled schools were also recorded with a Global Positioning System (GPS) (eTrex, Garmin International, Kansas, U.S.A) at arrival and at departure. All data and information collected were taken down on paper case report forms.

Monitoring

Throughout the survey period supervisory field visits were held for several teams to ensure that each team followed the correct methodology when sampling all students in each school. To assess teams systematically, the university team developed a checklist (Appendix 5) with which to evaluate the performance of each team and identify any challenges faced in the process of data collection. Furthermore, a random sub-sample of 10% of the Kato-Katz slides collected for each school were taken by every survey team for re-examination by another member of the team. This second member was blinded to the results of the first examination to ensure unbiased results, and consequently both readings were compared for the detection of any discrepancies (48).

During the survey period, progress reports were prepared by supervisors at Sana’a University and submitted to the manager of the control programme and the SCI. Each report provided a detailed overview of the achievements made so far, activities conducted, a summary of survey results, challenges faced and recommendations for improvement.

2.1.3 Ethical considerations

The prevalence re-mapping protocol was approved by the Imperial College Ethical Review Board and the Yemen MoPHP before commencement of the surveys. Sufficient information was provided to communities to ensure awareness and acceptability of the survey and corresponding diagnostic tests via governorate and district health and education officials for each targeted area. The head of each school was notified and consent for sampling obtained prior to the arrival of survey teams. In addition, verbal consent to provide urine and stool samples was obtained from students selected for sampling in each school.

2.2 Data analysis

Raw data on each sample was collected on paper case report forms and entered by team leaders into Microsoft Excel. Once data was complete for each district, the files were sent via email to the university team in Sana'a along with hard copies by pouch. The results were then cross-checked by supervisors at the university with corresponding raw data sent from the field before the complete dataset was emailed to the SCI at Imperial College London. Cleaning and consistency checks were conducted prior to analysis for all sections of the data. Pivot tables were used to calculate average prevalence for *S. mansoni, S. haematobium, Ascaris, Trichuris*, hookworm and for mild, moderate and severe anaemia; along with crude confidence intervals at governorate and district level.

Maps of the prevalence of infection, with suitable cut-offs (Tables 3 and 4), were developed using QGIS 2.4.0-Chugiak (Open Source Geospatial Foundation Project), an open source Geographic Information System (GIS). GIS data for Yemen was obtained from the DIVA-GIS database (www.diva-gis.org/gdata), apart from data on district-level population distribution which was sourced from the Yemen MoPHP (http://www.mophp-ye.org/english/data.html). Additional maps on the estimated number of people infected in the country were developed using the MoPHP population data and calculated prevalence rates. As the population point data used dated back to 2004 (52), the population size was projected to expected levels in 2014 based on medium-variant projections by the United Nations (UN) (53).

Robust 95% confidence intervals (CIs) were generated using the statistical software R 3.1.1 (R Foundation for Statistical Computing, Vienna, Austria) with the R ‘survey’ package (T. Lumley (2012) "survey: analysis of complex survey samples". R package version 3.28-2). The CIs were calculated by district taking into account clustering at school-level, where each child was not considered as an independent data point. This analysis accounts for the fact that children from the same school would show less heterogeneity than children from different schools. If this was not accounted for, the CIs produced at the end of the analysis would be artificially narrow.

3 Results

3.1 Re-mapping Survey

In total, 80,432 school-aged children from 2,585 schools across 332 districts within all governorates were sampled in the survey (full list of total numbers sampled in Appendix 6). The entire process took approximately 13 weeks, commencing on the 23rd of February 2014 and completed at the end of May 2014. Of the 333 districts targeted initially, Wald Rabi' (district code 1415) from Al Bayda' governorate was not sampled owing to the unstable security situation in the area. Hence, a final total of 332 districts were sampled. In addition, due to unforeseen circumstances the sample size of children per district had to be reduced from 280 to 250. The proposed sample size was re-evaluated as a result of the hijacking of two vehicles on Ma'rib road, the means of transport for two teams that were carrying important supplies and equipment for the survey. There was an insufficient amount of equipment and resources to resupply both affected teams and ensure they could carry out sampling in their assigned districts. Replacement supplies had to be taken from other survey teams and therefore the sample size was cut (48).

Furthermore, in several of the targeted districts there were an insufficient number of schools present for sampling purposes. Many schools were not primary schools, had an inadequate number of students enrolled, were not functioning at all or were closed because of lack of security in the area particularly within Hadramawt, Al Mahrah, al Jawf and Ma'rib governorates. As a result, sampling was often interrupted. Lack of compliance and awareness of locals in targeted districts also impeded sample collection from female students in various schools (48). Nevertheless, data on age and sex were available for 80,361 of the sampled students of which approximately 60% were male. The ages of the students ranged from 5 to 19 years old, with a mean age of 12.5 (inter-quartile range (IQR): 9-11.5 years).

3.2 Prevalence

3.2.1 Schistosomiasis

The overall prevalence of any infection with SCH was 3.2% (range 0-38.9% by district); 0.71% (0-10.2% by district) for *S. haematobium* and 2.5% (0-35.7% by district) for *S. mansoni*. In general, male children had a marginally higher average prevalence of 3.3% compared to 3.0% in females. Levels of infection were low for a majority of the districts with more than a third (122 districts) of the country uninfected. No districts were classified as high-risk for any SCH infection, and only three fell into this category when the corresponding minimum risk threshold was lowered from 40% to 30%: Ash Shamayatayn (38.9%, 95% CI 26.2-52.8%), Mashra'a Wa Hadnan (32.3%, 95% CI 24.2-41.2%) and Sabir Al Mawadim (32.9%, 95% CI 23.8-43.1%), all from Ta`izz governorate (Table 8).

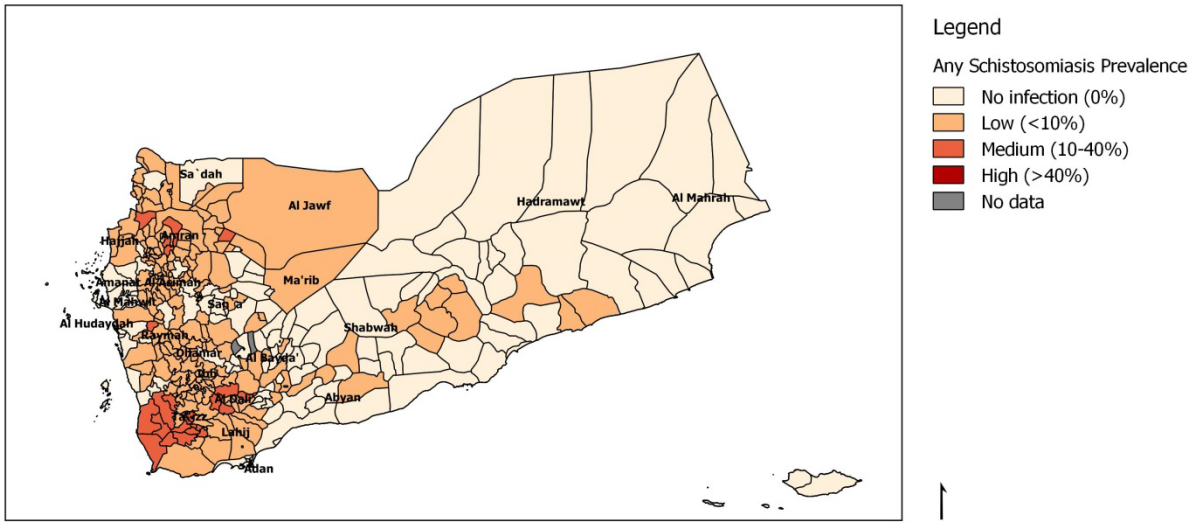
Table 8 : Classification of 332 sampled districts by risk category for schistosomiasis infection in Yemen

Category	Number of districts[a]	
	Standard thresholds	New thresholds
High-risk	0	3
Moderate-risk	25	22
Low-risk	185	185
Infected	**210**	**210**
Uninfected	122	122

[a]The standard thresholds used to classify the districts are ≥40% High-risk, ≥ 10% and <40% Moderate-risk and <10% Low-risk. For the new thresholds, high-risk districts are districts with an average prevalence of ≥30%.

Ta`izz, located in the southwest region of the country was where most of the infected districts were found (Figure 6). This region was an area where a generally higher population density (52, 53) is projected to be found within governorates such as Ibb, Al Hudaydah and Al Dali as shown in the map of the country's population distribution in Appendix 7. It was also within Ta`izz where two districts with the most severe infections with *S. mansoni* were located, namely Ash Shamayatayn (35.7%, 95% CI 22.7-50.4%) and Mashra'a Wa Hadnan (29.9%, 95% CI 22.7-37.9%).

A)



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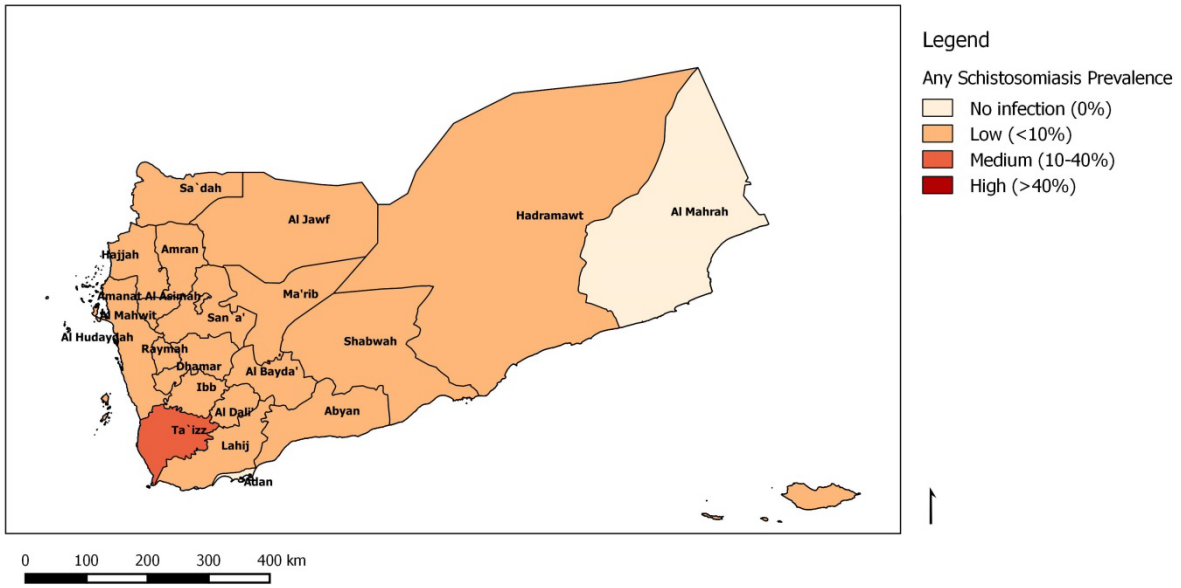


Figure 6: Prevalence maps of schistosomiasis infection at the A) District level and B) Governorate level in Yemen (2014)

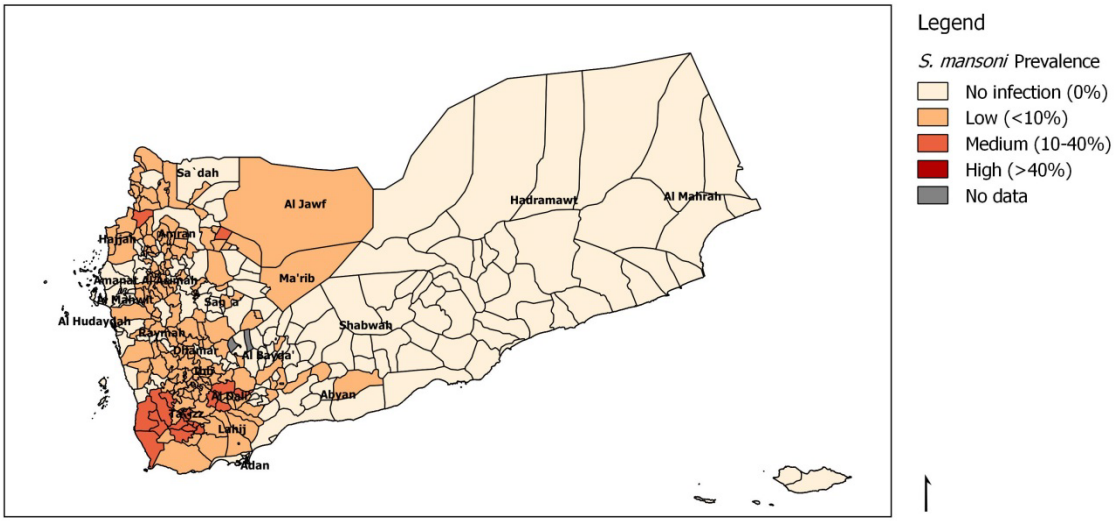
At 2.5%, *S. mansoni* prevalence was higher than that of *S. haematobium* with 75 more districts infected with the intestinal form of SCH (Table 9). Intestinal SCH was evident in the western region of the country (Figure 7) and had a larger number of moderate-risk areas, with the urogenital form spread across the southern region through Shabwah and Hadamawt governorates. The highest prevalence of urogenital SCH infection was within Habur Zulaymah district, Amran governorate, at 10.2% (95% CI 3.4-22.1%) prevalence. This district was the only moderate-risk district for this form of SCH infection in the country.

Table 9: Classification of 332 sampled districts by risk category for *S. mansoni* and *S. haematobium* infection in Yemen

Category[a]	Number of districts	
	S. mansoni	***S. haematobium***
High-risk	0	0
Moderate-risk	20	1
Low-risk	160	104
Infected	**180**	**105**
Uninfected	152	227

[a]Classification based on thresholds used in baseline mapping (≥40% High-risk, ≥ 10% and <40% Moderate-risk and <10% Low-risk).

A)



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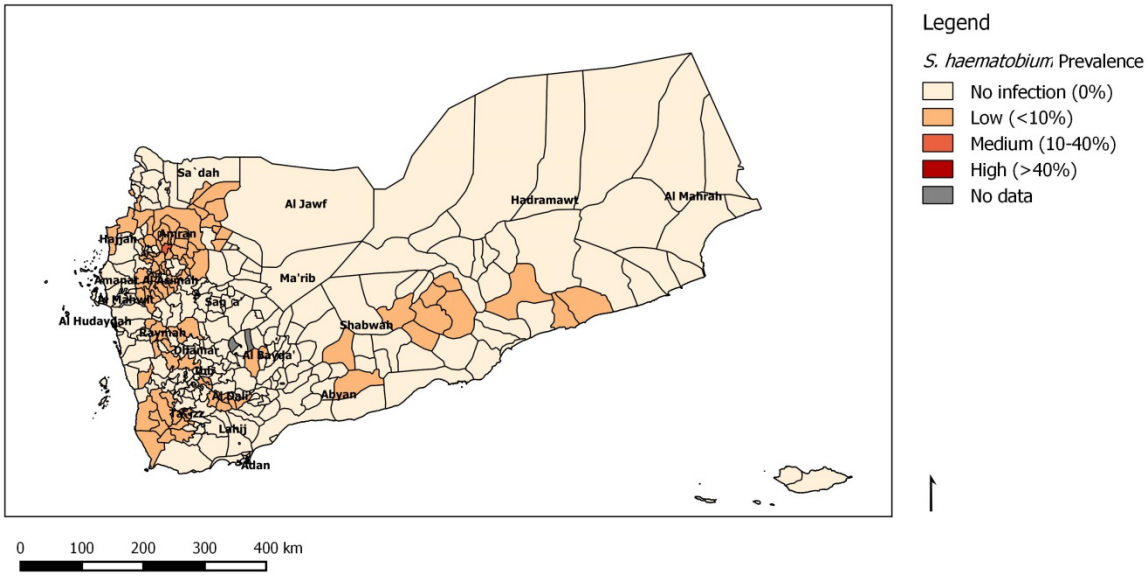


Figure 7: Prevalence maps of the distribution of A) Intestinal (*S. mansoni*) and B) Urogenital (*S. haematobium*) schistosomiasis infection in Yemen (2014)

3.2.2 Soil-transmitted helminths

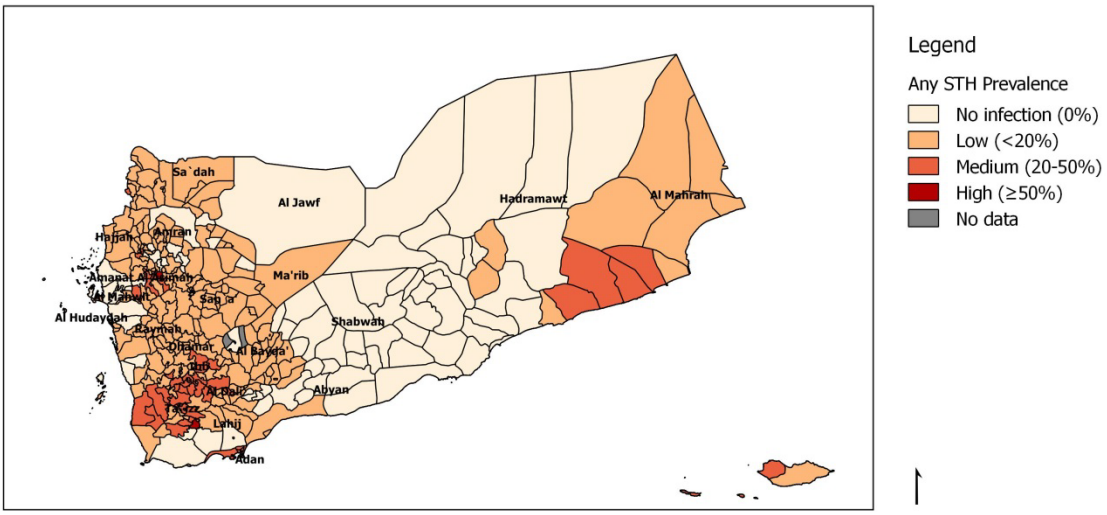
The overall prevalence of STH was 8.8% (range 0-60.3% by district), with female children having a higher prevalence at 10.2% compared to 7.8% in male children. A large majority of districts, namely 251 out of 332, were found to be infected with an STH infection (Figure 8). However, all 251 districts apart from two (Hayfan, prevalence 52.7% (95% CI 39.3-65.8%) and Maswar, 60.3% (95% CI 43.3-75.6%)) were classified under the standard low- or moderate-risk categories. Throughout the country the most common STH was *Ascaris*

(7.6%, range 0-52.7% by district), which contributed to most of the infection rates in the eastern region bordering Oman. *Ascaris* showed a distinct geographical pattern, affecting mainly the south-western and eastern governorates Aden, Ta`izz, Ibb and Al Mahrah (Table 10). *Ascaris* prevalence in Aden governorate was the highest average prevalence of all three STHs amongst the governorates. Furthermore, all 8 targeted districts within this governorate had overall STH prevalence rates above 24%, mainly due to *Ascaris* infection. Hence, *Ascaris* infection appeared to have a distinct influence on overall STH prevalence, driving rates up in many other districts as well (Figure 8). *Ascaris* covered more than two-thirds of the country, with 226 districts infected, and is the only STH with any districts classified under the standard high-risk category.

Table 10 : Average prevalence of *Ascaris* infection in four governorates in Yemen

Governorate	Prevalence (%)	
	Average	Range (by district)
Aden	30.9	24.1-30.2
Al Mahrah	20.0	7.4-33.9
Ibb	20.7	10.6-36.8
Ta`izz	23.7	7.2-52.7

A)



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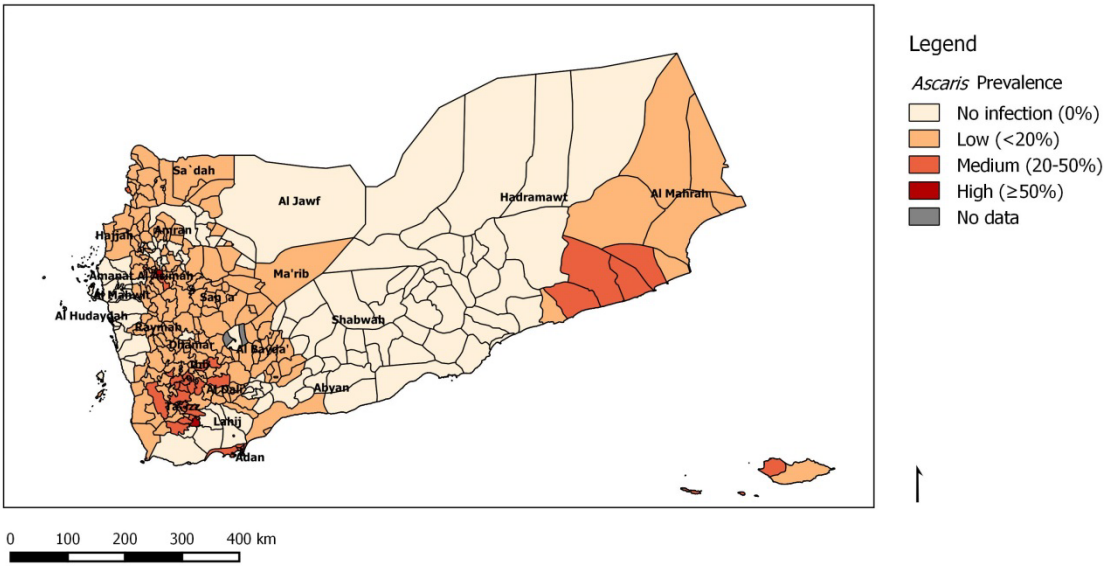


Figure 8: Prevalence maps of the distribution of A) Any soil-transmitted helminth and B) *Ascaris* infection in Yemen (2014)

In comparison, Hookworm and *Trichuris* prevalence were comparatively low with a nationwide average of 0.1% (range 0-8.4% by district) and 1.5% (range 0-33.2% by district) respectively. Al-Mahwit governorate experienced the highest average prevalence of both STHs in the country with 2.1% for Hookworm and 6.2% for *Trichuris.* Within Al Mahwit governorate, Al Mahwait district had a consistent, although low, prevalence of each form of STH: 12.8% *Ascaris* (95% CI 2-26.6%), 17.6% *Trichuris* (95% CI 3.9-43%) and 8.4% Hookworm (95% CI 2.3-20.3%) with an overall 29.2% (95% CI 8.5-59.4%) of its population infected with at least one STH. In contrast, Maswar district (Amran governorate), with the highest overall prevalence of STH (60.3%, 95% CI 43.3-75.6%) had the highest prevalence of *Trichuris* infection at 33.2% (95% CI 17.1-52.8%), but a distinctly

low Hookworm prevalence (0.36%, 95% CI 0-2.6%). Only 30 districts, all of which are classified under the standard low-risk category, are infected with Hookworm (Table 11).

Table 11 : Classification of 332 sampled districts by risk category for three STH infections in Yemen

Category[a]	Number of districts					
	Ascaris		*Trichuris*		Hookworm	
	Prevalence[b]	Upper Limit[c]	Prevalence[b]	Upper Limit[c]	Prevalence[b]	Upper Limit[c]
High-risk	2	9	0	3	0	0
Moderate-risk	38	72	5	13	0	1
Low-risk	186	145	144	133	30	29
Infected	**226**		**149**		**30**	
Uninfected	106		183		302	

[a]Classification based on WHO recommended thresholds (≥50% High-risk, ≥20% and <50% Moderate-risk and <20% Low-risk) (10).
[b]Districts were classified based on the prevalence of each STH separately by district.
[c]Districts were classified based on the upper boundary of the 95% confidence interval calculated for the prevalence of each STH by district.

3.2.3 Anaemia

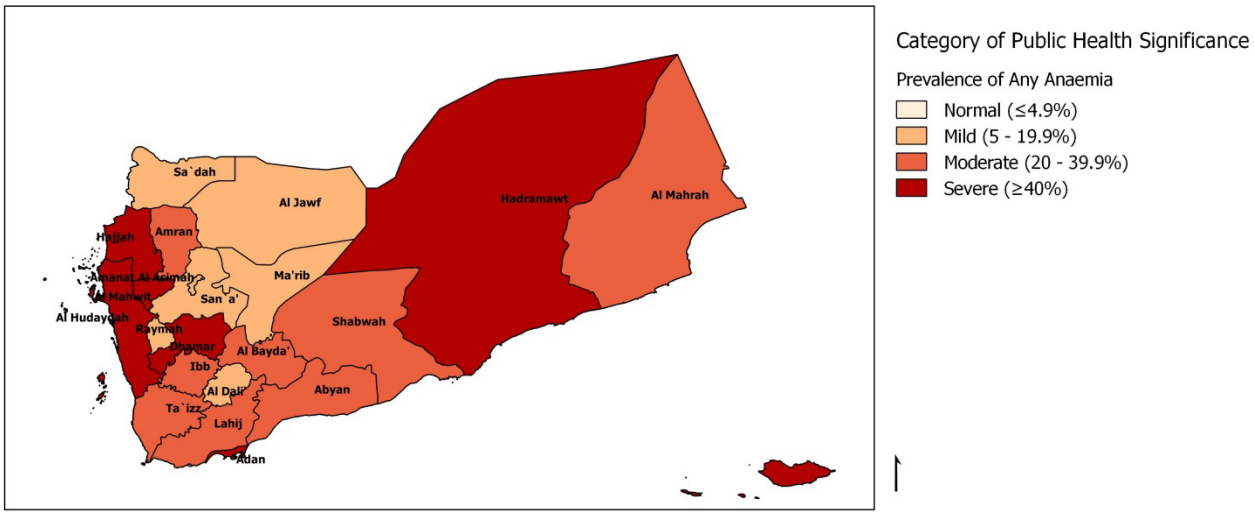
Anaemia was found to be a major problem in Yemen where over a quarter of the districts in the country were classified under severe public health significance (prevalence ≥40%) (Table 12). The entire country, apart from those living in 12 districts, were recorded as suffering from anaemia based on the results of the survey with an average prevalence of 30.5%. The maps in Figure 9 below show that the distribution of anaemia was widespread, and affected much of the western and central regions. Bani Qa'is, Hajjah governorate and Al Khabt, Al Mahwit governorate were the districts with the highest prevalence of anaemia at 98.8% (95% CI 94.7-99.9%, mean haemoglobin 104g/L, range 71-119g/L) and 96.4% (95% CI 91.3-99.0%, mean haemoglobin 106g/L, range 80-118g/L) respectively.

Table 12: Classification of 332 districts by category of public health significance of the prevalence of any anaemia in Yemen

Category	Prevalence of Any Anaemia[a] (%)	Number of districts[b]
No anaemia	≤ 4.9	12
Mild	5.0 - 19.9	112
Moderate	20.0 - 39.9	120
Severe	≥ 40	88
Total affected		**320**

[a]WHO guidelines by category of public health significance for prevalence rates obtained via estimation of haemoglobin concentrations in populations (45).
[b]Districts were classified based on prevalence of any anaemia (mild, moderate and severe) in each district.

A)



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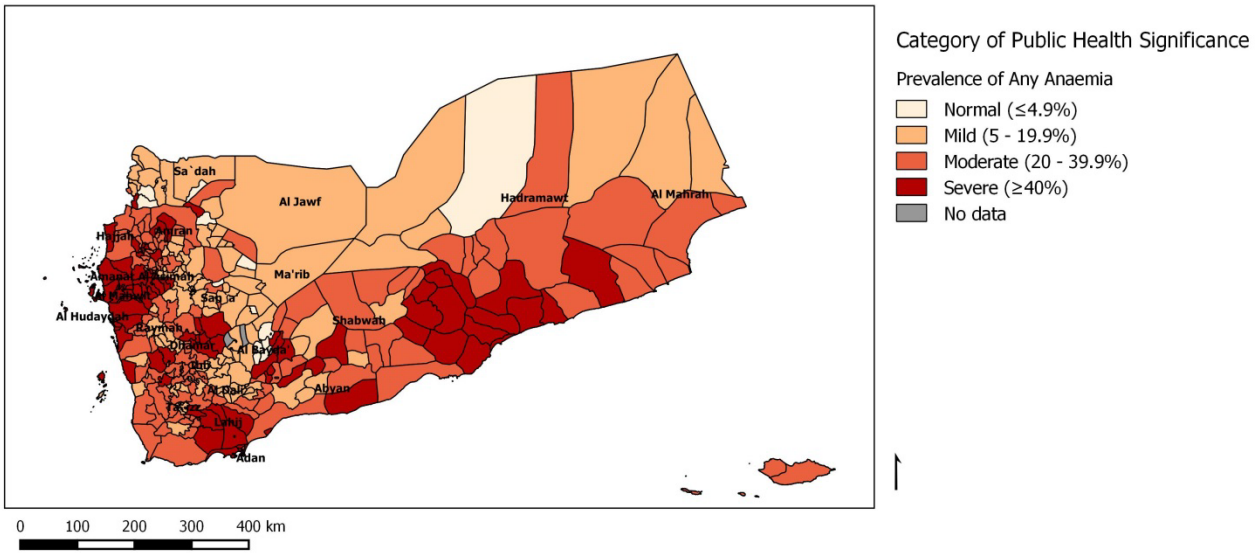

Figure 9: Prevalence maps of the distribution of anaemia at the A) Governorate level and B) District level in Yemen (2014)

Located along the coastline at the south-west of Yemen, Aden governorate had an average prevalence of 44% and was where not one district had a prevalence lower than the national average (range 38.0-49.4% by district). Of major concern however, was Al Mahwit governorate with a nearly 100% prevalence (92.8%). Al Mahwit far exceeded the prevalence of its bordering governorate Al Hudaydah, which, while ranked the second most prevalent governorate, had a prevalence that was over 40% lower (46.2%, range 13.9-82.3% by district). The public health significance of anaemia in Al Mahwit is hence extremely high especially compared to that of Al Hudaydah as every district had a prevalence of more than 80% (range 85.0-96.4% by district).

The prevalence of severe anaemia (haemoglobin concentration <80g/L) (45) was also analysed and it was discovered that just under half of all 332 districts in the country were affected by the severe form of this disease. Average prevalence of severe anaemia was 0.42%, affecting more than 100,000 people. Districts with severe anaemia were distributed throughout Yemen (Figure 10) including within Hadramawt and Al Jawf governorates in the northern regions of the country. Ain district, in Shabwah governorate, reported the highest prevalence of severe anaemia at 7.8% (mean haemoglobin 115g/L).

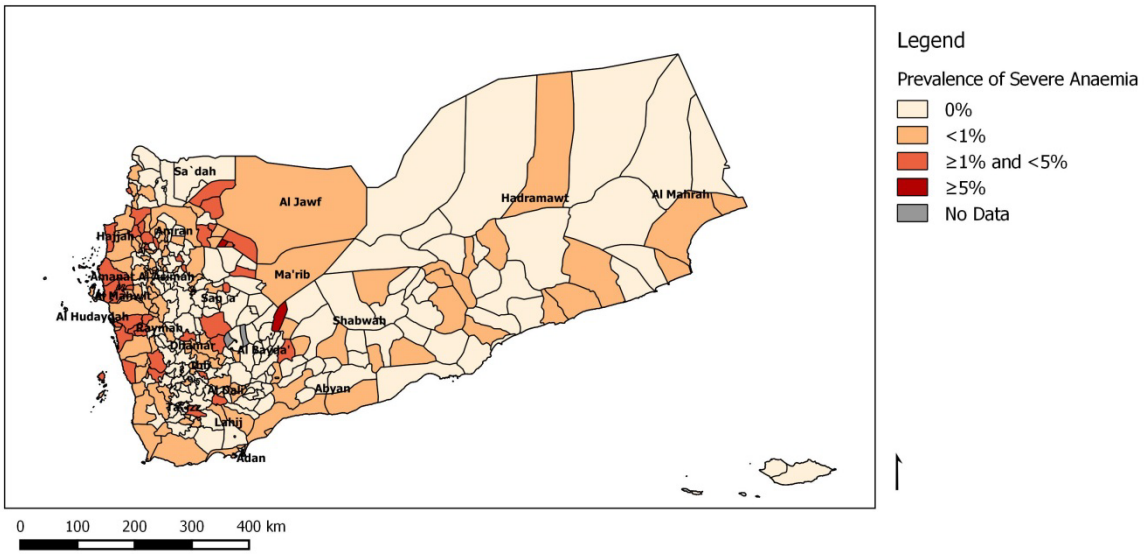

Figure 10: Prevalence map of the distribution of severe anaemia in Yemen (2014)

The complete list of districts and governorates and their corresponding prevalence of SCH, STH and anaemia is provided under Appendix 8. All prevalence maps not shown are listed under Appendix 9.

4 Discussion

To ensure successful and cost-effective control of the NTDs, it is essential that the distribution and prevalence of each disease is clearly understood for planning and implementation of large-scale control programmes. This is crucial, especially with the increased frequency and focus on disease control following the 54th World Health Assembly resolution WHA54.19 in 2001, where member states agreed on the said resolution to treat at least 75% of school-aged children regularly with PZQ and ALB for SCH and STH respectively by 2010 (54). The National Schistosomiasis Control Programme (NSCP) in Yemen is a great example of the integration of disease control within the country's own health-delivery system. Clear communication and coordination of the main institutional contributors who implement control efforts, in this case, the Yemen MoPHP and Sana'a University, have allowed Yemen to overcome various operational challenges that are faced by other countries striving to implement such programmes (55). The integrated mapping of the NTDs is an important tool in the aim for control of morbidity and elimination in geographical areas where co-endemicity is common and there exists a widespread overlap of disease distribution (56). In the recent prevalence re-mapping survey conducted in Yemen, various assessment methods were integrated into a single survey methodology for the diagnosis of SCH, STH and anaemia amongst school-aged children nationwide – one of few that have been conducted in this region. Results obtained from the survey provided a clear view of the progress and changes in the distribution of infection from those at baseline in 2010, highlighting the importance of re-mapping surveys in the context of NTD control.

Overall, the survey showed a significant reduction in the number of infected districts from 2010, with 64 fewer districts now harbouring any SCH infection and an average prevalence of 3.2% (Table 13). This decrease is a notable achievement, with no longer any districts classified as high-risk and 86.3% fewer districts moderate endemic, many of which are now either low endemic or free from infection. Even with a reduced threshold of ≥30% instead of ≥40% for high-risk prevalence, only 3 districts from Ta`izz governorate fell into this category with borderline moderate endemicities. Furthermore, the number of infected districts classified as low-risk has increased from 41 (14.9%) in 2010 (24) to 186 (88.2%) in 2014 showing that most of the country is now categorised as having low infection levels.

Table 13: Classification of sampled districts in 2010 and 2014 prevalence mapping surveys by risk category for schistosomiasis infection in Yemen

Category	Number of districts[a]		
	2010	2014[b]	
		Standard thresholds	New thresholds
High-risk	51	0	3
Moderate-risk	183	25	22
Low-risk	41	186	186
Infected	**275**	**211**	**211**
Uninfected	58	121	122
Total	**333**	**333**	**333**

[a]The thresholds used for 2010 and 2014 are ≥40% High-risk, ≥ 10% and <40% Moderate-risk and <10% Low-risk. For the new thresholds, high-risk districts are districts with prevalence rates of ≥30%.
[b]Wald Rabi' district that was not sampled was classified as low prevalence (<10%) based on the prevalence of neighbouring districts.

As with the 2010 survey, infection levels remain higher in the western side of Yemen, with reductions in the northern Sa`dah and Hadramawt governorates and the eastern part of the country mostly free of infection. In these larger governorates, however, there is a risk that communities in far-out, rural areas harbouring high infection levels may have been missed and not accounted for in average prevalence rates. Wald Rabi' district in Al Bayda' governorate, which was not sampled due to security reasons in the area, was classified as of low prevalence (<10%) based on the prevalence of surrounding districts for the purposes of comparison with baseline. This assumption should be treated with caution as SCH is a highly focal disease and control needs to be targeted on a community by community basis (34) and hence this may not be an accurate representation.

When comparing the prevalence of the two SCH species in the prevalence re-mapping survey, *S. mansoni* appears to be marginally more common than *S. haematobium.* The prevalence of the intestinal form was higher by approximately 1.8%, with a greater maximum district prevalence of 35.7% compared to 10.2%. Previous studies have been conflicting - a 2013 survey in Yemen amongst 400 school children from Ta`izz, Ibb, Dhamar, Sana'a and Al Hudaydah governorates found that *S. haematobium* was more

prevalent, accounting for 75% of the reported infections (57). On the other hand, another study amongst children from Ta`izz governorate indicated that *S. mansoni* was more common at 20.7% compared to 7.4% for *S. haematobium* (58). An older study by Raja'a and colleagues in Ibb in 2000 found similar results (59). The distribution of each form of SCH was similar to baseline results (Figure 11), where intestinal SCH was more prevalent in western governorates with some urogenital SCH infection found in central, southern districts.

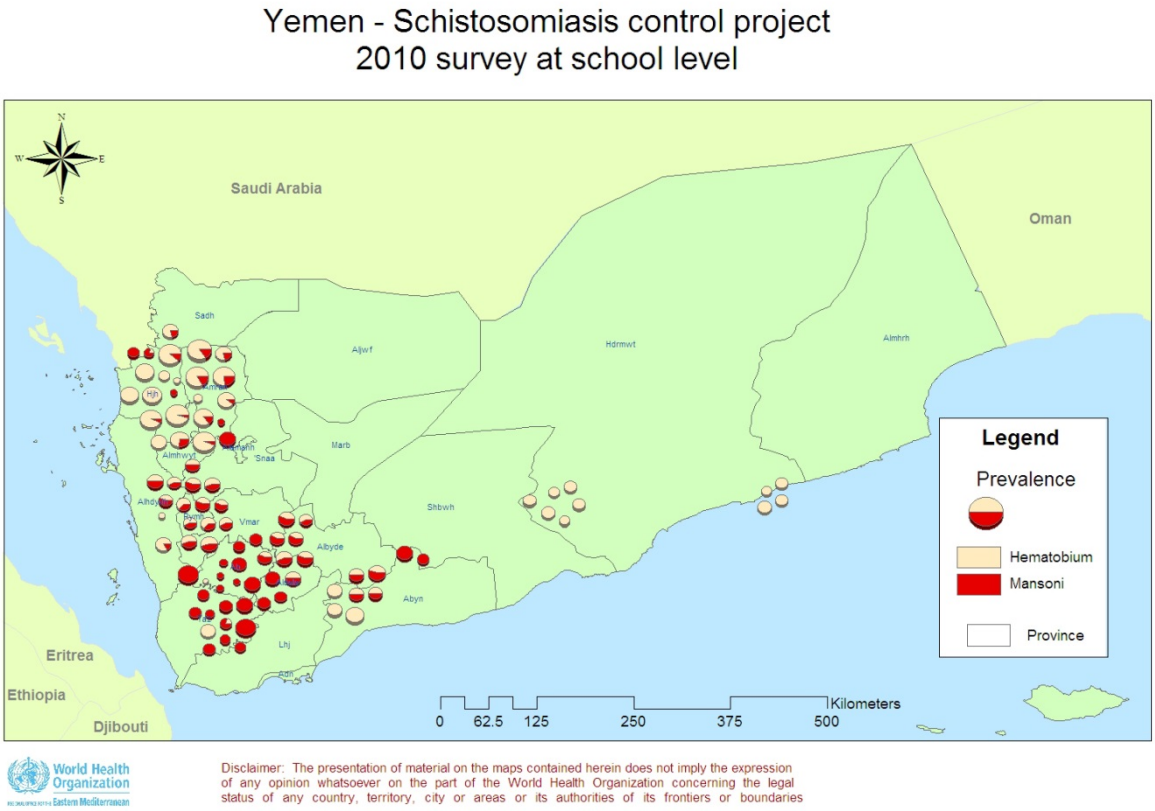

Figure 11: Prevalence map of *S. haematobium and S. mansoni* infection in Yemen in 2010 (French, M. *pers. comm.* (37))

Compared to SCH, STH infection is prevalent in more districts at 251 compared to 211 with SCH infection. Most of the infected districts were classified as low-risk for STH infection with only two high-risk districts in Amran and Ta`iz governorates (Table 14), both with a prevalence of more than 50%. In general, STH infection affected most populations residing within Ta`izz, Ibb, Aden, Al Dali and Al Mahwit governorates as shown in the map below (Figure 12) where more than 20,000 people were estimated to be infected with one of the parasitic worms.

Table 14: Classification of 332 sampled districts by risk category for STH infection in Yemen

Category[a]	Number of districts	Number of districts by Upper Limit[b]
High-risk	2	14
Moderate-risk	51	83
Low-risk	198	154
Infected	**251**	**251**
Uninfected	81	81

[a]Classification based on WHO recommended thresholds (≥50% High-risk, ≥20% and <50% Moderate-risk and <20% Low-risk) (10).
[b]Districts were classified based on the upper boundary of the 95% confidence interval calculated for each district.

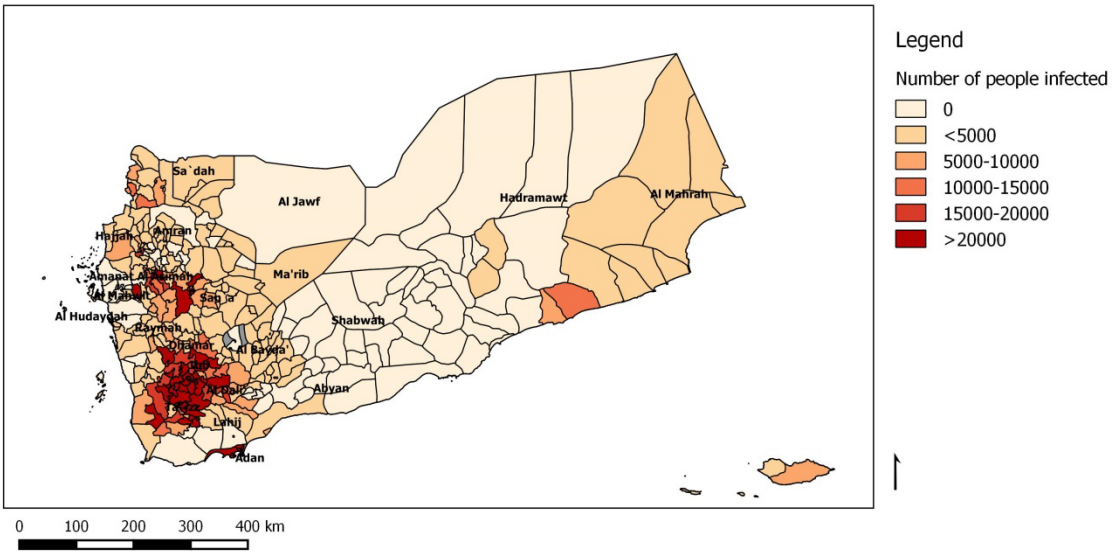

Figure 12: Map of the distribution of the population infected with STHs in Yemen (2014)

For the estimation of the number of people infected by district, population sizes used for this analysis were projected from population point data collected in 2004, where the population size was 19.5 million, to nearly 25 million in 2014 based on medium-variant projections by the United Nations (UN) (53). A projected growth of 27.7% was applied to the population size of each district to obtain numbers that were more comparable to current figures. A 2014 census was recently completed in Yemen and would have provided more up-to-date population figures, but the data was not available at the time of

the present study. Hence, the projected numbers were estimates as population growth would likely vary by district.

Co-endemicity of the two NTDs as well as co-infections with both species of SCH was found throughout the country up to district level, indicating the need for more specific, targeted approaches for integrated disease control. Geographical overlapping of STH and SCH infection was evident in the western region with high levels in Ta`izz governorate. On the contrary Al Mahrah and some parts of Hadramawt governorate, including Socotra Island, in the east were disproportionately affected by STH infection. Central regions surrounding Shabwah governorate had higher levels of *S. haematobium* infection than either *S. mansoni* or the STHs. Of particular note, *Ascaris* appears to be influencing the distribution of STH infection as its prevalence by district is generally much higher when compared to *Trichuris* or hookworm infections, indicating a need to focus on the reduction of this STH. *Ascaris* infection in Yemen has been known to be especially high – Yemen was previously estimated to have the second highest prevalence of this parasite, behind Egypt, among countries in the Middle East and North Africa (MENA) region (Figure 13). Moreover, throughout the MENA region *Ascaris* was the most common NTD, followed by SCH and *Trichuris* (19, 60). Such findings are worrying as heavy infections with *Ascaris* and the rest of the STHs lead to substantial morbidity, including reductions in work capacity and cognitive development as well as increases in child and maternal mortality (10).

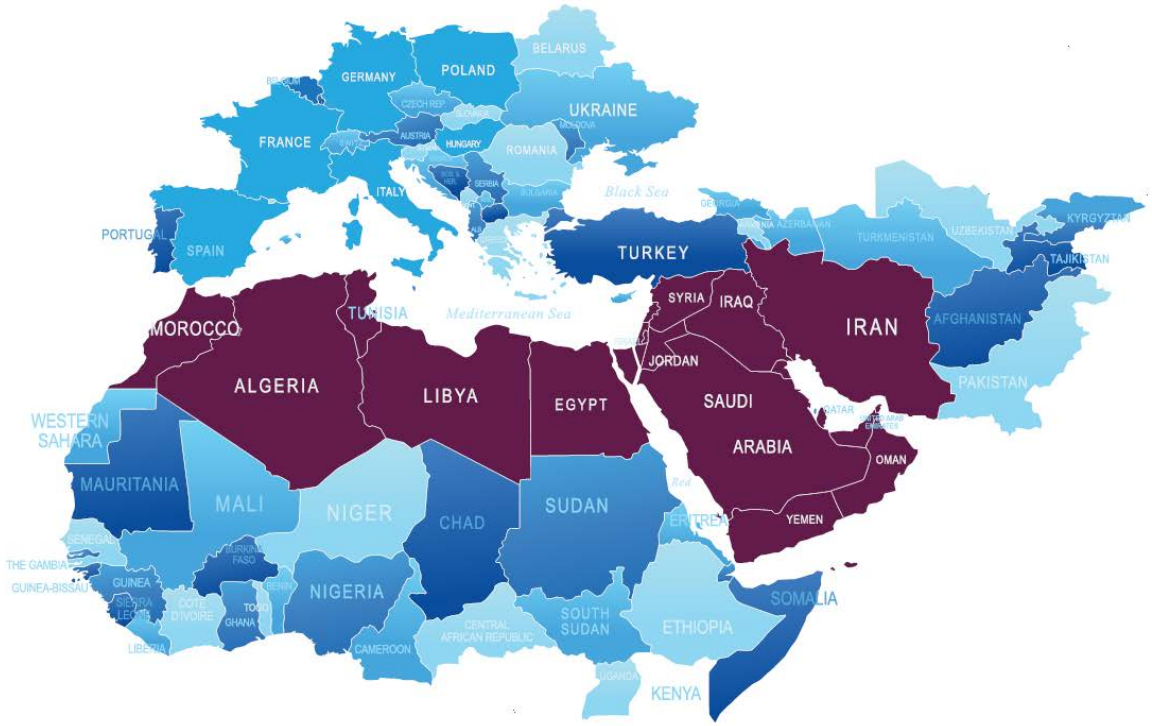

Figure 13: 'Map of the countries within the Middle East and North Africa (MENA) region' (highlighted in purple) ((19):p.2)

The findings of the present study showed that the average prevalence of SCH is approximately 0.3% higher in males than in females, with a wider gap between the sexes for STH in which females are more commonly infected (Table 15). The higher prevalence of SCH amongst male children were consistent with values found in studies from different countries (59, 61-63), although the opposite was reported in other studies (64, 65). Such findings may be related to different frequencies of water contact, behaviour, religious reasons and education levels. Although males would have had more contact with water via activities and games, females would be exposed whilst carrying out domestic activities such as washing clothes and collecting water (57).

Table 15: Average prevalence of schistosomiasis, STHs and anaemia amongst male and female school-aged children in Yemen

Sex	Average prevalence[a] (%)		
	SCH	STH	Anaemia
Male	3.3	7.8	30.1
Female	3.0	10.2	31.0

[a]Prevalence rates amongst a total of 31,425 females (39.1%) and 48,936 males (60.9%).

The remapping survey provided the first nationwide estimation of anaemia prevalence in Yemen amongst school-aged children. Anaemia has been significantly associated with SCH infection, along with reduced productivity and undernutrition (66). High levels of SCH prevalence and intensity are often found amongst 10 to 15 year olds, which may be a contributory factor to anaemia in this age group where there is a high iron demand for growth and development (67). Survey results on the distribution of anaemia in Yemen were alarming, with anaemia covering most of the country and leaving only an estimated 12 out of 332 districts with no anaemia (prevalence of <5%). One in three school-aged children in Yemen were estimated to be suffering from anaemia, having haemoglobin concentrations of at least less than 130g/L for males and less than 120g/L for females where the cut-off points vary with age (45-47). Districts such as Bani Qa'is in Hajjah governorate had an anaemia prevalence of 98.8%, meaning generally all students sampled in this district were anaemic.

According to data from the WHO (68), anaemia in Yemen has been classified previously as a severe public health problem amongst preschool-aged children, pregnant women and non-pregnant women of reproductive age. Such high levels of anaemia in the country have implications on the increased risk of maternal and child mortality (68), especially in the case of severe anaemia (0.42% prevalence). In this context, anaemia was likely related to several mechanisms that would have exacerbated the condition namely a high parasite burden, iron-deficiency caused by blood loss due to helminth infections, inflammation and chronic conditions such as HIV and poor nutrition. Singling out one cause is difficult, especially with overlapping infections in developing countries such as Yemen, where widespread prevalence of co-infections and nutritional deficiencies are present (41). These data are highly relevant to inform other public health programmes in the country and they provide an indication towards the interventions that need to be carried out to address the dangerously high levels of anaemia.

The present study did not focus on measuring changes in the intensity of infection to minimise the time and resources required. Instead, an impact evaluation study was implemented alongside the main treatment programme to identify any changes in the burden of infection and relevant health markers following treatment. Initial analysis of samples collected showed a significant decrease in the prevalence of any SCH infection following two rounds of treatment from 19.8% to 8.3%. Furthermore fewer than 4% of the samples harboured heavy infections, which was a positive result as those suffering from a

high burden of infection were more likely to develop severe morbidity (24, 30).

4.1 Limitations and recommendations for improvement

Throughout the re-mapping survey, 25 teams travelled all over the country to collect samples from schools in targeted districts, many of which were in remote locations that lacked security, were often dangerous, and difficult to reach. Hence the sampling process was not free from a variety of setbacks and challenges. A major obstacle arose at the very beginning of the survey when two vehicles were hijacked, leading to loss of sampling equipment. As the mapping progressed many other teams faced similar situations. For example, in Al-Jawf governorate gunshots were fired at one team, and in Sa'dah and Ma'rib governorate teams could not sample schools in several districts due to tribal prevention.

In addition, teams had to travel long distances from each school even within each district, especially in larger governorates such as Hadramawt, Al Mahrah, Shabwah and Socotra Island. Difficult terrain in governorates such as Amran, Ibb and Raymah, where altitudes exceeded 2000m above sea level (Figure 14), could not be navigated using the vehicles transporting the teams. Teams therefore took longer than anticipated to reach these schools, posing a challenge to complete the surveys within the set timetable. Internet access in such areas was also often limited making it hard for teams to send electronic data to supervisors. Furthermore, equipment used for sample testing, such as microscopes, sample containers and testing kits such as Kato-Katz were occasionally either damaged or of poor quality.

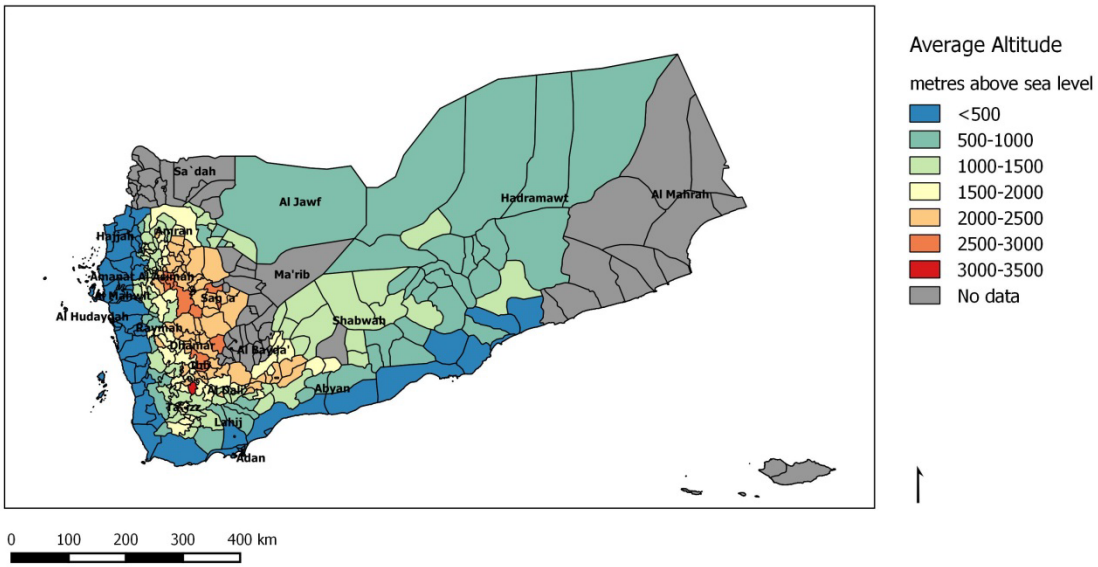

Figure 14: Map of the average altitude by district in Yemen based on re-mapping survey locations (2014)

In terms of administrative problems, assigned facilitators from the health and education sector and accountants needed to pay for necessary services were not available in some areas to provide notification to schools before teams arrived for sampling. There were also objections to the schools selected by the SCI for sampling, which assigned facilitators believed would not give an accurate representation of the prevalence of infection in the district (48).

All these issues could have been avoided, and should be taken into account during the planning process of subsequent prevalence mapping projects. More attention should have been made to early procurement planning; including ensuring that supplies are of high quality and are available in adequate amounts to guarantee that there will be sufficient stock in the case of damaged or lost supplies. Assigned facilitators and accountants, or any additional teams contributing to the surveys should be monitored closely and briefed in detail on the mapping process to avoid any unnecessary setbacks to sample collection. Most importantly, communities involved in the survey should be given more adequate information on the purposes of the study and its importance via community awareness campaigns in the targeted districts before the survey is carried out (2).

Furthermore, spatial data on the distribution of rivers and water bodies from the online DIVA-GIS database may not have provided adequate detail on the presence of water sources in Yemen. Commonly used water sources such as water pools and watering holes in Yemen are often not detected. Such water sources which are usually located close to

residential areas provide favourable breeding sites for the intermediate snail hosts of SCH (6). The presence of different snails species has an influence on the geographic distribution of SCH (57) and are useful indicators for the prediction of areas suitable for disease transmission. However, maps of overall distribution of water bodies and that of only perennial water bodies (Appendix 10) developed using available data would have overestimated and underestimated the distribution of usable water sources in Yemen, respectively. This complicates the situation in Yemen as it is more difficult to assess the overall impact of such environmental factors on SCH transmission. The identification of such transmission ‘hot-spots’ is becoming ever more important in light of the transition from control to elimination of infection (69).

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4.2 The road to elimination

In May 2001, the World Health Assembly resolved to treat at least 75% of school-aged children by 2010 (27). In Yemen, the re-mapping survey has found that approximately 950,000 individuals are infected with SCH especially in the western region (Figure 15). This number is a substantial decrease from baseline, where it was estimated that over 3 million people were infected (18). Based on the achievements of the recent control programme, it is clear that implementation of large-scale infection control is feasible as well as effective in the country. Surveys focussing on prevalence re-mapping and impact evaluation have shown that the NSCP has successfully reduced the geographical distribution and intensity of SCH and STH infection in the country, where 55.6% of districts are now classified as low-endemic compared to 14.9% at baseline. The prevalence of heavy and medium intensity infections have also significantly decreased.

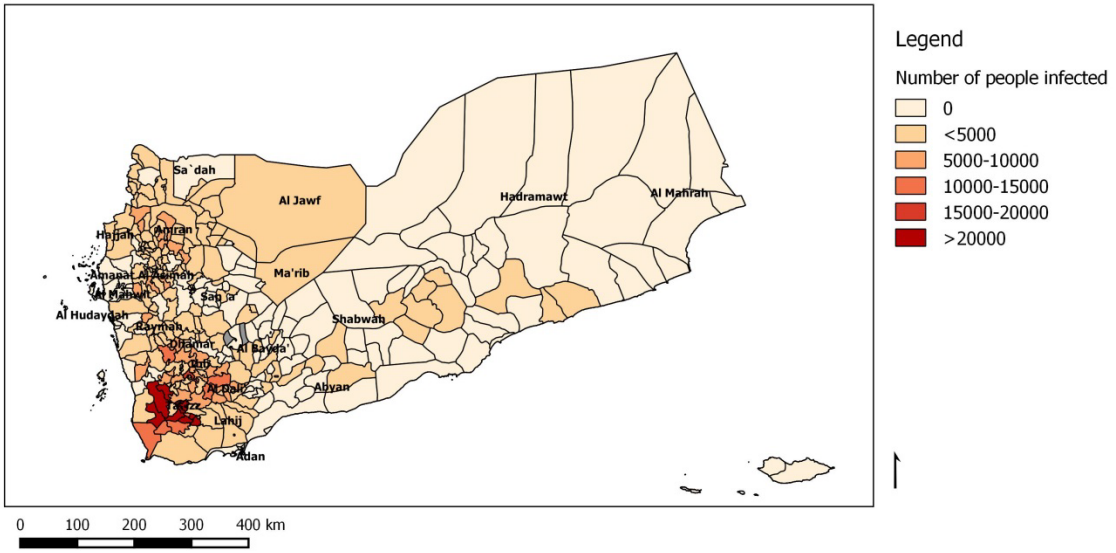

Figure 15: Map of the distribution of the population infected with schistosomiasis in Yemen (2014)

The NSCP has so far focused upon the control of morbidity due to SCH infection (20), and these positive results indicate that the programme has successfully reached this primary aim in most of the country before its slated completion in 2015. The programme can now look towards the elimination of SCH as a public health problem and hence the potential extension of the programme beyond 2015. Elimination of an NTD as a public health problem is not true elimination and is generally defined as achieving a prevalence of heavy-infections of less than 1% in all sentinel sites (42). This aim follows WHO recommendations, including the goals for global elimination of SCH and STH in the WHO Roadmap for Implementation (42) for 2020 and 2025. According to this report, elimination of *S. haematobium* is possible for countries within the same region as Yemen (WHO Eastern Mediterranean Region) including Saudi Arabia, Egypt, Libya and the Syrian Arab Republic. In Yemen, the prevalence re-mapping survey has found that elimination as a public health problem has already been accomplished in governorates such as Aden and Abyan, and will likely be achieved in other areas by the end of the programme's run. In order to maintain this level of disease control, ongoing control measures are vital, such as the identification of remaining pockets of infection in low-endemic districts, especially in rural areas, which will be a challenge in Yemen. Strengthened surveillance systems, accurate prevalence mapping and efficient and cost-effective testing methods are important (34) for the identification of any remaining areas that are in need of interventions. Accurate assessment of the epidemiological situation will become more crucial as the programme progresses from morbidity to transmission control (69).

Eventually, true elimination, that is, the elimination of transmission, can be aimed for in this country, with the possibility of extending the control programme beyond its set end date. This extension would likely be for at least another 5 years for the implementation of intensified preventive chemotherapy (24). Before that, preventive chemotherapy via MDA should be maintained and ensured that it is reaching all those who need it and more. To achieve this, it is important that strong advocacy is present and sufficient funding and supplies of necessary drugs are available. One round of treatment with preventive chemotherapy for subsequent years of the Yemen NSCP was estimated in the present study to cost over $2.8 million at $0.51 per capita (Table 16). This amount would cover more than 5.5 million people within the 210 infected districts classified based on infection prevalence. If the drugs needed for treatment were donated to Yemen as they are in sub-Saharan Africa (21), this cost would drop by nearly 50% to just under $1.5 million ($0.27 per capita). The cost of treating only those who are estimated to be infected (286,114 people) is approximately $145,000 ($77,000 excluding drug costs), although this total does not include the costs of extra diagnosis that would be needed to identify infected people. In addition, active surveillance is required to monitor for possible re-emergence of infection, in particular within areas where disease transmission is known to persist despite public health interventions (70). Such activities are vital as infections have been found to rebound to baseline levels (before treatment was undertaken) within approximately two years (71, 72), and may result in more severe morbidity in affected communities (73).

Table 16: Total costs for one round of treatment with preventive chemotherapy in Yemen

Population[a]	Number of people needing treatment	Total cost[c] ($)	
		Including drugs	Excluding drugs
All[b]	5,510,818	2,810,518	1,487,921
Infected only	286,114	145,919	77,251

[a]Based on standard district classifications for schistosomiasis (Table 8). Only the school-aged population (5-15 years old) from low/moderate-risk districts will be treated. For high-risk districts, the entire population will be treated. Population figures for 2014 were based on medium-variant projections by the United Nations (UN) (52, 53).
[b]Includes infected and uninfected people.
[c]Covers MDA and logistical costs along with costs of the appropriate dosage of PZQ and ALB/MBD for a total of $0.51 per person including drugs, and $0.27 per person excluding drugs. Total costs are rounded up to the nearest dollar.

More holistic approaches are crucial to aid in breaking the disease cycle and moving towards elimination of the NTDs. According to WHO recommendations (42, 70), these 'complementary' interventions include preventive chemotherapy, intermediate host control and the provision of safe Water, Sanitation and Hygiene (WASH). The NSCP have been preparing for the implementation of snail control in Yemen with training in the approaches for snail control in Zanzibar where a trial control effort has been taking place (24). Educational interventions focusing upon WASH need to be strengthened to increase awareness of the presence of the NTDs, their mode of transmission and how infections can be avoided. Integrating WASH in control efforts will contribute to reductions in exposure and transmission of STH (74) and SCH (75), which are particularly difficult to eliminate in poor communities with inadequate water and sanitation facilities (76). In Yemen water provision has often been lacking (57), especially within schools, and only 34% of rural communities in Yemen were estimated to be using improved sanitation facilities in 2012 (77). It is imperative that such poor conditions are addressed as a 90% coverage of sanitation facilities, which are properly built, utilised and maintained, is needed in order to influence STH transmission (78). Therefore these sustainable interventions should be incorporated, with the aim of improving living and environmental conditions and producing a change in risky behaviours. With that, ongoing transmission and the likelihood of reinfection (49) can be prevented for the benefit of the population.

A main characteristic of the NTDs is their close association to poverty and development and their tendency to cluster geographically (79). In the future, different disease control programmes could be integrated where possible, especially in cases where diseases are co-endemic (55). In Yemen, interventions under national programmes for onchocerciasis and malaria (80) could potentially be co-implemented with those under the NSCP to take advantage of shared activities and target areas. For example, the integration of measures such as preventive chemotherapy, bed nets for malaria control as well as micronutrient distribution to treat undernutrition and anaemia (55). However, with differing programme goals, institutional contributors and funding mechanisms, the implementation of these activities will likely be complex and difficult. Therefore, strong advocacy, political will, communication and coordination, as demonstrated by the NSCP in Yemen, will be important if co-implementation were to take place successfully.

5 Conclusions

The results of this report highlight the success of the national control programme for SCH and the STHs in Yemen and brings to light important issues that need to be addressed, in particular the alarmingly high prevalence of anaemia throughout the country. Urgent measures need to be taken to assess and appropriately treat the various aetiologies of this disease. Overall, the prevalence re-mapping survey is an example of an efficient integrated approach for the assessment of disease distribution. As the programme transitions from control of disease morbidity to elimination, careful planning needs to be undertaken as the focus shifts towards the control of transmission and surveillance, which would require higher costs, greater expertise and adaptation of current diagnostic methodologies and public health interventions. Community awareness and education on WASH and improved living conditions are necessary interventions that should be included alongside preventive chemotherapy. Over the last 3 years of the programme the Yemen NSCP has been a great example of a coordinated control effort with a clear aim and strategy and strong governance and political will to see the programme through. Such continued support will be vital as the programme moves forward with the hope of halting NTD transmission and morbidity and alleviating suffering nationwide.

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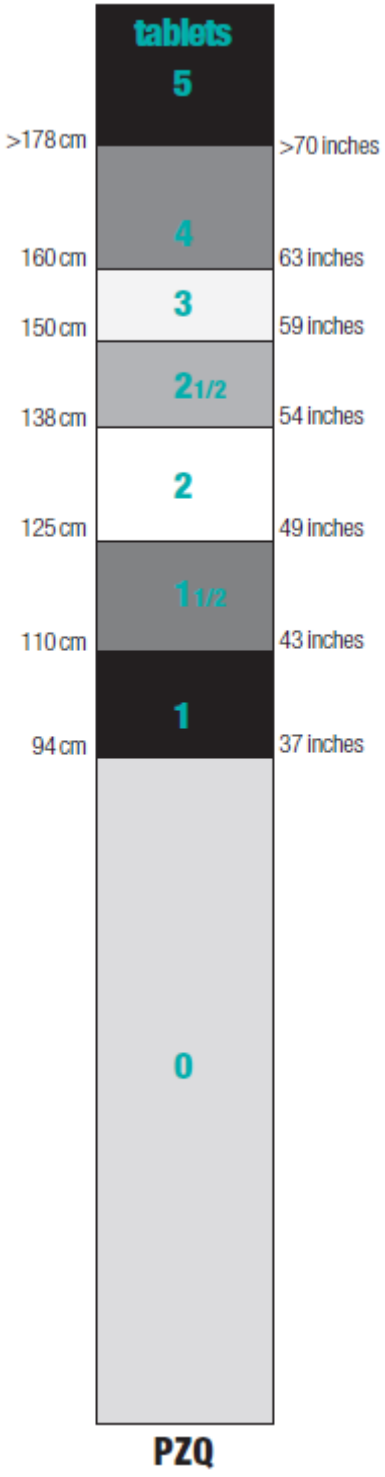
7 Appendices

Appendix 1: Recommended dose-pole for the mass drug administration of praziquantel for treatment of schistosomiasis



Source: WHO, 2006 ((2):p.50)

Appendix 2: Targeted districts and dates on which teams started the re-mapping survey in Yemen

Team No.	Districts within the governorates targeted for PM surveys by each team	No. of districts to survey per team	Date dispatched to field
1	Amanat Al Asimah[a]	10	22nd February, 2014
6	Al Hudaydah 1	16	3rd March, 2014
7	Al Hudaydah-Raymah	16	3rd March, 2014
13	Amran	16	3rd March, 2014
14	Amran-Dhamar	16	3rd March, 2014
3	Taiz 1	14	4th March, 2014
5	Ibb	14	4th March, 2014
4	Taiz-Ibb	15	4th March, 2014
10	Hajjah 1	13	4th March, 2014
12	Hajjah-Al Mahwit	13	4th March, 2014
20	Hadhramaut 1	13	5th March, 2014
21	Hadhramaut 2	13	5th March, 2014
11	Hajjah 2	14	5th March, 2014
19	Abyan	10	5th March, 2014
2	Sana'a	16	5th March, 2014
22	Hadhramaut-Al Mahrah-Socotra	13	6th March, 2014
25	Shabwah	17	6th March, 2014
24	Lahij-Ad Dali	12	6th March, 2014
15	Ma'rib	14	6th March, 2014
17	Sa'dah	15	9th March, 2014
8	Al Bayda' 1	10	9th March, 2014
9	Al Bayda' 2	10	9th March, 2014
16	Al-Jawf	12	9th March, 2014
23	Lahij	12	10th March, 2014
18	Aden	9	10th March, 2014

[a] Amanat Al Asimah represents the districts within the Capital City, Sana'a

Source: Al-Eryani, S.M. and Al-Mekhlafi, A.M., 2014 (48)

Appendix 3: Suggested Data Collection (paper case report) forms

Form 1: Mapping School Form

The Mapping Form is critical for the programme to succeed; it will allow us to gather background information required for the programme. This form must be filled out upon arrival at each of the schools that are participating in the activities of the Schistosomiasis and Soil Transmitted Helminth programme.

Section A: Site Details

Site Details should be filled out on arrival at the location as outlined on the forms.

1. Date of Visit: To be filled on the day of Mapping activities following:

   Day (DD) – Month (MMM) – Year (YYYY)
   Example: (DD-MMM-YYYY): |**2**|**7**|-|**F**|**E**|**B**|-|**2**|**0**|**1**|**3**|

2. Team Leader Initials: The data collector will record his/her initials in the allocated spot on the form:

Team Leader Initials	|___|___|___|
Example: John Jones Smith	|**J**|**J**|**S**|

3. District Name: Record the name of the District here in **BLOCK Capitals** to ensure it is easy to read
4. Educational District Name: Record the name of the Educational District here in **BLOCK Capitals** to ensure it is easy to read. This is our ' Mapping Area'.
5. Educational District Code: Fill in the district code (DDD) in accordance with the assigned code. This is a 3 digit number: 001 – 013.

Section B: GPS

The GPS device is likely to arrive with the default setting of degrees and minutes. At first use, you will need to change this to decimal degrees (instructions for the GARMIN eTrex® H):

1. Press PAGE and switch to the menu page
2. Select SETUP and press ENTER
3. Select UNITS and press ENTER
4. Select POSITION FRMT and press ENTER
5. Select the decimal degrees format hddd.ddddd and press ENTER.

GPS coordinates must be recorded on site at arrival and departure (stand in the same place for each recording).

Section C: School Details

School information will be gathered on site through conversations with the Headteacher who will assist you in the mapping activities.

1. School Name: Record the name of the school here in **BLOCK Capitals** to ensure it is easy to read

2. School Code: Fill in the school code (SSS) in accordance with the assigned codes (this is a 3 digit code: 001 – 008. Schools are numbered (arbitrarily) 1 to 8 within each Mapping Area (to be assigned by field team on arrival in 'Mapping Area'/District).

3. Name of Headteacher: Record the name of the Headteacher here in **BLOCK Capitals** to ensure it is easy to read

4. Have pupils in the school received deworming treatment in the last year?: Write the corresponding number in available space.

   1=Yes
   0=No
   2=Don't know

5. Lowest Level Taught: Write the corresponding number to the lowest Level taught in the school in the available space.
6. Highest Level Taught: Write the corresponding number to the highest grade taught in available space

Section D: Enrolment Numbers

Record the enrolment in the available space. The headteacher will be able to assist you with this section.
Example:

D. Enrolment numbers		
	Boys Enrolled	**Girls** Enrolled
Total	1. |___|1|8|4|	2. |___|1|6|3|
Level 6	3. |___|5|0|	4. |___|4|5|
Level 7	5. |___|7|5|	6. |___|6|3|
Level 8	7. |___|5|9|	8. |___|5|5|

Additional data on the number and condition of latrines present will be recorded on form 'Mapping latrine form'.

Form 2:– Mapping Pupil Form

The Mapping Pupil Form is critical for the mapping programme to succeed; it will allow us to gather background information required for the programme. This form must be filled out as samples are collected from students. The pots that these samples are collected in must be recorded with the ID number so that the analysis looking for eggs, haematuria and the dipstick results can be recorded next to the correct individual.

At the School

- Fill out the top of the form
  - Date of Survey
  - School Code SSS (from 'Mapping School Form')

- Page Number

- ID Number: This will be recorded using the district code (DDD), the school code (SSS) and the individual number (NN) which numbers 1-99; where the first student will be have an NN = 01
  - Label slides or take the corresponding sticker and put in the ID Number location.
    - E.g. The following would be the ID Number for the district with code 001, the school with code 001 and first student (01):

(DDD.SSS.NN) |**0**|**0**|**1**|.|**0**|**0**|**1**|.|**0**|**1**|

- Identical ID stickers should also be stuck on the child's sample containers.
- Sex: Record the gender of the student as either **M** for Male and **F** for Female
- Age: Record the age of the student in years.
  - E.g. |**1**|**1**|
- Take the sample containers (Urine and Faecal) and label with ID number (written or sticker)

At the school/In the lab

- Microscopist Initials: The lab technician who is handling the samples must record his/her initials in the provided location.
  - Lab Technicians Initials |___|___|___|
    - Example: John Jones Smith |**J**|**J**|**S**|
- Egg Detection (stool): Slides will be read for hookworm on the day of collection. Slides will be read for the follow species of parasitic helminths at least 24 hours later: *Schistosoma mansoni, Ascaris lumbricoides* and *Trichuris trichiura.*
  - A simple presence/absence test is being used for the mapping activities. If one egg is found of a species it must be recorded using the result key on the form.
    - E.g. *1=Yes, 0=No*
- Haematuria (Macro) will be recorded visually using the following codes:
  - *1=Yes, 0=No*
- Urine Dip Stick: The results of the dip stick test will be recorded as follows:
  - *0 = none, 1 = trace haemolysed, 2 = trace non-haemolysed, 3 = +, 4 = ++, 5 = +++*
  - **If positive use urine filtration to detect presence of eggs**

Urine filtration (if dip stick tests positive): A simple presence/absence test; if one egg is found, record *1=yes* otherwise, record *0=no*. If the original dip stick test was negative then leave this field blank.

Source: National Schistosomiasis Control Programme, 2014 (38)

Appendix 4: Yemen prevalence re-mapping team members and responsibilities

Team members (n=5)	Responsibilities	Note
Team leader	-Coordinates with the school principal for the collection of samples from school children. -Supervises the team members within his team. -Ensures data is recorded correctly.	Permanent tasks.
Team member no. 1	-Records GPS coordinates of the school sampled. -Provides instructions to the students during collection of samples. -Collects Hb data. -Records data into the forms provided.	Rotation of tasks
Team member no. 2	-Provides instruction to the students during collection of the samples. -Conducts the Kato-Katz method. -Records the data into the forms provided.	Rotation of tasks
Team member no. 3	-Provides instruction to the students during collection of the samples. -Conducts the Kato-Katz method. -Records the data into the forms provided.	Rotation of tasks.
Team member no. 4	-Provides instruction to the students during collection of the samples. -Conducts the Urine dipstick. -Conducts the Urine filtration.	Rotation of tasks.

Source: Al-Eryani, S.M. and Al-Mekhlafi, A.M., 2014 (48)

Appendix 5: Prevalence re-mapping supervisory field visit evaluation form

Yemen Prevalence Mapping of Schistosomiasis and Soil transmitted helminths

Checklist for field visits

Date_____ Time:_____

Governorate:_____

District_____Code_____

School Name_____ Code_____

Number of team members: _____

Team leader Name: _____

Team number: _____

1. Arriving at school

1.1. GPS coordinates of school on arrival? Yes_____ No_____

If no, give reasons.....

1.2. GPS coordinates of school on departure? Yes____ No____

If no, give reasons.....

2. School form:

2.1. Check if school form is filled out correctly with the school details. Yes____ No____

Note:_____

2.2. School details provided by whom? _____

3. Selecting the students for sampling:

3.1. Are they selecting randomly from levels 4, 5, 6? Yes____ No_____

Notes:.....

3.2. Did they sample a total of 30 students from this school: Yes___ No___

If No, why?.....

3.3. Did the sampled students include 50:50 ratio (females: males) ? Yes____ No____

If No, give reasons?.....

4. Preparation for collection of samples:

4.1. Observe working area, is it clean and organized? Yes____ No____

4.2. Gloves worn? Yes____ No____

4.3. Lab coats worn ? Yes____ No____

Samples collected: Did they collect from each student 3 samples (Stool, Urine, Blood);

- Stool? Yes____ No____
- Urine? yes___ No____

Note: (best sample for urine to be collected is between 10am and 12pm)

_____

- Finger prick? Yes____ No___

5. Student/Sample ID:

5.1. Check that the indicated student ID in the 'Mapping Pupil form' is also marked on stool container, urine container, slide for Kato-Katz. Yes___, No____

6. Kato-Katz method:

6.1. Ask how preparation of stain is made up: 3% malachite green, 100 ml glycerol, 100 ml distilled water

Note: How often do they prepare stain_____

6.2. Presoaked cellophane in stain: Yes____ No___

6.3 Is stool fresh? Yes___ No____

6.4. Sample container ID corresponds ID on slide with Kato-Katz smear? Yes___ No___

6.5. Check that two slides are prepared. Yes____ No____

6.6. Observe some specimens prepared.

Note_____

6.7. Examine quality of smear.

Note_____

6.8. Examine some positive slides previously prepared.

Note_____

7. Urine sample-Steps for urine sample investigation:

7.1. Do they check colour of urine? ': Yes____ No_____

7.2. Do they then use of dip stick to detect blood in urine?

Yes____ No____

7.3. Do they compare colour of the reagent strip to the colours on the label of the reagent strip container? Yes____ No____

7.4. Record results in the mapping pupil form? Yes___ No___

7.5. If blood detected (positive, trace/+) do they do urine filtration: Yes___ No____

Note: quantity of urine. Is it 10 ml? Yes____ No_____

Note _____

7.6. Observe urine filtration method of some specimens.

Note_____

8. Hb estimation:

8.1. Do they sterilize finger before collected blood sample? Yes____ No____

8.2. Do they use new lancet for each student? Yes____ No____

8.3. Observe method, is it correct? Yes____ No____

8.4. Record results in form? Yes____ No____

8.5 Do they dispose of used lancet appropriately? Yes____ No____

Note_____

9. Disposal of specimen containers, gloves, lancets, etc.

9.1. Do they use plastic bags for disposal? Yes____ No____

Note_____

9.2. Where and how do they dispose of the used containers, etc?

Describe_____

10. Mapping Pupil form

10.1. Is it correctly and completely filled out? Yes____ No_____

11. Team work during work:

Excellent ____ Very good_____ Good _____ Satisfactory_____ Poor_____

Challenges/Obstacles

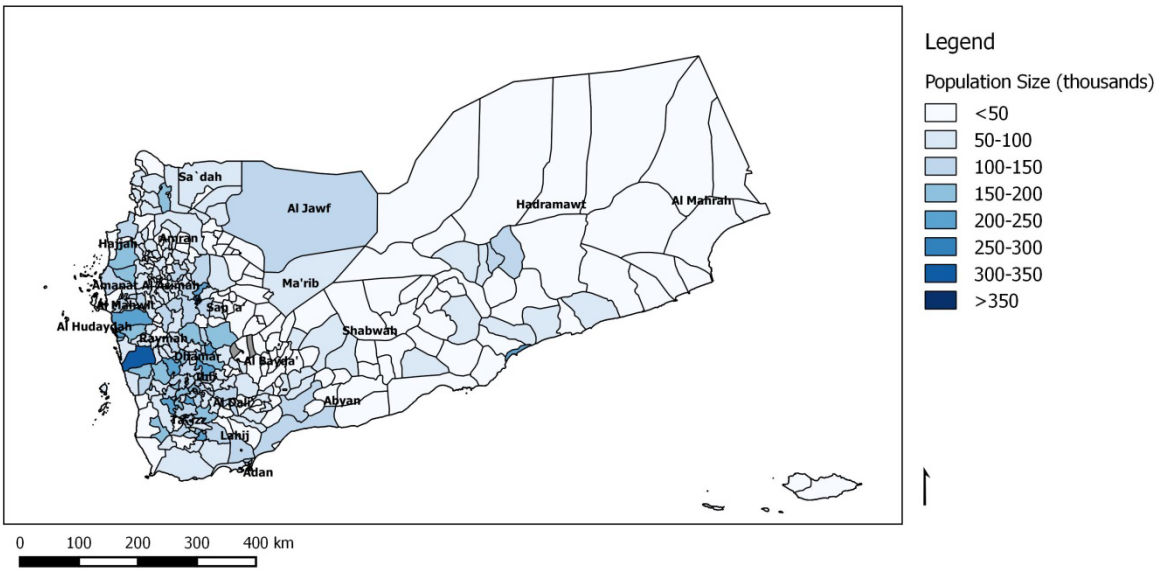
Source: Al-Eryani, S.M. and Al-Mekhlafi, A.M., 2014 (48)

Appendix 6: Planned and actual total numbers sampled by each team at the end of the prevalence re-mapping survey in Yemen

No. Team	Planned			Actual		
	No. districts	No. Schools	No. Students	No. districts	No. Schools	No. Students
1	10	80	2500	10	77	2620
2	16	128	4000	16	128	4067
3	14	112	3500	14	110	3548
4	15	120	3750	15	118	3824
5	14	112	3500	14	110	3539
6	16	128	4000	16	122	3884
7	16	128	4000	16	124	4008
8	10	80	2500	9	68	2040
9	10	80	2500	10	80	2386
10	13	104	3250	13	104	3321
11	14	112	3500	14	109	3559
12	13	104	3250	13	104	3312
13	16	128	4000	16	128	3945
14	16	128	4000	16	128	4036
15	14	112	3500	14	112	2980
16	12	96	3000	12	96	2909
17	15	120	3750	15	120	3759
18	9	72	2250	9	67	2184
19	10	80	2500	10	79	2410
20	13	104	3250	13	79	2221
21	13	104	3250	13	104	3247
22	13	104	3250	13	88	2811
23	12	96	3000	12	96	3037
24	12	96	3000	12	96	2912
25	17	136	4250	17	136	3873
Total	**333**	**2664**	**83250**	**332**	**2585**	**80432**

Source: Al-Eryani, S.M. and Al-Mekhlafi, A.M., 2014 (48)

Appendix 7: Map of the population distribution of Yemen



Map of the population distribution (2014, projected) by district in Yemen

Appendix 8: Prevalence of schistosomiasis, soil-transmitted helminths and anaemia in Yemen

Table of the prevalence of schistosomiasis, soil-transmitted helminths and anaemia by governorate in Yemen (2014)

Governorate	Governorate code	Average Prevalence (%)									
		Schistosomiasis (SCH)			Soil-transmitted helminths (STH)				Anaemia		
		Any	*S. mansoni*	*S. haematobium*	Any	*Ascaris*	*Trichuris*	Hookworm	Any	At least Moderate	Severe
Abyan	12	0.15	0.11	0.04	1.88	1.88	0.04	0.00	30.12	11.51	0.23
Aden	24	0.00	0.00	0.00	31.07	30.91	0.32	0.00	43.97	22.06	0.21
Al Bayda'	14	0.30	0.25	0.05	4.05	3.84	0.21	0.00	29.71	16.03	0.18
Al Dali'	30	9.42	8.87	0.78	16.60	14.86	1.87	0.50	17.20	6.50	0.41
Al Hudaydah	18	0.80	0.68	0.16	1.04	0.42	0.62	0.06	46.22	23.62	0.91
Al Jawf	16	3.95	2.68	1.27	0.79	0.34	0.07	0.38	18.47	8.92	2.18
Al Mahrah	28	0.00	0.00	0.00	20.15	20.04	0.33	0.06	28.33	10.44	0.28
Al Mahwit	27	5.28	1.99	3.38	12.72	6.75	6.23	2.12	92.82	50.78	0.26
Amanat Al Asimah	13	0.69	0.61	0.08	9.39	8.82	0.76	0.00	10.88	4.54	0.19
Amran	29	4.21	1.88	2.40	5.11	4.05	2.06	0.36	23.44	11.28	0.34
Dhamar	20	2.07	1.74	0.33	4.35	2.81	1.54	0.00	40.11	23.12	0.74
Hadramawt	19	0.42	0.00	0.42	3.12	3.06	0.08	0.00	41.62	24.37	0.15
Hajjah	17	3.60	2.36	1.37	9.24	5.81	4.84	0.09	43.30	20.97	0.64
Ibb	11	4.28	4.11	0.18	23.78	20.67	5.02	0.00	23.82	9.24	0.20
Lahij	25	1.57	1.54	0.03	2.42	2.23	0.27	0.00	28.12	10.93	0.11
Ma'rib	26	0.13	0.13	0.00	2.64	2.24	0.30	0.10	8.06	2.31	0.17
Raymah	31	1.61	0.40	1.21	4.21	3.21	0.87	0.20	13.44	4.15	0.20
Sa`dah	22	1.89	1.54	0.35	9.82	9.71	0.11	0.00	11.40	3.22	0.19
San`a'	23	0.53	0.39	0.15	7.77	7.14	0.68	0.00	16.08	7.11	0.15
Shabwah	21	0.41	0.00	0.41	0.00	0.00	0.00	0.00	25.50	10.72	0.69
Ta`izz	15	17.73	16.54	1.59	24.77	23.68	1.74	0.10	24.95	10.40	0.24
Grand Total		**3.18**	**2.54**	**0.71**	**8.76**	**7.63**	**1.51**	**0.14**	**30.45**	**14.63**	**0.42**

Table of the prevalence of schistosomiasis by district in Yemen (2014)

Governorate	District	District code	Average Prevalence of Schistosomiasis (SCH)[a] (%)								
			Any SCH			*S. mansoni*			*S. haematobium*		
			%	Lower CI	Upper CI	%	Lower CI	Upper CI	%	Lower CI	Upper CI
`Adan	Al Buraiqeh	2404	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Al Mansura	2403	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Al Mualla	2406	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Ash Shaikh Outhman	2402	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Attawahi	2405	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Craiter	2407	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Dar Sad	2401	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Khur Maksar	2408	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
Abyan	Al Mahfad	1201	0.83	0.00	5.92	0.42	0.00	2.99	0.42	0.00	2.99
	Ahwar	1209	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Al Wade'a	1208	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Jayshan	1203	0.42	0.00	2.99	0.42	0.00	2.99	0.00	NA	NA
	Khanfir	1211	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Lawdar	1204	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Mudiyah	1202	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Rasad	1206	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Sarar	1207	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Sibah	1205	0.42	0.00	2.99	0.42	0.00	2.99	0.00	NA	NA
	Zingibar	1210	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
Al Bayda'	Al A'rsh	1416	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Al Bayda	1410	0.39	0.00	2.80	0.39	0.00	2.80	0.00	NA	NA
	Al Bayda City	1409	1.94	0.53	4.88	1.94	0.53	4.88	0.00	NA	NA
	Al Malagim	1420	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Al Quraishyah	1414	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA

	Ar Ryashyyah	1418	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	As Sawadiyah	1411	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	As Sawma'ah	1404	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Ash Sharyah	1419	0.42	0.00	2.99	0.00	NA	NA	0.42	0.00	2.99
	At Taffah	1407	0.43	0.00	3.05	0.43	0.00	3.05	0.00	NA	NA
	Az Zahir	1405	0.40	0.00	3.13	0.40	0.00	3.13	0.00	NA	NA
	Dhi Na'im	1406	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Maswarah	1403	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Mukayras	1408	0.40	0.00	2.86	0.40	0.00	2.86	0.00	NA	NA
	Na'man	1401	0.45	0.00	3.47	0.45	0.00	3.47	0.00	NA	NA
	Nati'	1402	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Rada'	1413	0.42	0.00	2.99	0.42	0.00	2.99	0.00	NA	NA
	Radman Al Awad	1412	0.42	0.00	2.99	0.00	NA	NA	0.42	0.00	2.99
	Sabah	1417	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
Al Dali'	Ad Dhale'e	3006	6.36	3.48	10.52	4.24	1.79	8.35	2.12	0.07	10.79
	Al Azariq	3008	13.62	7.95	21.24	13.19	7.93	20.19	0.43	0.00	3.04
	Al Husha	3009	18.80	9.35	31.96	17.20	9.49	27.61	3.60	0.13	17.07
	Al Hussein	3005	7.20	3.55	12.74	7.20	3.55	12.74	0.00	NA	NA
	Ash Shu'ayb	3004	10.66	4.81	19.68	10.66	4.81	19.68	0.00	NA	NA
	Damt	3002	7.66	3.15	15.12	7.66	3.15	15.12	0.00	NA	NA
	Jahaf	3007	6.33	4.55	8.53	5.49	3.21	8.67	0.84	0.00	6.06
	Juban	3001	3.02	0.90	7.25	3.02	0.90	7.25	0.00	NA	NA
	Qa'atabah	3003	11.44	7.16	17.07	11.44	7.16	17.07	0.00	NA	NA
Al Hudaydah	Ad Dahi	1809	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Ad Durayhimi	1814	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Al Garrahi	1825	5.99	2.54	11.67	5.63	2.43	10.88	0.35	NA	NA
	Al Hajjaylah	1811	0.40	0.00	2.88	0.40	0.00	2.88	0.00	NA	NA
	Al Hali	1823	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Al Hawak	1821	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA

	Al Khawkhah	1820	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Al Mansuriyah	1816	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Al Marawi'ah	1813	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Al Mighlaf	1808	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Al Mina	1822	0.78	0.00	5.64	0.39	0.00	2.85	0.39	0.00	2.85
	Al Munirah	1805	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Al Qanawis	1806	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Alluheyah	1802	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	As Salif	1804	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	As Sukhnah	1815	0.40	0.00	2.91	0.40	0.00	2.91	0.00	NA	NA
	At Tuhayat	1826	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Az Zaydiyah	1807	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Az Zuhrah	1801	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Bajil	1810	0.41	0.00	2.95	0.41	0.00	2.95	0.00	NA	NA
	Bayt Al Faqiah	1817	0.40	0.00	2.90	0.40	0.00	2.90	0.00	NA	NA
	Bura	1812	11.60	2.26	31.22	9.20	2.41	22.50	2.82	NA	NA
	Hays	1819	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Jabal Ra's	1818	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Kamaran	1803	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Zabid	1824	0.40	0.00	2.90	0.40	0.00	2.90	0.00	NA	NA
Al Jawf	Al Ghayl	1608	0.84	0.00	5.94	0.84	0.00	5.94	0.00	NA	NA
	Al Hazm	1605	0.36	0.00	2.61	0.36	0.00	2.61	0.00	NA	NA
	Al Humaydat	1602	5.38	0.70	17.74	0.00	NA	NA	5.38	0.70	17.74
	Al Khalq	1609	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Al Maslub	1607	7.85	1.64	21.33	7.02	1.33	19.97	0.83	NA	NA
	Al Matammah	1603	6.60	1.04	20.13	6.60	1.04	20.13	0.00	NA	NA
	Al Maton	1606	10.67	6.38	16.46	10.28	6.58	15.10	0.40	0.00	2.83
	Az Zahir	1604	5.51	2.33	10.78	4.72	1.48	10.94	0.79	0.00	5.56
	Bart Al Anan	1610	5.08	1.02	14.38	0.00	NA	NA	5.08	1.02	14.38
	Khabb wa ash Sha'af	1601	0.73	0.07	2.82	0.73	0.07	2.82	0.00	NA	NA

	Kharab Al Marashi	1612	3.97	1.33	8.91	1.59	0.01	10.97	2.39	NA	NA
	Rajuzah	1611	0.40	0.00	2.86	0.00	NA	NA	0.40	0.00	2.86
Al Mahrah	Al Ghaydah	2804	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Al Masilah	2806	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Hat	2802	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Hawf	2803	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Huswain	2809	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Man'ar	2805	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Qishn	2808	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Sayhut	2807	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Shahan	2801	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
Al Mahwit	Al Khabt	2704	1.20	0.08	5.22	0.40	0.00	2.86	0.80	NA	NA
	Al Mahwait	2709	8.80	2.45	21.04	4.00	0.20	17.52	4.80	2.14	9.11
	Al Mahwait City	2708	8.57	3.50	16.91	5.36	1.02	15.45	3.57	0.66	10.56
	Ar Rujum	2703	3.57	0.83	9.61	2.50	0.15	10.75	1.07	0.21	3.16
	At Tawilah	2702	7.54	3.38	14.13	1.59	0.50	3.73	5.95	1.69	14.38
	Bani Sa'd	2707	2.40	0.46	7.11	0.80	0.07	3.25	1.60	0.07	7.72
	Hufash	2706	3.20	1.21	6.73	0.80	0.06	3.29	2.40	0.65	6.06
	Milhan	2705	6.80	3.90	10.88	0.80	0.07	3.25	6.00	3.16	10.20
	Shibam Kawkaban	2701	5.20	1.45	12.70	1.20	0.01	8.41	4.40	1.44	9.97
Amanat Al Asimah	Al Wahdah	1306	0.36	0.00	2.68	0.36	0.00	2.68	0.00	NA	NA
	As Sabain	1305	0.80	0.05	3.54	0.80	0.05	3.54	0.00	NA	NA
	Assafi'yah	1304	1.20	0.07	5.30	1.20	0.07	5.30	0.00	NA	NA
	At Tahrir	1307	1.81	0.61	4.09	1.81	0.61	4.09	0.00	NA	NA
	Ath'thaorah	1309	0.71	0.06	2.90	0.71	0.06	2.90	0.00	NA	NA
	Az'zal	1303	0.40	0.00	2.84	0.00	NA	NA	0.40	0.00	2.84
	Bani Al Harith	1310	0.36	0.00	2.57	0.36	0.00	2.57	0.00	NA	NA
	Ma'ain	1308	0.80	0.07	3.18	0.80	0.07	3.18	0.00	NA	NA
	Old City	1301	0.36	0.00	2.82	0.00	NA	NA	0.36	0.00	2.82

	Shu'aub	1302	0.36	0.00	2.57	0.36	0.00	2.57	0.00	NA	NA
Amran	Al Ashah	2903	10.28	4.89	18.43	5.93	1.63	14.51	4.35	0.61	14.15
	Al Madan	2906	5.77	1.36	15.16	4.62	1.03	12.51	1.15	0.01	8.27
	Al Qaflah	2904	2.33	0.33	7.75	1.95	0.14	8.13	0.39	0.00	2.76
	Amran	2915	1.81	0.20	6.52	1.44	0.06	6.91	0.36	0.00	2.58
	As Sawd	2914	0.41	0.00	2.95	0.41	0.00	2.95	0.00	NA	NA
	As Sudah	2913	8.30	3.69	15.59	4.56	2.38	7.84	4.15	1.11	10.41
	Bani Suraim	2920	1.22	0.25	3.58	0.82	0.07	3.29	0.41	0.00	2.92
	Dhi Bin	2909	0.82	0.07	3.34	0.82	0.07	3.34	0.41	0.00	2.97
	Habur Zulaymah	2908	11.79	5.29	21.77	2.03	0.87	4.00	10.16	3.38	22.15
	Harf Sufyan	2901	6.11	1.24	17.04	0.00	NA	NA	6.11	1.24	17.04
	Huth	2902	0.86	0.00	6.15	0.43	0.00	3.10	0.43	0.00	3.10
	Iyal Surayh	2918	2.47	0.01	16.80	0.82	0.01	5.83	2.06	0.01	14.14
	Jabal Iyal Yazid	2912	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Khamir	2919	6.93	1.87	17.01	3.90	0.57	12.59	3.03	0.72	8.13
	Kharif	2910	8.33	0.18	39.55	0.00	NA	NA	8.33	0.18	39.55
	Maswar	2916	2.89	0.27	10.91	2.89	0.27	10.91	0.00	NA	NA
	Raydah	2911	0.82	0.01	5.75	0.00	NA	NA	0.82	0.01	5.75
	Shaharah	2905	10.58	6.30	16.38	6.20	1.82	14.73	4.38	0.63	14.14
	Suwayr	2907	1.23	0.24	3.64	0.00	NA	NA	1.23	0.24	3.64
	Thula	2917	0.80	0.07	3.15	0.00	NA	NA	0.80	0.07	3.15
Dhamar	Al Hada	2001	0.41	0.00	2.98	0.41	0.00	2.98	0.00	NA	NA
	Al Manar	2012	3.16	0.30	11.90	3.16	0.30	11.90	0.00	NA	NA
	Anss	2010	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Dawran Aness	2011	2.51	0.39	8.07	1.67	0.07	7.92	0.84	0.01	5.86
	Dhamar City	2008	0.36	0.00	2.56	0.36	0.00	2.56	0.00	NA	NA
	Jabal Ash sharq	2003	4.47	1.34	10.61	1.63	0.25	5.30	2.85	0.22	11.41
	Jahran	2002	0.35	0.00	2.45	0.35	0.00	2.45	0.00	NA	NA
	Maghirib Ans	2004	2.08	0.94	3.96	2.08	0.94	3.96	0.00	NA	NA

	Mayfa'at Anss	2009	1.67	0.01	11.69	1.67	0.01	11.69	0.00	NA	NA
	Utmah	2005	2.86	0.33	10.16	2.86	0.33	10.16	0.00	NA	NA
	Wusab Al Ali	2006	5.00	1.15	13.37	4.58	0.80	13.75	0.42	0.00	2.99
	Wusab As Safil	2007	2.50	0.24	9.38	2.50	0.24	9.38	0.00	NA	NA
Hadramawt	Ad Dis	1914	1.15	0.01	7.63	0.00	NA	NA	1.15	0.01	7.63
	Adh Dhlia'ah	1922	0.41	0.00	2.88	0.00	NA	NA	0.41	0.00	2.88
	Al Abr	1906	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Al Mukalla	1930	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Al Mukalla City	1929	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Al Qaf	1903	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Al Qatn	1907	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Amd	1921	3.57	0.14	16.88	0.00	NA	NA	3.57	0.14	16.88
	Ar Raydah Wa Qusayar	1913	1.13	0.08	4.76	0.00	NA	NA	1.13	0.08	4.76
	As Sawm	1912	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Ash Shihr	1915	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Brom Mayfa	1925	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Daw'an	1918	1.96	0.32	6.18	0.00	NA	NA	1.96	0.32	6.18
	Ghayl Ba Wazir	1917	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Ghayl Bin Yamin	1916	1.54	0.07	7.24	0.00	NA	NA	1.54	0.07	7.24
	Hagr As Sai'ar	1905	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Hajr	1924	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Hidaybu	1926	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Huraidhah	1928	0.42	0.00	2.97	0.00	NA	NA	0.42	0.00	2.97
	Qulensya Wa Abd Al Kuri	1927	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Rakhyah	1920	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Rumah	1901	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Sah	1909	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Sayun	1910	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Shibam	1908	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Tarim	1911	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA

	Thamud	1902	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Wadi Al Ayn	1919	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Yabuth	1923	0.40	0.00	2.84	0.00	NA	NA	0.40	0.00	2.84
	Zamakh wa Manwakh	1904	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
Hajjah	Abs	1704	0.40	0.00	2.86	0.40	0.00	2.86	0.00	NA	NA
	Aflah Al Yaman	1714	6.72	0.40	26.96	3.56	0.02	23.62	3.16	0.68	8.84
	Aflah Ash Shawm	1710	0.40	0.00	2.86	0.40	0.00	2.86	0.00	NA	NA
	Al Jamimah	1708	1.99	0.31	6.41	1.99	0.31	6.41	0.00	NA	NA
	Al Maghrabah	1717	3.94	0.02	25.92	0.00	NA	NA	3.94	0.02	25.92
	Al Mahabishah	1715	3.17	0.00	99.27	0.00	NA	NA	3.17	0.00	99.27
	Al Miftah	1716	5.16	0.68	17.00	3.57	0.68	10.45	2.78	0.01	18.90
	Ash Shaghadirah	1725	4.40	0.65	14.03	2.40	0.14	10.53	2.40	0.46	7.11
	Ash Shahil	1721	5.28	1.37	13.38	0.41	0.00	3.04	4.88	1.10	13.15
	Aslem	1712	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Bakil Al Mir	1701	18.49	7.56	34.91	17.23	7.87	30.87	1.68	0.06	8.41
	Bani Al Awam	1727	2.80	1.07	5.89	2.00	0.90	3.81	0.80	0.07	3.21
	Bani Qa'is	1724	1.20	0.08	5.22	0.00	NA	NA	1.20	0.08	5.22
	Hajjah	1729	0.72	0.00	5.11	0.72	0.00	5.11	0.00	NA	NA
	Hajjah City	1728	6.23	0.65	21.81	4.28	0.72	13.09	2.33	0.06	12.41
	Harad	1702	2.71	1.28	5.01	1.36	0.20	4.50	1.69	0.46	4.32
	Hayran	1705	0.40	0.00	2.89	0.40	0.00	2.89	0.00	NA	NA
	Khayran Al Muharraq	1711	0.39	0.00	2.82	0.00	NA	NA	0.39	0.00	2.82
	Ku'aydinah	1722	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Kuhlan Affar	1718	3.95	0.74	11.64	3.16	0.30	11.89	0.79	0.06	3.23
	Kuhlan Ash Sharaf	1709	2.39	0.01	16.30	2.39	0.01	16.30	0.00	NA	NA
	Kushar	1707	2.78	1.08	5.76	1.98	0.58	4.85	0.79	0.00	5.69
	Mabyan	1720	2.05	0.06	10.45	0.41	0.00	2.93	1.64	0.01	11.46
	Midi	1703	3.19	1.01	7.40	2.79	1.09	5.79	0.40	0.00	3.11
	Mustaba	1706	1.99	0.19	7.56	1.99	0.19	7.56	0.00	NA	NA
	Najrah	1726	3.20	0.43	10.76	0.80	0.07	3.21	2.80	0.33	9.84

	Qafl Shamer	1713	6.23	0.27	27.10	0.00	NA	NA	6.23	0.27	27.10
	Qarah	1731	8.70	2.29	21.31	6.72	0.90	21.64	1.98	0.08	9.44
	Sharas	1719	6.02	1.31	16.37	6.02	1.31	16.37	0.80	0.00	5.76
	Wadhrah	1723	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Washhah	1730	7.39	4.29	11.72	7.39	4.29	11.72	0.00	NA	NA
Ibb	Al Dhihar	1119	3.57	1.79	6.30	3.57	1.79	6.30	0.00	NA	NA
	Al Makhadir	1107	5.28	2.39	9.94	5.28	2.39	9.94	0.00	NA	NA
	Al Mashannah	1118	5.44	1.03	15.71	5.44	1.03	15.71	0.00	NA	NA
	Al Qafr	1101	7.51	1.30	21.93	6.72	0.86	21.96	0.79	0.06	3.27
	Al Udayn	1111	5.20	1.48	12.61	5.20	1.48	12.61	0.00	NA	NA
	An Nadirah	1104	5.35	1.90	11.58	5.35	1.90	11.58	0.00	NA	NA
	Ar Radmah	1103	4.53	1.10	11.87	4.53	1.10	11.87	0.00	NA	NA
	As Sabrah	1114	4.40	1.14	11.20	4.40	1.14	11.20	0.00	NA	NA
	As Saddah	1106	2.44	0.35	8.09	2.44	0.35	8.09	0.00	NA	NA
	As Sayyani	1115	3.60	0.72	10.31	3.60	0.72	10.31	0.00	NA	NA
	Ash Sha'ir	1105	5.74	1.19	15.92	3.28	0.42	11.19	2.46	0.01	16.75
	Ba'dan	1113	3.41	0.52	10.85	3.03	0.32	11.04	0.38	0.00	2.90
	Dhi As Sufal	1116	1.20	0.25	3.43	1.20	0.25	3.43	0.00	NA	NA
	Far Al Udayn	1110	6.80	0.48	26.19	6.80	0.48	26.19	0.00	NA	NA
	Hazm Al Udayn	1109	4.58	1.11	11.99	4.58	1.11	11.99	0.00	NA	NA
	Hubaysh	1108	1.90	0.06	9.75	1.90	0.06	9.75	0.00	NA	NA
	Ibb	1120	9.38	0.95	31.66	9.38	0.95	31.66	0.00	NA	NA
	Jiblah	1112	1.62	0.27	5.12	1.62	0.27	5.12	0.00	NA	NA
	Mudhaykhirah	1117	0.40	0.00	2.80	0.40	0.00	2.80	0.00	NA	NA
	Yarim	1102	3.20	1.23	6.68	3.20	1.23	6.68	0.00	NA	NA
Lahij	Al Hawtah	2514	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Al Had	2501	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Al Madaribah Wa Al Arah	2513	0.40	0.00	2.84	0.40	0.00	2.84	0.00	NA	NA
	Al Maflahy	2503	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA

	Al Maqatirah	2512	2.36	0.63	6.03	2.36	0.63	6.03	0.00	NA	NA
	Al Milah	2508	1.18	0.24	3.47	1.18	0.24	3.47	0.00	NA	NA
	Al Musaymir	2509	2.35	1.30	3.91	2.35	1.30	3.91	0.00	NA	NA
	Al Qabbaytah	2510	1.58	0.07	7.55	1.58	0.07	7.55	0.00	NA	NA
	Habil Jabr	2505	5.02	2.00	10.19	5.02	2.00	10.19	0.00	NA	NA
	Halimayn	2506	4.17	2.37	6.73	3.75	1.76	6.91	0.42	0.00	3.01
	Radfan	2507	1.22	0.25	3.56	1.22	0.25	3.56	0.00	NA	NA
	Tuban	2515	3.14	0.15	14.14	3.14	0.15	14.14	0.00	NA	NA
	Tur Al Bahah	2511	2.38	1.30	3.98	2.38	1.30	3.98	0.00	NA	NA
	Yafa'a	2502	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Yahr	2504	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
Ma'rib	Al Abdiyah	2611	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Al Jubah	2607	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Bidbadah	2605	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Harib	2609	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Harib Al Qaramish	2604	0.47	0.00	3.12	0.47	0.00	3.12	0.00	NA	NA
	Jabal Murad	2614	0.49	0.01	3.16	0.49	0.01	3.16	0.00	NA	NA
	Mahliyah	2610	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Majzar	2601	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Marib	2613	0.44	0.00	3.22	0.44	0.00	3.22	0.00	NA	NA
	Marib City	2612	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Medghal	2603	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Raghwan	2602	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Rahabah	2608	0.47	0.00	3.21	0.47	0.00	3.21	0.00	NA	NA
	Sirwah	2606	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
Raymah	Al Jabin	3102	0.80	0.00	6.10	0.00	NA	NA	0.80	0.00	6.10
	Al Jafariyah	3105	0.78	0.03	3.86	0.39	0.00	3.48	0.39	0.00	3.34
	As Salafiyah	3103	0.81	0.07	3.15	0.81	0.07	3.15	0.00	NA	NA
	Bilad At Ta'am	3101	4.86	1.54	11.16	0.40	0.00	2.89	4.49	NA	NA

	Kusmah	3104	0.80	0.00	5.67	0.80	0.00	5.67	0.00	NA	NA
	Mazhar	3106	1.65	0.01	12.46	0.00	NA	NA	1.65	0.01	12.46
Sa`dah	Al Dhaher	2207	5.60	1.74	12.95	3.20	0.57	9.69	2.40	0.64	6.11
	Al Hashwah	2213	1.60	0.01	11.18	0.40	0.00	2.88	1.20	0.01	8.47
	As Safra	2212	0.40	0.00	2.86	0.40	0.00	2.86	0.00	NA	NA
	Baqim	2201	0.80	0.07	3.14	0.80	0.07	3.14	0.00	NA	NA
	Ghamr	2204	2.40	0.64	6.10	2.40	0.64	6.10	0.00	NA	NA
	Haydan	2208	0.80	0.07	3.23	0.80	0.07	3.23	0.00	NA	NA
	Kitaf wa Al Boqe'e	2214	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Majz	2210	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Monabbih	2203	0.80	0.07	3.23	0.80	0.07	3.23	0.00	NA	NA
	Qatabir	2202	0.40	0.00	2.86	0.40	0.00	2.86	0.00	NA	NA
	Razih	2205	2.00	0.35	6.15	2.00	0.35	6.15	0.00	NA	NA
	Sa'adah	2215	0.40	0.00	2.90	0.40	0.00	2.90	0.00	NA	NA
	Sahar	2211	2.80	0.33	9.82	2.80	0.33	9.82	0.00	NA	NA
	Saqayn	2209	3.60	0.05	20.32	3.60	0.05	20.32	0.00	NA	NA
	Shada'a	2206	6.56	2.77	12.81	5.02	1.78	10.89	1.54	0.25	4.93
San`a'	Al Haymah Ad Dakhiliyah	2308	0.71	0.06	2.80	0.71	0.06	2.80	0.00	NA	NA
	Al Haymah Al Kharijiyah	2309	1.06	0.21	3.15	1.06	0.21	3.15	0.00	NA	NA
	Al Husn	2315	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Arhab	2302	2.50	0.06	13.23	0.00	NA	NA	2.50	0.06	13.23
	Attyal	2313	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Bani Dhabyan	2314	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Bani Hushaysh	2304	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Bani Matar	2307	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Bilad Ar Rus	2306	0.83	0.00	5.92	0.83	0.00	5.92	0.00	NA	NA
	Hamdan	2301	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Jihanah	2316	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Khwlan	2312	0.42	0.00	3.28	0.42	0.00	3.28	0.00	NA	NA

	Manakhah	2310	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Nihm	2303	1.79	0.01	12.41	1.79	0.01	12.41	0.00	NA	NA
	Sa'fan	2311	1.05	0.01	7.48	1.05	0.01	7.48	0.00	NA	NA
	Sanhan	2305	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
Shabwah	Ain	2106	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Al Talh	2102	5.93	0.04	35.16	0.00	NA	NA	5.93	0.04	35.16
	Ar Rawdah	2115	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Arma	2104	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	As Said	2112	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Ataq	2113	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Bayhan	2107	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Dhar	2101	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Habban	2114	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Hatib	2111	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Jardan	2103	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Mayfa'a	2116	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Merkhah Al Ulya	2108	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Merkhah As Sufla	2109	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Nisab	2110	0.42	0.00	2.99	0.00	NA	NA	0.42	0.00	2.99
	Rudum	2117	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Usaylan	2105	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
Ta`izz	Al Mukha	1506	19.12	8.34	34.87	18.33	7.60	34.40	0.80	0.04	3.60
	Al Ma'afer	1521	21.74	16.13	28.24	20.95	15.30	27.56	1.58	0.53	3.60
	Al Mawasit	1522	20.71	11.88	32.19	20.71	11.88	32.19	0.00	NA	NA
	Al Misrakh	1512	25.69	11.41	45.16	23.32	10.35	41.42	3.16	0.77	8.35
	Al Mudhaffar	1518	7.50	2.86	15.44	7.14	2.93	14.14	0.72	NA	NA
	Al Qahirah	1519	9.42	4.42	17.07	9.06	4.32	16.27	0.36	0.00	2.77
	Al Wazi'iyah	1516	11.60	6.12	19.42	9.60	4.09	18.42	2.00	0.19	7.66
	As Silw	1514	12.69	5.76	23.22	12.69	5.76	23.22	0.00	NA	NA

	Ash Shamayatayn	1515	38.89	26.23	52.75	35.71	22.72	50.45	4.37	2.55	6.92
	At Ta'iziyah	1502	4.69	1.70	10.05	4.69	1.70	10.05	0.00	NA	NA
	Dhubab	1507	23.60	17.71	30.35	21.60	16.62	27.27	2.40	0.38	7.65
	Dimnat Khadir	1513	7.69	1.44	21.83	7.69	1.44	21.83	0.00	NA	NA
	Hayfan	1517	23.01	14.01	34.28	23.01	14.01	34.28	0.00	NA	NA
	Jabal Habashy	1509	8.40	3.16	17.35	8.00	2.73	17.43	0.80	0.07	3.26
	Maqbanah	1505	26.69	20.25	33.95	25.90	19.31	33.40	1.59	0.58	3.46
	Mashra'a Wa Hadnan	1510	32.27	24.22	41.17	29.88	22.67	37.91	2.80	NA	NA
	Mawiyah	1501	5.60	2.02	12.00	5.60	2.02	12.00	0.00	NA	NA
	Mawza	1508	26.48	19.15	34.91	20.95	13.66	29.92	7.14	NA	NA
	Sabir Al Mawadim	1511	32.93	23.85	43.06	29.72	20.01	40.98	4.42	2.04	8.23
	Salh	1520	8.76	2.65	20.17	8.76	2.65	20.17	0.00	NA	NA
	Sama	1523	20.40	13.36	29.08	18.40	11.93	26.48	2.80	1.03	6.01
	Shara'b Ar Rawnah	1504	21.96	15.98	28.94	20.39	15.20	26.43	1.96	0.52	5.02
	Shara'b As Salam	1503	0.40	0.00	2.90	0.40	0.00	2.90	0.00	NA	NA
Grand Total			**3.18**	**-**	**-**	**2.54**	**-**	**-**	**0.71**	**-**	**-**

[a]95% Confidence Interval (CI), calculated by district taking into account clustering at school-level.

Table of the prevalence of soil-transmitted helminths by district in Yemen (2014)

Governorate	District	District code	Average Prevalence of Soil-transmitted helminths (STH)[a] (%)											
			Any STH			*Ascaris*			*Trichuris*			Hookworm		
			%	Lower CI	Upper CI	%	Lower CI	Upper CI	%	Lower CI	Upper CI	%	Lower CI	Upper CI
`Adan	Al Buraiqeh	2404	28.68	18.59	40.62	28.68	18.59	40.62	0.39	0.00	2.75	0.00	NA	NA
	Al Mansura	2403	30.98	22.71	40.26	30.20	21.44	40.15	0.78	0.07	3.16	0.00	NA	NA
	Al Mualla	2406	27.78	17.24	40.48	27.78	17.24	40.48	0.51	0.00	4.13	0.00	NA	NA
	Ash Shaikh Outhman	2402	42.40	29.62	55.97	42.40	29.62	55.97	0.00	NA	NA	0.00	NA	NA
	Attawahi	2405	34.20	28.01	40.81	34.20	28.01	40.81	0.00	NA	NA	0.00	NA	NA
	Craiter	2407	30.52	22.07	40.06	30.12	21.71	39.65	0.40	0.00	3.07	0.00	NA	NA
	Dar Sad	2401	28.14	12.77	48.46	28.14	12.77	48.46	0.00	NA	NA	0.00	NA	NA
	Khur Maksar	2408	24.10	16.32	33.39	24.10	16.32	33.39	0.51	0.00	4.17	0.00	NA	NA
Abyan	Al Mahfad	1201	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Ahwar	1209	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Al Wade'a	1208	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Jayshan	1203	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Khanfir	1211	0.36	0.00	2.57	0.36	0.00	2.57	0.00	NA	NA	0.00	NA	NA
	Lawdar	1204	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Mudiyah	1202	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Rasad	1206	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Sarar	1207	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Sibah	1205	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Zingibar	1210	19.68	12.34	28.92	19.68	12.34	28.92	0.40	0.00	2.91	0.00	NA	NA
Al Bayda'	Al A'rsh	1416	4.69	1.98	9.23	4.23	1.62	8.80	0.47	0.00	3.31	0.00	NA	NA
	Al Bayda	1410	7.84	3.78	14.07	7.84	3.78	14.07	0.00	NA	NA	0.00	NA	NA
	Al Bayda City	1409	7.75	4.79	11.73	7.75	4.79	11.73	0.00	NA	NA	0.00	NA	NA
	Al Malagim	1420	2.92	0.34	10.30	2.50	0.20	9.97	0.42	0.00	2.99	0.00	NA	NA
	Al Quraishyah	1414	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA

	Ar Ryashyyah	1418	6.25	1.78	15.02	6.25	1.78	15.02	0.00	NA	NA	0.00	NA	NA
	As Sawadiyah	1411	2.08	0.23	7.56	0.83	0.07	3.38	1.25	0.01	8.79	0.00	NA	NA
	As Sawma'ah	1404	4.45	1.64	9.48	4.45	1.64	9.48	0.00	NA	NA	0.00	NA	NA
	Ash Sharyah	1419	4.58	2.11	8.55	3.33	1.27	7.01	1.25	0.08	5.48	0.00	NA	NA
	At Taffah	1407	2.16	0.40	6.44	2.16	0.40	6.44	0.00	NA	NA	0.00	NA	NA
	Az Zahir	1405	2.79	0.93	6.33	2.79	0.93	6.33	0.00	NA	NA	0.00	NA	NA
	Dhi Na'im	1406	3.57	1.23	7.93	3.57	1.23	7.93	0.00	NA	NA	0.00	NA	NA
	Maswarah	1403	4.71	2.03	9.13	4.71	2.03	9.13	0.00	NA	NA	0.00	NA	NA
	Mukayras	1408	9.13	4.27	16.60	9.13	4.27	16.60	0.00	NA	NA	0.00	NA	NA
	Na'man	1401	1.79	0.09	8.28	1.79	0.09	8.28	0.00	NA	NA	0.00	NA	NA
	Nati'	1402	1.02	0.16	3.30	1.02	0.16	3.30	0.00	NA	NA	0.00	NA	NA
	Rada'	1413	4.58	2.39	7.88	4.58	2.39	7.88	0.00	NA	NA	0.00	NA	NA
	Radman Al Awad	1412	0.83	0.07	3.38	0.42	0.00	2.99	0.42	0.00	2.99	0.00	NA	NA
	Sabah	1417	2.50	0.93	5.33	2.50	0.93	5.33	0.00	NA	NA	0.00	NA	NA
Al Dali'	Ad Dhale'e	3006	14.83	7.75	24.77	13.98	6.84	24.36	1.27	0.25	3.76	0.00	NA	NA
	Al Azariq	3008	12.77	6.98	20.84	11.91	6.43	19.66	0.85	0.07	3.44	0.00	NA	NA
	Al Husha	3009	23.20	18.42	28.55	19.60	16.25	23.31	2.40	0.45	7.17	2.80	0.60	7.84
	Al Hussein	3005	21.19	13.56	30.64	18.22	11.52	26.70	3.39	0.62	10.13	0.85	0.00	6.04
	Ash Shu'ayb	3004	17.62	9.95	27.86	15.98	11.11	21.93	2.05	0.01	14.76	0.00	NA	NA
	Damt	3002	16.94	8.91	28.02	14.52	7.24	24.97	3.23	0.61	9.50	0.00	NA	NA
	Jahaf	3007	7.59	4.49	11.88	7.17	4.43	10.87	0.42	0.00	3.02	0.00	NA	NA
	Juban	3001	12.08	6.93	19.11	11.32	6.41	18.12	0.38	0.00	2.66	0.75	0.00	5.48
	Qa'atabah	3003	23.31	15.66	32.49	21.19	14.62	29.06	2.97	0.80	7.50	0.00	NA	NA
Al Hudaydah	Ad Dahi	1809	0.41	0.00	2.95	0.00	NA	NA	0.41	0.00	2.95	0.00	NA	NA
	Ad Durayhimi	1814	0.38	0.00	2.74	0.00	NA	NA	0.38	0.00	2.74	0.00	NA	NA
	Al Garrahi	1825	2.82	0.89	6.57	2.82	0.89	6.57	0.00	NA	NA	0.00	NA	NA
	Al Hajjaylah	1811	2.02	0.54	5.12	0.81	0.07	3.23	1.21	0.24	3.55	0.00	NA	NA
	Al Hali	1823	0.70	0.06	2.86	0.00	NA	NA	0.70	0.06	2.86	0.00	NA	NA
	Al Hawak	1821	1.06	0.15	3.61	0.00	NA	NA	1.06	0.15	3.61	0.00	NA	NA

	Al Khawkhah	1820	0.77	0.05	3.27	0.77	0.05	3.27	0.00	NA	NA	0.00	NA	NA
	Al Mansuriyah	1816	0.82	0.08	3.23	0.82	0.08	3.23	0.41	0.00	2.92	0.00	NA	NA
	Al Marawi'ah	1813	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Al Mighlaf	1808	0.81	0.07	3.29	0.00	NA	NA	0.81	0.07	3.29	0.00	NA	NA
	Al Mina	1822	2.34	0.34	7.70	0.00	NA	NA	2.34	0.34	7.70	0.00	NA	NA
	Al Munirah	1805	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Al Qanawis	1806	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Alluheyah	1802	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	As Salif	1804	2.12	0.76	4.62	0.00	NA	NA	0.71	0.04	3.24	1.41	0.50	3.14
	As Sukhnah	1815	2.41	0.92	5.06	1.61	0.25	5.19	0.80	0.07	3.18	0.00	NA	NA
	At Tuhayat	1826	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Az Zaydiyah	1807	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Az Zuhrah	1801	1.20	0.23	3.60	0.00	NA	NA	1.20	0.23	3.60	0.00	NA	NA
	Bajil	1810	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Bayt Al Faqiah	1817	0.40	0.00	2.98	0.00	NA	NA	0.40	0.00	2.98	0.00	NA	NA
	Bura	1812	2.80	0.35	9.70	1.20	0.08	5.20	1.60	0.01	11.04	0.00	NA	NA
	Hays	1819	1.27	0.07	5.72	1.27	0.07	5.72	0.00	NA	NA	0.00	NA	NA
	Jabal Ra's	1818	4.45	0.51	15.45	1.62	0.01	11.29	4.05	0.47	14.06	0.00	NA	NA
	Kamaran	1803	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Zabid	1824	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
Al Jawf	Al Ghayl	1608	0.84	0.06	3.45	0.00	NA	NA	0.00	NA	NA	0.84	0.06	3.45
	Al Hazm	1605	0.73	0.05	3.09	0.00	NA	NA	0.36	0.00	2.69	0.36	0.00	2.67
	Al Humaydat	1602	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Al Khalq	1609	1.10	0.24	3.12	0.55	0.00	5.29	0.00	NA	NA	0.55	0.00	4.99
	Al Maslub	1607	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Al Matammah	1603	0.47	0.00	3.31	0.00	NA	NA	0.47	0.00	3.31	0.00	NA	NA
	Al Maton	1606	1.98	0.06	10.09	1.58	0.01	11.08	0.00	NA	NA	0.40	0.00	2.81
	Az Zahir	1604	1.18	0.07	5.23	1.18	0.07	5.23	0.00	NA	NA	0.00	NA	NA
	Bart Al Anan	1610	1.56	0.25	5.00	0.39	0.00	2.84	0.00	NA	NA	1.17	0.08	5.07
	Khabb wa ash Sha'af	1601	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA

	Kharab Al Marashi	1612	1.19	0.24	3.48	0.00	NA	NA	0.00	NA	NA	1.19	0.24	3.48
	Rajuzah	1611	0.40	0.00	2.86	0.40	0.00	2.86	0.00	NA	NA	0.00	NA	NA
Al Mahrah	Al Ghaydah	2804	11.60	6.53	18.61	11.29	6.20	18.41	0.31	0.00	2.32	0.00	NA	NA
	Al Masilah	2806	33.93	27.51	40.82	33.93	27.51	40.82	0.00	NA	NA	0.00	NA	NA
	Hat	2802	12.50	1.43	39.19	12.50	1.43	39.19	0.00	NA	NA	0.00	NA	NA
	Hawf	2803	17.60	9.53	28.55	17.60	9.53	28.55	1.60	0.08	7.46	0.00	NA	NA
	Huswain	2809	15.32	7.83	25.90	15.32	7.83	25.90	0.00	NA	NA	0.00	NA	NA
	Man'ar	2805	7.41	3.27	14.03	7.41	3.27	14.03	0.00	NA	NA	0.00	NA	NA
	Qishn	2808	28.63	21.81	36.24	28.63	21.81	36.24	0.00	NA	NA	0.00	NA	NA
	Sayhut	2807	26.61	15.59	40.28	26.21	14.76	40.63	0.00	NA	NA	0.40	0.00	2.97
	Shahan	2801	13.68	1.20	44.98	13.68	1.20	44.98	0.85	0.00	7.30	0.00	NA	NA
Al Mahwit	Al Khabt	2704	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Al Mahwait	2709	29.20	8.46	59.36	12.80	2.00	36.62	17.60	3.87	43.04	8.40	2.30	20.26
	Al Mahwait City	2708	14.64	7.63	24.52	5.00	1.82	10.70	9.64	5.17	16.07	0.00	NA	NA
	Ar Rujum	2703	12.14	4.40	25.10	8.21	3.82	15.04	3.21	0.36	11.41	1.07	0.07	4.71
	At Tawilah	2702	23.02	13.38	35.29	20.24	10.10	34.18	0.00	NA	NA	3.97	0.92	10.67
	Bani Sa'd	2707	2.00	0.06	10.26	0.40	0.00	2.90	2.00	0.06	10.26	0.00	NA	NA
	Hufash	2706	4.80	1.38	11.59	1.60	0.07	7.65	2.00	0.22	7.23	1.60	0.25	5.13
	Milhan	2705	21.60	3.63	54.95	10.00	0.20	46.23	21.20	3.52	54.35	0.00	NA	NA
	Shibam Kawkaban	2701	6.80	2.24	15.18	2.40	0.15	10.30	0.40	0.00	2.86	4.40	1.43	10.02
Amanat Al Asimah	Al Wahdah	1306	11.83	7.89	16.82	11.83	7.89	16.82	0.00	NA	NA	0.00	NA	NA
	As Sabain	1305	10.40	6.50	15.55	10.00	6.61	14.36	0.40	0.00	3.12	0.00	NA	NA
	Assafi'yah	1304	17.60	11.06	25.92	17.20	10.59	25.71	0.40	0.00	2.90	0.00	NA	NA
	At Tahrir	1307	5.43	1.60	12.93	4.98	1.24	12.84	0.45	0.00	3.40	0.00	NA	NA
	Ath'thaorah	1309	0.71	0.06	2.90	0.00	NA	NA	0.71	0.06	2.90	0.00	NA	NA
	Az'zal	1303	17.60	13.62	22.18	16.40	13.24	19.97	1.60	0.26	5.09	0.00	NA	NA
	Bani Al Harith	1310	14.29	6.64	25.63	12.50	5.99	22.17	2.50	0.45	7.56	0.00	NA	NA
	Ma'ain	1308	11.60	6.16	19.34	10.80	5.15	19.31	1.20	0.25	3.43	0.00	NA	NA
	Old City	1301	0.36	0.00	2.82	0.36	0.00	2.82	0.00	NA	NA	0.00	NA	NA

	Shu'aub	1302	5.36	1.55	12.85	5.36	1.55	12.85	0.36	0.00	2.49	0.00	NA	NA
Amran	Al Ashah	2903	0.79	0.01	5.53	0.79	0.01	5.53	0.00	NA	NA	0.00	NA	NA
	Al Madan	2906	0.38	0.00	2.72	0.38	0.00	2.72	0.00	NA	NA	0.00	NA	NA
	Al Qaflah	2904	1.56	0.07	7.36	1.56	0.07	7.36	0.00	NA	NA	0.00	NA	NA
	Amran	2915	2.53	0.72	6.22	1.81	0.31	5.62	0.72	0.00	5.17	0.00	NA	NA
	As Sawd	2914	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	As Sudah	2913	2.90	0.14	13.13	0.83	0.07	3.37	0.41	0.00	2.98	1.66	0.07	7.96
	Bani Suraim	2920	0.41	0.00	2.92	0.41	0.00	2.92	0.00	NA	NA	0.00	NA	NA
	Dhi Bin	2909	0.82	0.01	5.77	0.82	0.01	5.77	0.00	NA	NA	0.00	NA	NA
	Habur Zulaymah	2908	2.85	0.50	8.64	0.00	NA	NA	0.00	NA	NA	2.85	0.50	8.64
	Harf Sufyan	2901	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Huth	2902	0.43	0.00	3.04	0.43	0.00	3.04	0.00	NA	NA	0.00	NA	NA
	Iyal Surayh	2918	0.41	0.00	2.96	0.41	0.00	2.96	0.00	NA	NA	0.00	NA	NA
	Jabal Iyal Yazid	2912	1.62	0.26	5.20	1.21	0.24	3.57	0.40	0.00	2.90	0.00	NA	NA
	Khamir	2919	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Kharif	2910	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Maswar	2916	60.29	43.31	75.63	50.18	30.81	69.51	33.21	17.09	52.84	0.36	0.00	2.58
	Raydah	2911	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Shaharah	2905	2.19	0.01	15.28	2.19	0.01	15.28	0.00	NA	NA	0.00	NA	NA
	Suwayr	2907	0.41	0.00	2.96	0.00	NA	NA	0.00	NA	NA	0.41	0.00	2.96
	Thula	2917	17.60	3.14	45.96	14.00	3.16	34.98	2.80	0.06	14.89	2.00	0.15	8.19
Dhamar	Al Hada	2001	0.41	0.00	2.94	0.41	0.00	2.94	0.00	NA	NA	0.00	NA	NA
	Al Manar	2012	0.79	0.01	5.50	0.00	NA	NA	0.79	0.01	5.50	0.00	NA	NA
	Anss	2010	8.40	3.63	16.06	1.26	0.08	5.42	7.14	2.58	15.16	0.00	NA	NA
	Dawran Aness	2011	1.26	0.08	5.45	0.84	0.07	3.36	0.42	0.00	2.98	0.00	NA	NA
	Dhamar City	2008	4.98	1.45	11.94	1.42	0.11	5.78	3.56	0.42	12.43	0.00	NA	NA
	Jabal Ash sharq	2003	4.07	1.01	10.58	4.07	1.01	10.58	0.00	NA	NA	0.00	NA	NA
	Jahran	2002	3.48	0.19	15.08	1.74	0.01	11.85	1.74	0.13	7.19	0.00	NA	NA
	Maghirib Ans	2004	3.75	0.80	10.48	2.08	0.07	10.45	1.67	0.22	5.71	0.00	NA	NA

	Mayfa'at Anss	2009	2.92	0.67	7.92	0.83	0.01	5.88	2.08	0.55	5.32	0.00	NA	NA
	Utmah	2005	4.90	1.32	12.19	4.49	1.26	11.00	0.41	0.00	2.95	0.00	NA	NA
	Wusab Al Ali	2006	16.67	6.70	32.00	16.25	6.21	32.08	0.42	0.00	2.99	0.00	NA	NA
	Wusab As Safil	2007	0.83	0.07	3.40	0.83	0.07	3.40	0.00	NA	NA	0.00	NA	NA
Hadramawt	Ad Dis	1914	18.32	7.67	34.22	17.94	7.43	33.76	0.38	0.00	2.73	0.00	NA	NA
	Adh Dhlia'ah	1922	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Al Abr	1906	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Al Mukalla	1930	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Al Mukalla City	1929	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Al Qaf	1903	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Al Qatn	1907	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Amd	1921	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Ar Raydah Wa Qusayar	1913	21.89	14.12	31.43	21.51	13.64	31.28	0.38	0.00	2.74	0.00	NA	NA
	As Sawm	1912	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Ash Shihr	1915	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Brom Mayfa	1925	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Daw'an	1918	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Ghayl Ba Wazir	1917	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Ghayl Bin Yamin	1916	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Hagr As Sai'ar	1905	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Hajr	1924	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Hidaybu	1926	17.90	10.93	26.86	17.90	10.93	26.86	0.00	NA	NA	0.00	NA	NA
	Huraidhah	1928	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Qulensya Wa Abd Al Kuri	1927	23.08	9.38	42.77	23.08	9.38	42.77	0.48	0.00	3.51	0.00	NA	NA
	Rakhyah	1920	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Rumah	1901	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Sah	1909	0.41	0.00	2.87	0.00	NA	NA	0.41	0.00	2.87	0.00	NA	NA
	Sayun	1910	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Shibam	1908	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Tarim	1911	0.41	0.00	2.88	0.00	NA	NA	0.41	0.00	2.88	0.00	NA	NA

	Thamud	1902	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Wadi Al Ayn	1919	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Yabuth	1923	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Zamakh wa Manwakh	1904	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
Hajjah	Abs	1704	4.40	1.56	9.56	4.40	1.56	9.56	0.00	NA	NA	0.00	NA	NA
	Aflah Al Yaman	1714	33.20	3.90	78.70	18.58	2.49	51.79	32.41	3.83	77.59	0.00	NA	NA
	Aflah Ash Shawm	1710	0.40	0.00	2.84	0.00	NA	NA	0.40	0.00	2.84	0.00	NA	NA
	Al Jamimah	1708	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Al Maghrabah	1717	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Al Mahabishah	1715	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Al Miftah	1716	5.56	0.19	25.63	5.16	0.21	23.35	0.79	0.00	5.63	0.00	NA	NA
	Ash Shaghadirah	1725	24.00	12.70	38.79	5.20	2.15	10.33	22.40	11.87	36.34	0.00	NA	NA
	Ash Shahil	1721	4.88	0.38	18.84	0.41	0.00	2.92	4.88	0.38	18.84	0.00	NA	NA
	Aslem	1712	2.40	0.57	6.46	2.40	0.57	6.46	0.00	NA	NA	0.00	NA	NA
	Bakil Al Mir	1701	15.55	4.31	35.50	15.55	4.31	35.50	0.00	NA	NA	0.00	NA	NA
	Bani Al Awam	1727	39.60	22.88	58.31	34.40	20.24	50.93	14.40	8.49	22.27	2.80	0.39	9.32
	Bani Qa'is	1724	4.80	1.38	11.59	2.00	0.15	8.19	2.80	0.80	6.89	0.00	NA	NA
	Hajjah	1729	27.60	8.94	54.66	22.22	5.89	49.08	9.32	2.66	21.95	0.00	NA	NA
	Hajjah City	1728	7.78	2.67	16.93	6.23	2.29	13.15	2.33	0.47	6.78	0.00	NA	NA
	Harad	1702	3.05	0.85	7.56	3.05	0.85	7.56	0.00	NA	NA	0.00	NA	NA
	Hayran	1705	2.01	0.58	4.93	2.01	0.58	4.93	0.00	NA	NA	0.00	NA	NA
	Khayran Al Muharraq	1711	6.23	2.35	12.95	6.23	2.35	12.95	0.00	NA	NA	0.00	NA	NA
	Ku'aydinah	1722	4.02	1.35	9.01	4.02	1.35	9.01	0.00	NA	NA	0.00	NA	NA
	Kuhlan Affar	1718	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Kuhlan Ash Sharaf	1709	5.98	0.44	23.04	4.38	0.33	17.24	2.79	0.21	11.25	0.00	NA	NA
	Kushar	1707	3.97	1.57	8.14	3.97	1.57	8.14	0.00	NA	NA	0.00	NA	NA
	Mabyan	1720	2.87	0.66	7.82	1.23	0.08	5.38	1.64	0.07	7.83	0.00	NA	NA
	Midi	1703	6.77	3.26	12.18	6.77	3.26	12.18	0.00	NA	NA	0.00	NA	NA
	Mustaba	1706	3.98	1.14	9.68	3.98	1.14	9.68	0.00	NA	NA	0.00	NA	NA
	Najrah	1726	14.40	2.53	39.05	6.00	1.11	17.35	10.40	1.64	30.46	0.00	NA	NA

	Qafl Shamer	1713	29.96	12.21	53.63	3.11	0.30	11.61	28.40	12.33	49.86	0.00	NA	NA
	Qarah	1731	1.58	0.33	4.51	1.58	0.33	4.51	0.00	NA	NA	0.00	NA	NA
	Sharas	1719	9.24	2.63	21.77	6.83	1.45	18.59	3.21	0.61	9.45	0.00	NA	NA
	Wadhrah	1723	10.80	1.42	33.28	1.60	0.45	3.99	10.00	0.96	33.93	0.00	NA	NA
	Washhah	1730	3.50	1.27	7.56	3.50	1.27	7.56	0.00	NA	NA	0.00	NA	NA
Ibb	Al Dhihar	1119	30.56	18.48	44.97	24.21	16.03	34.05	7.54	2.73	15.95	0.00	NA	NA
	Al Makhadir	1107	12.60	9.11	16.84	10.57	7.78	13.94	3.25	1.23	6.84	0.00	NA	NA
	Al Mashannah	1118	21.77	13.31	32.41	20.41	12.76	30.01	2.04	0.55	5.17	0.00	NA	NA
	Al Qafr	1101	14.23	9.34	20.42	11.46	6.74	17.86	3.56	1.25	7.80	0.00	NA	NA
	Al Udayn	1111	30.40	20.26	42.16	23.60	18.09	29.85	10.00	3.06	22.72	0.00	NA	NA
	An Nadirah	1104	14.81	9.72	21.25	14.81	9.72	21.25	0.00	NA	NA	0.00	NA	NA
	Ar Radmah	1103	24.28	13.71	37.76	20.58	11.45	32.58	4.53	1.12	11.75	0.00	NA	NA
	As Sabrah	1114	25.60	18.73	33.49	24.80	17.78	32.95	0.80	0.07	3.22	0.00	NA	NA
	As Saddah	1106	24.80	14.09	38.38	22.36	11.65	36.62	3.66	1.48	7.40	0.00	NA	NA
	As Sayyani	1115	38.40	33.24	43.76	36.80	30.75	43.17	2.40	0.68	5.95	0.00	NA	NA
	Ash Sha'ir	1105	14.75	9.13	22.07	13.52	8.59	19.89	1.23	0.07	5.47	0.00	NA	NA
	Ba'dan	1113	20.83	10.50	34.93	18.18	8.88	31.30	7.58	3.44	14.11	0.00	NA	NA
	Dhi As Sufal	1116	34.40	24.65	45.22	30.00	22.07	38.92	7.60	1.14	23.30	0.00	NA	NA
	Far Al Udayn	1110	16.00	8.59	26.21	13.60	6.33	24.43	2.40	0.09	11.58	0.00	NA	NA
	Hazm Al Udayn	1109	17.08	12.96	21.89	16.67	12.50	21.55	0.83	0.09	3.08	0.00	NA	NA
	Hubaysh	1108	19.77	14.17	26.42	18.25	12.95	24.60	2.28	0.45	6.64	0.00	NA	NA
	Ibb	1120	26.95	15.24	41.61	21.88	12.56	33.88	9.38	1.49	27.67	0.00	NA	NA
	Jiblah	1112	26.72	17.56	37.62	21.46	14.07	30.51	12.55	5.89	22.52	0.00	NA	NA
	Mudhaykhirah	1117	35.60	22.73	50.19	31.20	18.62	46.19	7.20	3.08	13.89	0.00	NA	NA
	Yarim	1102	26.00	17.69	35.80	18.80	12.42	26.69	11.60	5.53	20.68	0.00	NA	NA
Lahij	Al Hawtah	2514	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Al Had	2501	0.39	0.00	2.53	0.00	NA	NA	0.39	0.00	2.53	0.00	NA	NA
	Al Madaribah Wa Al Arah	2513	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Al Maflahy	2503	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA

	Al Maqatirah	2512	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Al Milah	2508	0.39	0.00	2.82	0.00	NA	NA	0.39	0.00	2.82	0.00	NA	NA
	Al Musaymir	2509	0.78	0.07	3.17	0.00	NA	NA	0.78	0.07	3.17	0.00	NA	NA
	Al Qabbaytah	2510	0.40	0.00	2.83	0.00	NA	NA	0.40	0.00	2.83	0.00	NA	NA
	Habil Jabr	2505	14.23	9.34	20.40	13.81	9.00	19.93	0.42	0.00	3.00	0.00	NA	NA
	Halimayn	2506	11.25	5.41	19.97	11.25	5.41	19.97	1.25	0.08	5.48	0.00	NA	NA
	Radfan	2507	9.80	6.60	13.86	9.80	6.60	13.86	0.00	NA	NA	0.00	NA	NA
	Tuban	2515	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Tur Al Bahah	2511	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Yafa'a	2502	0.40	0.00	2.87	0.00	NA	NA	0.40	0.00	2.87	0.00	NA	NA
	Yahr	2504	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
Ma'rib	Al Abdiyah	2611	0.86	0.06	3.71	0.86	0.06	3.71	0.00	NA	NA	0.00	NA	NA
	Al Jubah	2607	0.43	0.00	3.17	0.43	0.00	3.17	0.00	NA	NA	0.00	NA	NA
	Bidbadah	2605	3.41	0.75	9.40	3.41	0.75	9.40	0.00	NA	NA	0.00	NA	NA
	Harib	2609	0.81	0.07	3.30	0.81	0.07	3.30	0.00	NA	NA	0.00	NA	NA
	Harib Al Qaramish	2604	0.95	0.09	3.65	0.47	0.00	3.20	0.47	0.00	3.42	0.00	NA	NA
	Jabal Murad	2614	0.49	0.00	3.57	0.49	0.00	3.57	0.00	NA	NA	0.00	NA	NA
	Mahliyah	2610	3.47	0.94	8.69	3.47	0.94	8.69	0.00	NA	NA	0.00	NA	NA
	Majzar	2601	8.41	3.08	17.63	7.48	2.26	17.34	0.00	NA	NA	0.93	0.00	7.14
	Marib	2613	2.67	0.60	7.36	1.78	0.32	5.39	0.89	0.08	3.49	0.00	NA	NA
	Marib City	2612	1.79	0.47	4.59	0.71	0.06	2.90	1.07	0.21	3.16	0.00	NA	NA
	Medghal	2603	4.61	1.68	9.86	3.95	1.29	8.99	0.66	0.01	4.38	0.00	NA	NA
	Raghwan	2602	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Rahabah	2608	4.67	1.94	9.28	3.74	1.34	8.09	0.93	0.08	3.73	0.00	NA	NA
	Sirwah	2606	5.26	2.21	10.36	4.82	2.14	9.20	0.00	NA	NA	0.44	0.00	3.23
Raymah	Al Jabin	3102	3.61	0.62	11.05	3.61	0.62	11.05	0.00	NA	NA	0.00	NA	NA
	Al Jafariyah	3105	10.08	2.67	24.37	5.81	0.74	19.19	4.65	1.19	11.89	0.00	NA	NA
	As Salafiyah	3103	5.24	1.77	11.66	3.63	0.92	9.39	0.40	0.00	2.93	1.21	0.01	8.62
	Bilad At Ta'am	3101	1.62	0.25	5.27	1.62	0.25	5.27	0.00	NA	NA	0.00	NA	NA

	Kusmah	3104	0.40	0.00	2.94	0.40	0.00	2.94	0.00	NA	NA	0.00	NA	NA
	Mazhar	3106	4.12	0.12	20.45	4.12	0.12	20.45	0.00	NA	NA	0.00	NA	NA
Sa`dah	Al Dhaher	2207	15.20	6.65	28.10	15.20	6.65	28.10	0.00	NA	NA	0.00	NA	NA
	Al Hashwah	2213	8.00	5.37	11.37	8.00	5.37	11.37	0.00	NA	NA	0.00	NA	NA
	As Safra	2212	6.00	2.49	11.84	6.00	2.49	11.84	0.00	NA	NA	0.00	NA	NA
	Baqim	2201	2.80	0.84	6.69	2.80	0.84	6.69	0.00	NA	NA	0.00	NA	NA
	Ghamr	2204	5.60	1.95	12.22	5.60	1.95	12.22	0.00	NA	NA	0.00	NA	NA
	Haydan	2208	13.60	9.07	19.30	13.60	9.07	19.30	0.00	NA	NA	0.00	NA	NA
	Kitaf wa Al Boqe'e	2214	6.00	2.93	10.71	6.00	2.93	10.71	0.00	NA	NA	0.00	NA	NA
	Majz	2210	4.80	1.06	13.06	4.80	1.06	13.06	0.00	NA	NA	0.00	NA	NA
	Monabbih	2203	14.40	4.84	30.49	14.40	4.84	30.49	0.00	NA	NA	0.00	NA	NA
	Qatabir	2202	6.80	3.13	12.57	6.80	3.13	12.57	0.00	NA	NA	0.00	NA	NA
	Razih	2205	15.60	10.37	22.14	14.00	8.22	21.74	1.60	0.25	5.15	0.00	NA	NA
	Sa'adah	2215	3.60	0.77	10.02	3.60	0.77	10.02	0.00	NA	NA	0.00	NA	NA
	Sahar	2211	4.40	2.03	8.18	4.40	2.03	8.18	0.00	NA	NA	0.00	NA	NA
	Saqayn	2209	4.40	1.63	9.33	4.40	1.63	9.33	0.00	NA	NA	0.00	NA	NA
	Shada'a	2206	35.14	23.38	48.37	35.14	23.38	48.37	0.00	NA	NA	0.00	NA	NA
San`a'	Al Haymah Ad Dakhiliyah	2308	8.13	1.78	21.58	6.36	1.80	15.33	2.12	0.01	14.65	0.00	NA	NA
	Al Haymah Al Kharijiyah	2309	8.83	3.82	16.84	8.83	3.82	16.84	0.00	NA	NA	0.00	NA	NA
	Al Husn	2315	8.33	4.25	14.38	8.33	4.25	14.38	0.00	NA	NA	0.00	NA	NA
	Arhab	2302	2.92	0.83	7.15	2.92	0.83	7.15	0.00	NA	NA	0.00	NA	NA
	Attyal	2313	7.92	3.06	16.15	7.92	3.06	16.15	0.00	NA	NA	0.00	NA	NA
	Bani Dhabyan	2314	2.86	0.29	10.57	2.86	0.29	10.57	0.00	NA	NA	0.00	NA	NA
	Bani Hushaysh	2304	8.75	3.54	17.35	8.75	3.54	17.35	0.00	NA	NA	0.00	NA	NA
	Bani Matar	2307	16.67	11.12	23.56	16.25	10.35	23.77	0.42	0.00	2.99	0.00	NA	NA
	Bilad Ar Rus	2306	7.08	1.73	18.15	7.08	1.73	18.15	0.42	0.00	2.99	0.00	NA	NA
	Hamdan	2301	5.00	0.70	16.15	5.00	0.70	16.15	0.00	NA	NA	0.00	NA	NA
	Jihanah	2316	11.67	4.57	23.23	11.67	4.57	23.23	0.00	NA	NA	0.00	NA	NA
	Khwlan	2312	7.50	3.96	12.68	7.50	3.96	12.68	0.00	NA	NA	0.00	NA	NA

	Manakhah	2310	5.71	3.01	9.73	5.36	2.44	10.03	0.36	0.00	2.57	0.00	NA	NA
	Nihm	2303	2.14	0.42	6.29	2.14	0.42	6.29	0.00	NA	NA	0.00	NA	NA
	Sa'fan	2311	12.98	5.54	24.54	7.02	3.07	13.39	5.96	0.25	26.30	0.00	NA	NA
	Sanhan	2305	9.17	4.73	15.68	8.33	4.25	14.38	0.83	0.07	3.38	0.00	NA	NA
Shabwah	Ain	2106	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Al Talh	2102	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Ar Rawdah	2115	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Arma	2104	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	As Said	2112	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Ataq	2113	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Bayhan	2107	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Dhar	2101	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Habban	2114	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Hatib	2111	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Jardan	2103	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Mayfa'a	2116	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Merkhah Al Ulya	2108	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Merkhah As Sufla	2109	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Nisab	2110	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Rudum	2117	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
	Usaylan	2105	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA	0.00	NA	NA
Ta`izz	Al Mukha	1506	21.91	9.59	39.43	19.92	8.20	37.26	1.99	0.55	5.00	0.00	NA	NA
	Al Ma'afer	1521	11.07	5.14	20.09	11.07	5.14	20.09	0.40	0.00	2.85	0.00	NA	NA
	Al Mawasit	1522	38.93	24.69	54.70	38.93	24.69	54.70	0.00	NA	NA	0.00	NA	NA
	Al Misrakh	1512	9.88	4.14	19.11	9.09	3.37	18.86	0.79	0.07	3.11	0.40	0.00	2.72
	Al Mudhaffar	1518	20.71	12.62	30.98	18.57	11.15	28.16	2.14	0.42	6.29	0.00	NA	NA
	Al Qahirah	1519	44.57	38.74	50.51	43.48	36.78	50.36	1.45	0.11	5.94	0.36	0.00	2.75
	Al Wazi'iyah	1516	13.60	10.43	17.31	12.00	8.33	16.56	1.60	0.30	4.81	0.00	NA	NA
	As Silw	1514	46.54	31.08	62.50	43.46	26.73	61.36	5.38	1.63	12.65	0.00	NA	NA

	Ash Shamayatayn	1515	28.57	22.22	35.61	28.57	22.22	35.61	1.59	0.25	5.13	0.00	NA	NA
	At Ta'iziyah	1502	22.66	11.16	38.24	22.27	10.73	38.08	0.78	0.10	2.74	0.00	NA	NA
	Dhubab	1507	7.60	2.93	15.54	7.20	3.07	13.94	0.40	0.00	2.71	0.40	0.00	2.85
	Dimnat Khadir	1513	40.38	28.75	52.87	40.38	28.75	52.87	0.38	0.00	2.76	0.00	NA	NA
	Hayfan	1517	52.72	39.33	65.83	52.72	39.33	65.83	1.26	0.08	5.52	0.42	0.00	2.94
	Jabal Habashy	1509	13.60	8.81	19.72	12.80	8.04	19.01	0.80	0.06	3.30	0.00	NA	NA
	Maqbanah	1505	22.71	17.36	28.81	21.91	16.02	28.78	1.99	0.54	5.05	0.00	NA	NA
	Mashra'a Wa Hadnan	1510	14.34	9.89	19.84	12.35	8.39	17.32	1.99	0.25	6.95	0.00	NA	NA
	Mawiyah	1501	18.40	9.97	29.79	17.20	8.77	28.97	2.00	0.52	5.19	0.00	NA	NA
	Mawza	1508	20.16	13.02	29.02	19.76	12.74	28.50	0.40	0.00	2.81	0.00	NA	NA
	Sabir Al Mawadim	1511	23.69	15.84	33.13	21.69	14.45	30.48	3.61	0.93	9.28	0.00	NA	NA
	Salh	1520	35.86	26.73	45.80	34.66	25.47	44.78	5.58	1.93	12.21	0.00	NA	NA
	Sama	1523	18.40	6.56	37.08	18.40	6.56	37.08	0.00	NA	NA	0.00	NA	NA
	Shara'b Ar Rawnah	1504	20.78	13.28	30.10	18.43	11.15	27.81	1.96	0.51	5.08	0.78	0.07	3.18
	Shara'b As Salam	1503	19.60	13.34	27.20	16.80	10.64	24.64	3.60	1.53	7.06	0.00	NA	NA
Grand Total			**8.76**	**-**	**-**	**7.63**	**-**	**-**	**1.51**	**-**	**-**	**0.14**	**-**	**-**

[a]95% Confidence Interval (CI), calculated by district taking into account clustering at school-level.

Table of the prevalence of anaemia by district in Yemen (2014)

Governorate	District	District code	Average Prevalence of Anaemia (%)[a]				
			Any Anaemia[b]			At least Moderate[c]	Severe
			%	Lower CI	Upper CI		
`Adan	Al Buraiqeh	2404	41.47	34.75	48.44	21.71	0.39
	Al Mansura	2403	43.92	32.98	55.32	20.00	0.00
	Al Mualla	2406	41.92	27.88	56.98	23.23	0.00
	Ash Shaikh Outhman	2402	38.00	28.32	48.43	21.20	0.00
	Attawahi	2405	43.29	33.97	52.98	20.78	0.00
	Craiter	2407	49.40	30.90	68.02	25.70	0.40
	Dar Sad	2401	47.91	41.09	54.79	23.19	0.38
	Khur Maksar	2408	45.64	31.82	59.97	20.51	0.51
Abyan	Al Mahfad	1201	26.25	15.56	39.47	9.17	0.00
	Ahwar	1209	44.17	36.98	51.54	17.50	0.83
	Al Wade'a	1208	17.92	13.66	22.84	5.00	0.00
	Jayshan	1203	45.83	35.11	56.84	20.83	0.00
	Khanfir	1211	37.86	27.71	48.85	12.86	0.71
	Lawdar	1204	15.00	5.89	29.38	3.33	0.42
	Mudiyah	1202	18.75	9.62	31.32	5.00	0.00
	Rasad	1206	29.58	13.69	50.18	12.92	0.00
	Sarar	1207	29.05	11.94	52.04	10.95	0.00
	Sibah	1205	24.58	14.39	37.39	6.25	0.00
	Zingibar	1210	40.56	31.06	50.62	22.09	0.40
Al Bayda'	Al A'rsh	1416	11.74	5.07	22.16	6.10	0.00
	Al Bayda	1410	20.00	10.81	32.28	9.02	0.39
	Al Bayda City	1409	33.72	20.79	48.71	18.22	0.00
	Al Malagim	1420	3.33	0.61	9.94	0.42	0.00
	Al Quraishyah	1414	5.83	1.89	13.22	1.67	0.00

	Ar Ryashyyah	1418	19.58	11.35	30.32	9.58	0.00
	As Sawadiyah	1411	2.08	0.23	7.56	0.42	0.00
	As Sawma'ah	1404	23.48	14.77	34.22	8.50	0.00
	Ash Sharyah	1419	5.42	2.61	9.78	2.92	0.00
	At Taffah	1407	55.17	46.81	63.33	31.47	0.00
	Az Zahir	1405	52.59	39.99	64.95	28.69	0.00
	Dhi Na'im	1406	44.44	32.13	57.28	19.44	0.00
	Maswarah	1403	65.45	58.74	71.73	38.22	2.09
	Mukayras	1408	55.56	42.33	68.23	28.57	0.00
	Na'man	1401	64.29	55.91	72.07	41.07	0.00
	Nati'	1402	71.57	53.28	85.82	47.21	0.00
	Rada'	1413	15.83	7.70	27.53	7.50	0.42
	Radman Al Awad	1412	0.83	0.07	3.38	0.42	0.00
	Sabah	1417	15.00	5.89	29.38	8.33	0.83
Al Dali'	Ad Dhale'e	3006	16.95	7.77	30.35	8.05	0.00
	Al Azariq	3008	34.04	12.68	61.61	19.15	1.70
	Al Husha	3009	20.40	12.93	29.73	8.80	0.00
	Al Hussein	3005	9.32	4.70	16.16	0.85	0.42
	Ash Shu'ayb	3004	15.57	6.11	30.43	6.97	0.82
	Damt	3002	17.00	NA	NA	4.86	0.00
	Jahaf	3007	12.66	6.46	21.58	2.95	0.42
	Juban	3001	12.08	4.75	23.96	1.89	0.00
	Qa'atabah	3003	17.37	10.83	25.74	5.51	0.42
Al Hudaydah	Ad Dahi	1809	56.56	46.32	66.40	26.23	0.41
	Ad Durayhimi	1814	67.94	52.85	80.71	34.35	1.15
	Al Garrahi	1825	21.48	14.56	29.84	7.39	0.70
	Al Hajjaylah	1811	22.18	16.07	29.31	7.66	0.40
	Al Hali	1823	73.59	61.09	83.82	44.72	1.06
	Al Hawak	1821	76.95	69.39	83.42	47.87	0.35

	Al Khawkhah	1820	13.90	9.80	18.92	5.02	0.39
	Al Mansuriyah	1816	32.10	25.08	39.78	13.17	1.23
	Al Marawi'ah	1813	55.82	45.49	65.79	26.51	1.20
	Al Mighlaf	1808	61.29	50.13	71.65	36.69	0.81
	Al Mina	1822	47.27	35.97	58.77	19.14	0.00
	Al Munirah	1805	64.78	49.25	78.31	37.25	1.62
	Al Qanawis	1806	62.90	49.43	75.05	34.68	1.21
	Alluheyah	1802	53.36	36.10	70.05	28.06	1.19
	As Salif	1804	82.33	73.45	89.22	52.30	0.71
	As Sukhnah	1815	36.55	27.65	46.18	15.66	2.01
	At Tuhayat	1826	49.00	40.15	57.89	24.90	1.20
	Az Zaydiyah	1807	53.52	38.91	67.69	31.25	1.95
	Az Zuhrah	1801	53.60	38.00	68.70	29.60	0.80
	Bajil	1810	46.72	28.54	65.57	22.54	0.82
	Bayt Al Faqiah	1817	23.79	14.46	35.41	10.48	0.40
	Bura	1812	24.00	14.53	35.79	11.60	1.20
	Hays	1819	22.88	16.67	30.11	5.08	0.00
	Jabal Ra's	1818	25.10	14.00	39.23	9.72	1.62
	Kamaran	1803	44.18	28.93	60.27	19.68	0.40
	Zabid	1824	18.95	10.04	31.06	3.63	0.81
Al Jawf	Al Ghayl	1608	17.99	10.04	28.62	10.88	7.53
	Al Hazm	1605	20.73	12.51	31.18	10.55	4.73
	Al Humaydat	1602	4.04	1.44	8.77	0.90	0.00
	Al Khalq	1609	13.19	9.34	17.90	4.95	2.75
	Al Maslub	1607	10.71	NA	NA	3.13	0.89
	Al Matammah	1603	19.34	7.18	38.08	7.08	1.42
	Al Maton	1606	9.49	4.65	16.74	4.74	0.79
	Az Zahir	1604	12.20	3.78	27.17	5.91	3.54
	Bart Al Anan	1610	35.55	22.38	50.53	18.75	1.17
	Khabb wa ash Sha'af	1601	12.77	7.53	19.82	7.66	0.36

	Kharab Al Marashi	1612	50.40	30.49	70.21	26.19	0.40
	Rajuzah	1611	11.34	7.79	15.78	3.24	2.43
Al Mahrah	Al Ghaydah	2804	26.02	14.90	39.96	6.90	0.31
	Al Masilah	2806	41.07	30.81	51.93	18.75	0.45
	Hat	2802	13.64	2.66	36.02	5.68	0.00
	Hawf	2803	28.00	15.85	43.07	10.80	0.80
	Huswain	2809	32.43	19.24	48.04	10.81	0.45
	Man'ar	2805	24.69	19.54	30.44	13.58	0.00
	Qishn	2808	29.39	18.76	41.96	9.54	0.00
	Sayhut	2807	26.61	14.78	41.53	8.87	0.00
	Shahan	2801	17.95	0.71	63.40	9.40	0.00
Al Mahwit	Al Khabt	2704	96.40	91.32	98.95	64.00	0.00
	Al Mahwait	2709	91.60	79.44	97.77	48.00	0.40
	Al Mahwait City	2708	85.00	77.07	91.01	39.29	0.71
	Ar Rujum	2703	95.36	89.84	98.38	52.86	0.00
	At Tawilah	2702	92.46	79.00	98.52	49.21	0.00
	Bani Sa'd	2707	95.60	93.22	97.33	57.60	0.80
	Hufash	2706	90.80	83.66	95.53	40.80	0.00
	Milhan	2705	94.80	84.26	99.13	62.40	0.40
	Shibam Kawkaban	2701	94.00	87.22	97.82	44.00	0.00
Amanat Al Asimah	Al Wahdah	1306	13.26	7.32	21.49	5.02	0.00
	As Sabain	1305	8.40	3.52	16.34	2.40	0.40
	Assafi'yah	1304	9.60	3.16	21.11	3.20	0.00
	At Tahrir	1307	15.38	5.29	32.06	9.05	0.00
	Ath'thaorah	1309	7.86	4.35	12.86	4.64	0.36
	Az'zal	1303	8.80	4.17	15.90	4.80	0.00
	Bani Al Harith	1310	8.21	3.35	16.23	2.86	0.36
	Ma'ain	1308	14.40	7.70	23.73	4.40	0.40
	Old City	1301	8.21	4.04	14.51	2.50	0.00

	Shu'aub	1302	15.36	9.54	22.88	7.14	0.36
Amran	Al Ashah	2903	46.25	28.01	65.25	28.06	0.00
	Al Madan	2906	38.08	25.04	52.50	16.92	0.00
	Al Qaflah	2904	50.58	32.62	68.43	32.68	0.39
	Amran	2915	11.55	7.67	16.50	3.97	0.36
	As Sawd	2914	27.46	10.54	51.03	12.30	0.00
	As Sudah	2913	15.77	11.58	20.74	5.39	0.41
	Bani Suraim	2920	10.61	5.23	18.61	4.90	0.41
	Dhi Bin	2909	22.54	12.79	35.11	9.84	0.00
	Habur Zulaymah	2908	20.73	9.96	35.71	8.13	0.41
	Harf Sufyan	2901	21.40	11.43	34.65	5.24	0.44
	Huth	2902	22.75	14.00	33.65	13.73	0.00
	Iyal Surayh	2918	10.70	4.25	21.24	3.70	0.00
	Jabal Iyal Yazid	2912	27.94	8.30	56.86	16.60	0.00
	Khamir	2919	17.75	6.52	35.41	7.36	0.00
	Kharif	2910	17.46	8.98	29.23	7.14	0.00
	Maswar	2916	10.11	6.86	14.23	3.97	0.00
	Raydah	2911	10.61	6.51	16.07	3.27	1.22
	Shaharah	2905	38.69	17.11	64.12	19.34	0.73
	Suwayr	2907	35.80	23.05	50.22	18.93	2.47
	Thula	2917	10.40	6.10	16.26	2.80	0.00
Dhamar	Al Hada	2001	41.49	16.50	70.22	31.54	1.24
	Al Manar	2012	45.45	26.67	65.24	29.64	1.98
	Anss	2010	48.32	22.08	75.27	33.19	0.42
	Dawran Aness	2011	28.87	13.58	48.74	12.13	0.00
	Dhamar City	2008	41.64	29.69	54.35	22.42	0.36
	Jabal Ash sharq	2003	31.30	18.73	46.26	9.76	0.00
	Jahran	2002	44.95	25.59	65.50	27.53	0.00
	Maghirib Ans	2004	34.58	19.90	51.78	20.42	0.42

	Mayfa'at Anss	2009	59.00	NA	NA	42.26	3.35
	Utmah	2005	16.33	7.75	28.74	5.71	0.00
	Wusab Al Ali	2006	44.58	33.40	56.18	20.00	0.00
	Wusab As Safil	2007	44.17	28.82	60.38	22.50	1.25
Hadramawt	Ad Dis	1914	49.24	31.56	67.06	23.66	0.76
	Adh Dhlia'ah	1922	60.74	30.63	85.79	45.87	0.00
	Al Abr	1906	13.16	5.86	24.29	4.61	0.00
	Al Mukalla	1930	63.82	32.11	88.51	46.34	0.41
	Al Mukalla City	1929	45.78	26.64	65.88	32.13	0.00
	Al Qaf	1903	0.00	NA	NA	0.00	0.00
	Al Qatn	1907	29.75	17.51	44.56	13.22	0.00
	Amd	1921	46.43	30.15	63.28	35.71	0.00
	Ar Raydah Wa Qusayar	1913	29.06	17.84	42.52	13.58	0.38
	As Sawm	1912	27.82	15.55	43.13	12.50	0.00
	Ash Shihr	1915	55.87	34.45	75.80	28.74	0.00
	Brom Mayfa	1925	70.04	43.43	89.37	49.80	0.00
	Daw'an	1918	48.63	25.65	72.04	32.94	0.39
	Ghayl Ba Wazir	1917	43.39	20.47	68.60	24.79	0.00
	Ghayl Bin Yamin	1916	51.35	25.65	76.54	28.57	0.00
	Hagr As Sai'ar	1905	14.06	0.34	57.56	6.25	0.00
	Hajr	1924	53.15	30.07	75.28	33.46	0.00
	Hidaybu	1926	26.07	17.96	35.58	5.84	0.00
	Huraidhah	1928	56.25	31.34	79.04	33.33	0.42
	Qulensya Wa Abd Al Kuri	1927	33.82	NA	NA	17.39	0.00
	Rakhyah	1920	25.00	13.13	40.45	12.93	0.00
	Rumah	1901	19.17	5.39	42.39	10.00	0.00
	Sah	1909	28.46	15.58	44.53	10.16	0.00
	Sayun	1910	35.60	22.23	50.85	12.80	0.00
	Shibam	1908	34.43	22.79	47.61	15.16	0.41
	Tarim	1911	20.82	11.19	33.64	5.71	0.41

	Thamud	1902	20.90	4.24	50.82	10.45	0.75
	Wadi Al Ayn	1919	50.56	28.09	72.87	37.45	0.37
	Yabuth	1923	62.30	34.79	84.97	45.24	0.00
	Zamakh wa Manwakh	1904	14.81	0.00	100.00	7.41	0.00
Hajjah	Abs	1704	36.40	26.91	46.74	14.00	0.80
	Aflah Al Yaman	1714	50.99	41.99	59.94	27.67	0.79
	Aflah Ash Shawm	1710	48.41	42.96	53.89	27.38	0.40
	Al Jamimah	1708	31.87	20.66	44.86	14.34	0.00
	Al Maghrabah	1717	51.57	30.13	72.60	27.95	0.00
	Al Mahabishah	1715	33.33	10.12	64.74	14.29	0.00
	Al Miftah	1716	31.08	NA	NA	14.74	0.80
	Ash Shaghadirah	1725	90.80	83.61	95.55	49.60	0.40
	Ash Shahil	1721	22.36	14.47	32.02	10.98	0.81
	Aslem	1712	44.40	34.13	55.04	18.00	0.40
	Bakil Al Mir	1701	36.55	21.46	53.86	16.81	1.68
	Bani Al Awam	1727	94.40	88.98	97.65	48.00	0.00
	Bani Qa'is	1724	98.80	94.74	99.93	72.00	0.80
	Hajjah	1729	29.39	14.08	49.08	9.32	0.72
	Hajjah City	1728	23.35	16.08	31.98	10.12	0.39
	Harad	1702	39.66	28.04	52.21	19.66	0.68
	Hayran	1705	36.95	27.07	47.70	14.06	0.40
	Khayran Al Muharraq	1711	36.19	26.02	47.35	16.34	0.78
	Ku'aydinah	1722	26.91	16.23	39.99	9.24	0.00
	Kuhlan Affar	1718	35.97	16.79	59.12	17.79	0.40
	Kuhlan Ash Sharaf	1709	40.24	28.24	53.16	21.51	1.20
	Kushar	1707	31.35	20.24	44.28	13.49	1.19
	Mabyan	1720	31.56	20.94	43.81	13.93	0.82
	Midi	1703	41.43	29.33	54.34	16.73	1.99
	Mustaba	1706	39.04	26.39	52.88	15.54	1.20
	Najrah	1726	87.60	73.48	95.82	49.60	0.80

	Qafl Shamer	1713	46.30	40.67	52.00	20.62	0.00
	Qarah	1731	30.83	21.32	41.70	10.28	0.40
	Sharas	1719	38.96	24.69	54.75	17.67	0.00
	Wadhrah	1723	19.20	10.76	30.39	6.80	0.00
	Washhah	1730	31.52	23.02	41.03	8.56	1.56
Ibb	Al Dhihar	1119	12.30	4.46	25.40	5.56	0.00
	Al Makhadir	1107	32.93	23.18	43.88	12.60	0.41
	Al Mashannah	1118	17.69	10.48	27.10	4.08	0.00
	Al Qafr	1101	37.15	26.55	48.75	17.00	0.00
	Al Udayn	1111	22.80	13.52	34.54	8.40	0.00
	An Nadirah	1104	18.93	13.55	25.34	6.17	0.00
	Ar Radmah	1103	17.28	8.82	29.09	8.23	0.41
	As Sabrah	1114	16.80	11.01	24.04	6.00	0.00
	As Saddah	1106	16.67	10.28	24.91	5.69	0.00
	As Sayyani	1115	24.80	11.03	43.73	9.60	0.00
	Ash Sha'ir	1105	34.43	20.82	50.19	18.03	2.05
	Ba'dan	1113	23.48	14.89	34.04	5.68	0.00
	Dhi As Sufal	1116	15.60	8.72	24.94	7.20	0.00
	Far Al Udayn	1110	40.00	26.66	54.52	18.40	0.00
	Hazm Al Udayn	1109	29.58	17.03	44.89	12.08	0.00
	Hubaysh	1108	27.76	15.24	43.46	10.65	0.00
	Ibb	1120	22.27	17.58	27.53	5.08	0.00
	Jiblah	1112	28.34	20.61	37.13	13.77	0.81
	Mudhaykhirah	1117	18.00	9.15	30.30	4.00	0.00
	Yarim	1102	20.80	14.71	28.04	8.00	0.40
Lahij	Al Hawtah	2514	28.63	16.37	43.72	12.94	0.00
	Al Had	2501	20.78	8.69	38.43	8.63	0.00
	Al Madaribah Wa Al Arah	2513	38.10	20.92	57.77	17.06	0.40
	Al Maflahy	2503	11.20	6.33	17.94	4.00	0.00

	Al Maqatirah	2512	22.83	12.07	37.04	5.51	0.00
	Al Milah	2508	42.52	31.97	53.59	22.83	0.39
	Al Musaymir	2509	40.78	26.83	55.91	15.29	0.39
	Al Qabbaytah	2510	41.50	31.09	52.50	16.60	0.00
	Habil Jabr	2505	27.20	18.32	37.63	7.53	0.00
	Halimayn	2506	14.58	8.48	22.77	5.00	0.42
	Radfan	2507	22.04	12.37	34.60	7.35	0.00
	Tuban	2515	41.18	35.68	46.84	17.25	0.00
	Tur Al Bahah	2511	43.25	27.31	60.29	16.67	0.00
	Yafa'a	2502	7.17	2.92	14.24	2.39	0.00
	Yahr	2504	18.47	10.75	28.59	4.02	0.00
Ma'rib	Al Abdiyah	2611	3.45	0.33	12.83	0.43	0.00
	Al Jubah	2607	10.68	7.02	15.39	4.27	0.00
	Bidbadah	2605	5.68	2.20	11.70	1.70	1.14
	Harib	2609	7.69	4.64	11.85	2.02	0.00
	Harib Al Qaramish	2604	3.32	0.50	10.65	0.00	0.00
	Jabal Murad	2614	3.94	1.22	9.21	0.99	0.00
	Mahliyah	2610	5.45	1.03	15.72	1.98	0.00
	Majzar	2601	12.15	6.51	20.12	2.34	0.00
	Marib	2613	11.56	9.39	14.02	4.89	0.44
	Marib City	2612	15.00	10.00	21.25	4.29	0.00
	Medghal	2603	13.16	5.25	25.77	5.26	1.32
	Raghwan	2602	4.05	0.66	12.51	0.58	0.00
	Rahabah	2608	8.41	3.10	17.57	0.93	0.00
	Sirwah	2606	6.14	2.90	11.19	2.19	0.00
Raymah	Al Jabin	3102	8.03	4.43	13.18	1.61	0.00
	Al Jafariyah	3105	20.93	10.92	34.39	9.69	0.39
	As Salafiyah	3103	18.15	12.28	25.34	4.84	0.40
	Bilad At Ta'am	3101	14.57	7.95	23.71	4.86	0.40

	Kusmah	3104	8.00	4.37	13.21	2.00	0.00
	Mazhar	3106	10.70	5.01	19.34	1.65	0.00
Sa`dah	Al Dhaher	2207	43.60	31.89	55.85	18.40	0.40
	Al Hashwah	2213	3.20	1.49	5.94	0.80	0.00
	As Safra	2212	5.60	1.58	13.60	1.20	0.00
	Baqim	2201	6.00	3.41	9.67	1.60	0.00
	Ghamr	2204	6.80	2.38	14.72	2.00	0.00
	Haydan	2208	3.60	1.22	8.06	0.40	0.00
	Kitaf wa Al Boqe'e	2214	5.20	2.18	10.25	0.80	0.00
	Majz	2210	8.40	4.08	14.96	2.00	0.00
	Monabbih	2203	18.40	6.05	38.42	7.60	0.40
	Qatabir	2202	14.58	NA	NA	2.92	0.00
	Razih	2205	7.50	NA	NA	1.25	0.42
	Sa'adah	2215	6.40	3.08	11.53	0.00	0.00
	Sahar	2211	7.20	2.08	17.09	0.80	0.00
	Saqayn	2209	4.58	NA	NA	0.42	0.42
	Shada'a	2206	28.96	17.79	42.36	7.72	1.16
San`a'	Al Haymah Ad Dakhiliyah	2308	10.60	5.02	19.04	3.53	0.00
	Al Haymah Al Kharijiyah	2309	23.02	NA	NA	7.55	0.00
	Al Husn	2315	13.33	4.84	27.37	5.42	0.00
	Arhab	2302	12.08	2.09	33.72	7.08	0.83
	Attyal	2313	22.92	15.52	31.79	13.75	0.42
	Bani Dhabyan	2314	11.49	NA	NA	3.40	0.00
	Bani Hushaysh	2304	14.58	8.30	23.08	4.58	0.00
	Bani Matar	2307	19.58	10.96	30.98	7.92	0.00
	Bilad Ar Rus	2306	25.42	13.68	40.51	11.25	0.00
	Hamdan	2301	17.14	7.78	30.85	8.21	0.00
	Jihanah	2316	7.92	3.73	14.39	2.92	0.00
	Khwlan	2312	14.17	8.78	21.18	5.83	0.00

	Manakhah	2310	21.30	NA	NA	8.66	0.72
	Nihm	2303	23.13	NA	NA	13.81	0.00
	Sa'fan	2311	13.33	4.42	28.59	7.72	0.35
	Sanhan	2305	5.83	1.74	13.75	1.25	0.00
Shabwah	Ain	2106	33.04	10.05	64.27	23.91	7.83
	Al Talh	2102	17.79	5.59	37.99	5.14	0.00
	Ar Rawdah	2115	24.48	12.62	40.08	9.54	0.00
	Arma	2104	30.09	16.18	47.32	8.41	0.44
	As Said	2112	7.49	1.69	19.80	2.64	0.00
	Ataq	2113	20.43	9.80	35.26	6.09	0.00
	Bayhan	2107	34.62	10.03	67.45	20.09	0.85
	Dhar	2101	29.41	17.91	43.22	11.34	0.00
	Habban	2114	24.11	16.69	32.87	9.82	0.89
	Hatib	2111	20.35	9.11	36.43	9.09	0.00
	Jardan	2103	28.51	17.23	42.17	10.21	0.00
	Mayfa'a	2116	30.42	15.16	49.66	13.33	0.83
	Merkhah Al Ulya	2108	5.46	3.19	8.65	2.52	0.42
	Merkhah As Sufla	2109	18.75	7.98	34.68	3.33	0.00
	Nisab	2110	41.25	35.46	47.22	23.75	0.42
	Rudum	2117	34.21	20.29	50.45	13.16	0.00
	Usaylan	2105	37.42	21.09	56.15	9.68	0.00
Ta`izz	Al Mukha	1506	26.69	18.01	36.93	15.14	0.40
	Al Ma'afer	1521	22.53	13.08	34.61	8.30	0.00
	Al Mawasit	1522	21.79	13.94	31.47	10.00	0.36
	Al Misrakh	1512	19.37	12.73	27.57	6.32	0.00
	Al Mudhaffar	1518	16.97	NA	NA	9.03	0.00
	Al Qahirah	1519	31.52	23.25	40.75	14.49	0.00
	Al Wazi'iyah	1516	31.20	20.60	43.47	11.20	0.40
	As Silw	1514	38.85	20.62	59.68	19.62	0.00

	Ash Shamayatayn	1515	19.05	8.38	34.58	5.56	0.00
	At Ta'iziyah	1502	25.00	10.35	45.55	9.77	0.00
	Dhubab	1507	30.40	17.03	46.72	12.80	0.40
	Dimnat Khadir	1513	50.00	42.47	57.53	25.00	1.92
	Hayfan	1517	25.52	13.74	40.66	6.69	0.42
	Jabal Habashy	1509	23.60	14.81	34.42	6.80	0.00
	Maqbanah	1505	24.70	15.13	36.53	11.55	0.40
	Mashra'a Wa Hadnan	1510	10.36	5.44	17.45	2.39	0.00
	Mawiyah	1501	34.00	15.44	57.05	18.40	0.00
	Mawza	1508	22.92	13.30	35.19	8.70	0.00
	Sabir Al Mawadim	1511	13.25	8.44	19.46	2.81	0.00
	Salh	1520	19.92	9.81	33.94	9.56	0.40
	Sama	1523	23.20	17.20	30.12	7.20	0.40
	Shara'b Ar Rawnah	1504	27.84	12.31	48.58	11.37	0.39
	Shara'b As Salam	1503	14.40	10.37	19.26	5.20	0.00
Grand Total			**30.45**	**-**	**-**	**14.63**	**0.42**

[a]For mild, moderate and severe anaemia determined using WHO recommended anaemia cut-offs for measured haemoglobin levels (45-47).
[b]Any anaemia prevalence includes all those with mild, moderate and severe anaemia.
[c]At least moderate anaemia prevalence includes those with moderate and severe anaemia only.

Classification of 332 districts by level of severity of the prevalence of severe anaemia in Yemen

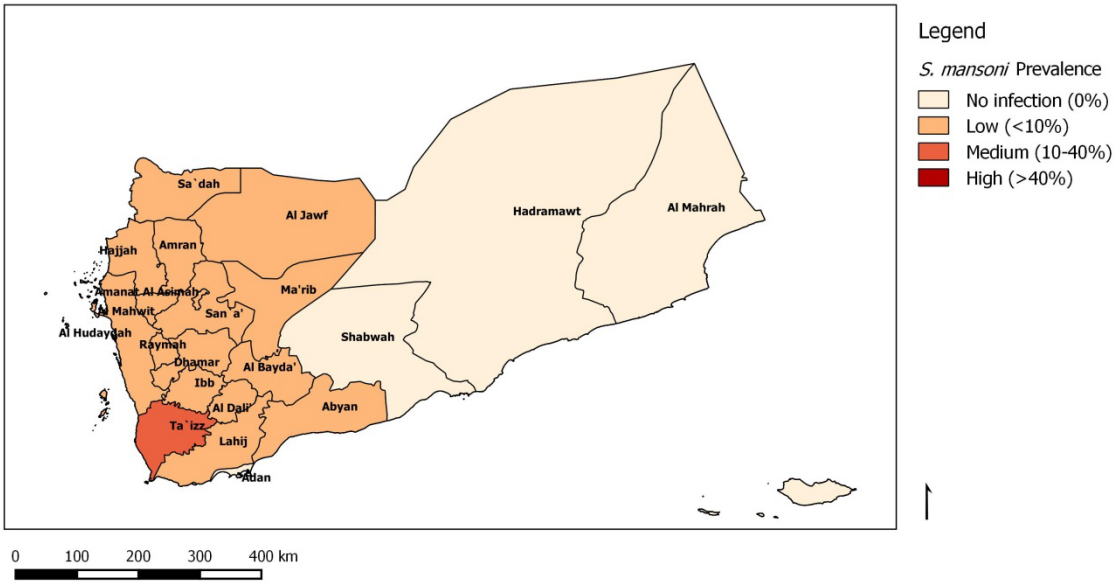
Category	Prevalence of Severe Anaemia[1] (%)	Number of districts[2]
None	0	178
Mild	<1	115
Moderate	1-5	37
Severe	≥5	2
Total affected	**-**	**154**

[1]Cut-offs were determined based on the range (0-7.8% by district) of the prevalence of severe anaemia to distinguish between the most and least affected districts in the country
[2]Districts were classified based on prevalence of severe anaemia (haemoglobin concentrations of <80 g/L) in each district

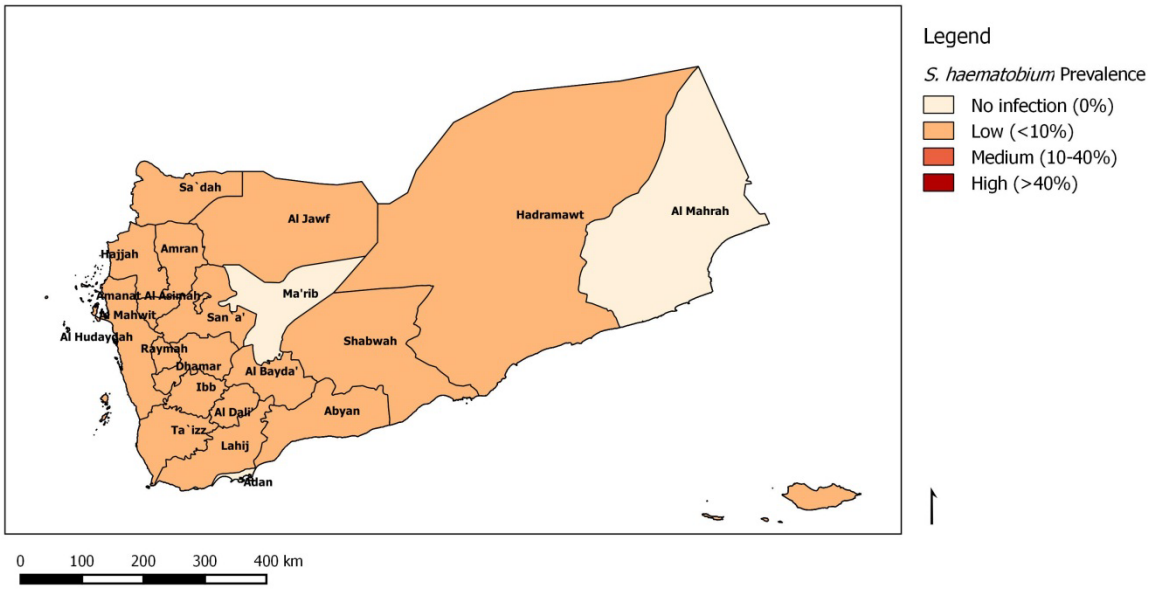
Appendix 9: Prevalence maps of disease distribution in Yemen

Schistosomiasis

A)

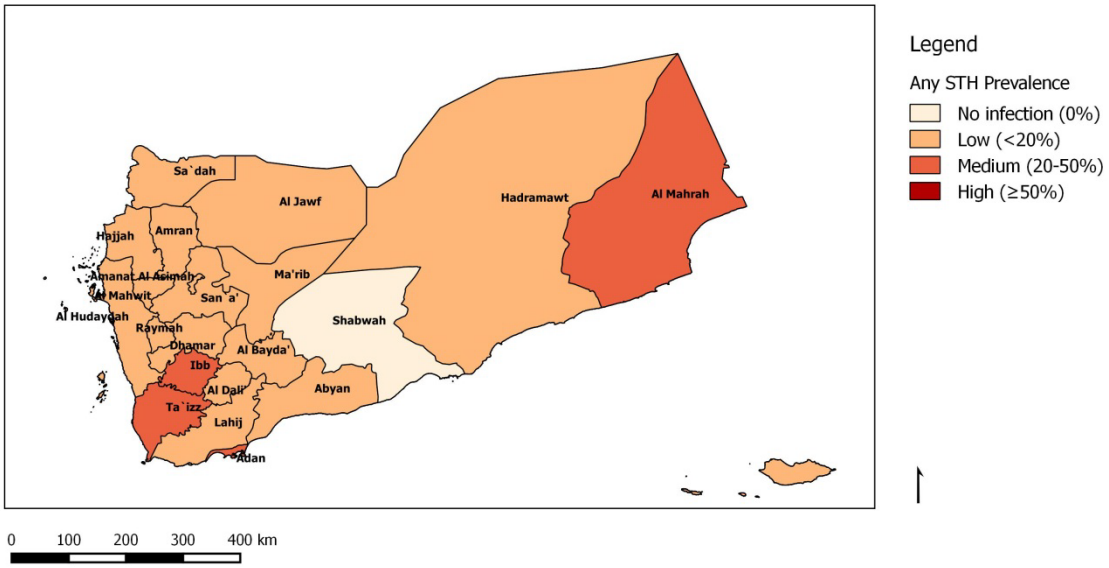


B)



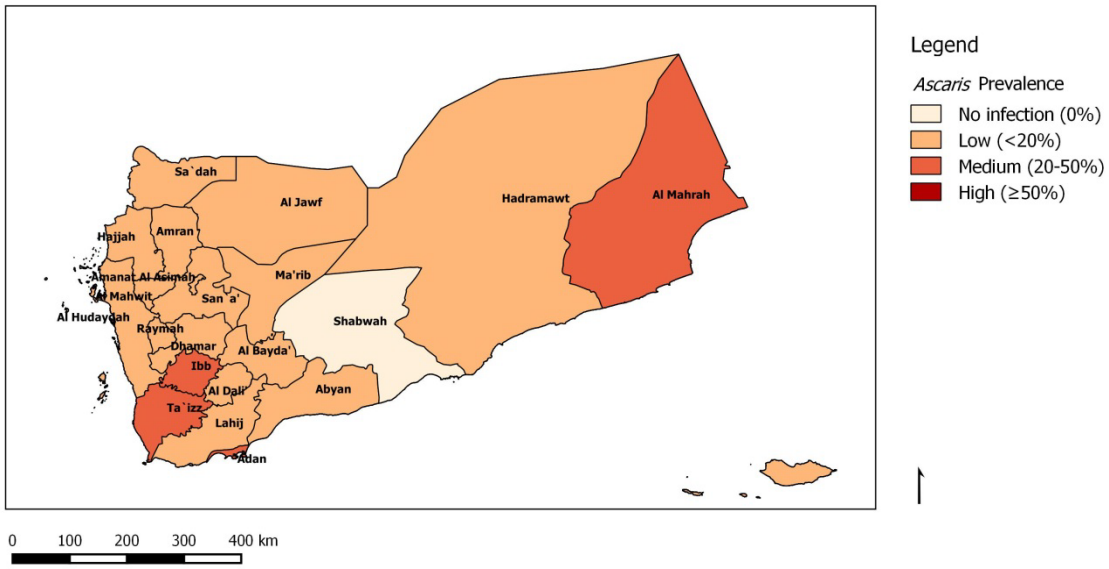
Prevalence maps of A) Intestinal (*S. mansoni*) and B) Urogenital (*S. haematobium*) schistosomiasis infection at the governorate level in Yemen (2014)

Soil-transmitted helminths



Prevalence map of soil-transmitted helminth infection at the governorate level in Yemen (2014)

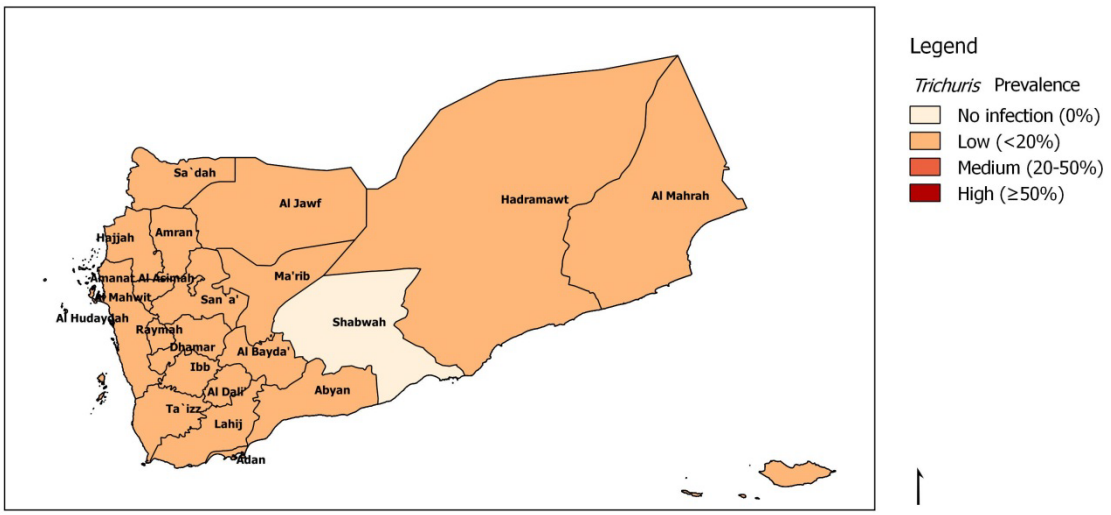
i) *Ascaris*



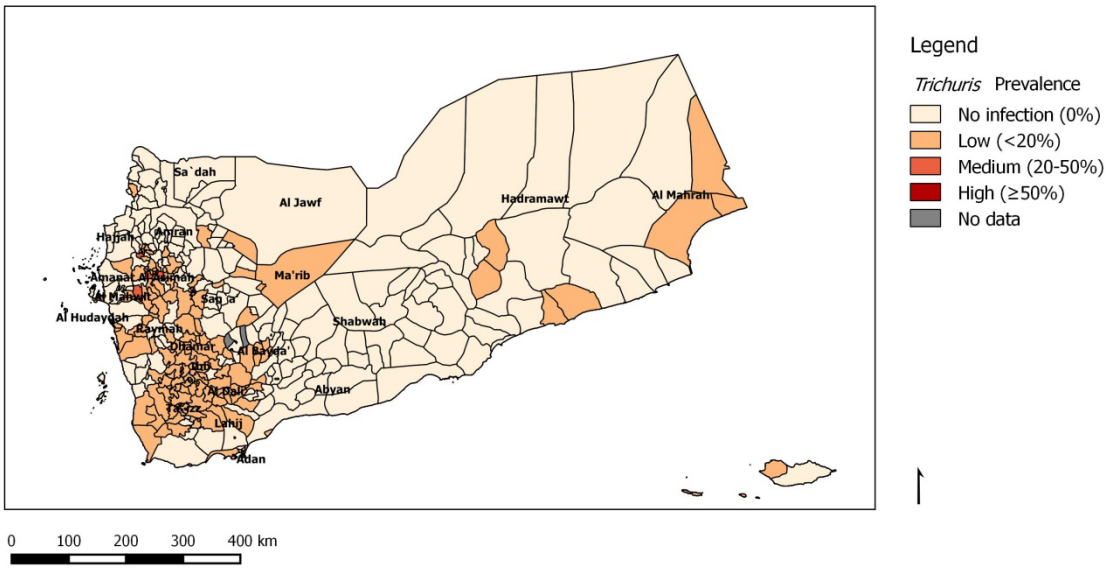
Prevalence map of *Ascaris* infection at the governorate level in Yemen (2014)

ii) *Trichuris*

A)



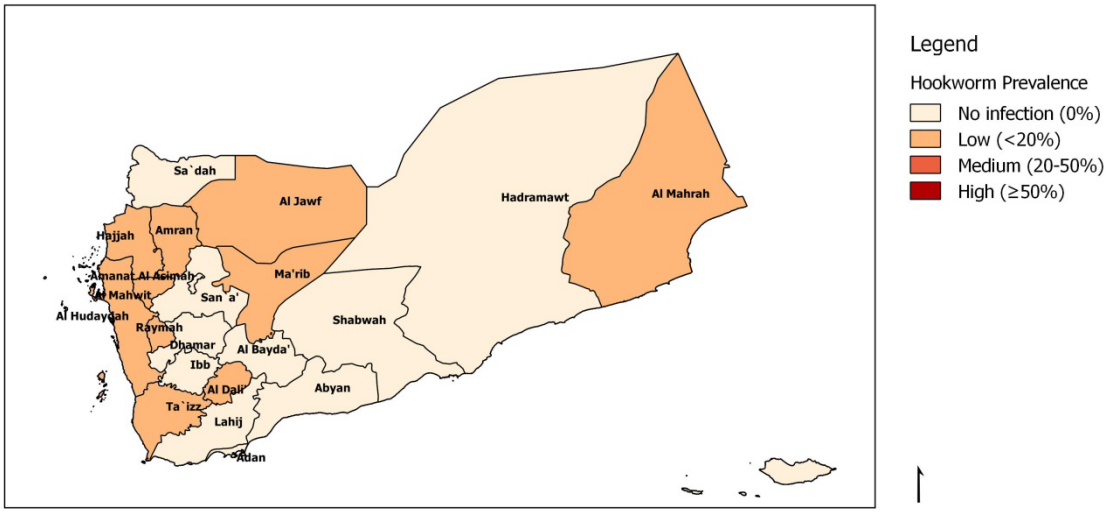
B)



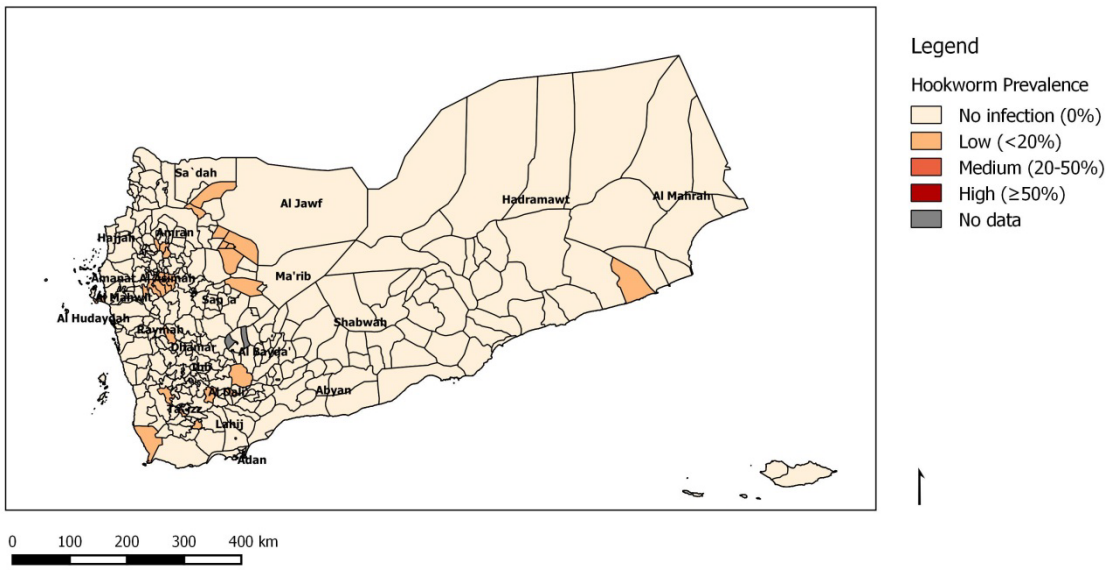
Prevalence maps of *Trichuris* infection at the A) Governorate level and B) District level in Yemen (2014)

iii) Hookworm

A)



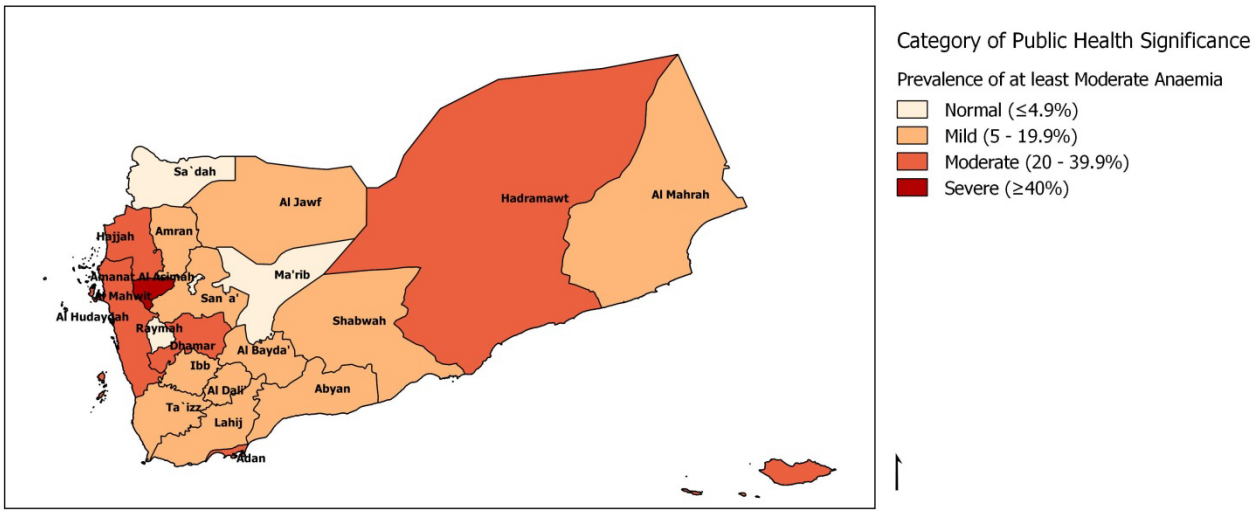
B)



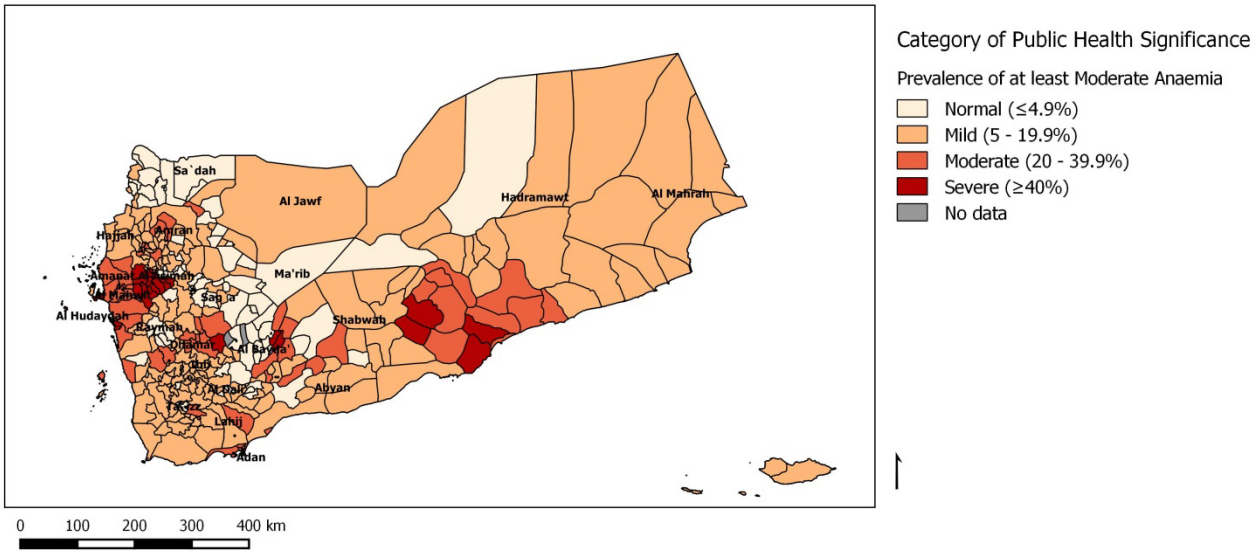
Prevalence map of Hookworm infection at the A) Governorate level and B) District level in Yemen (2014)

Anaemia

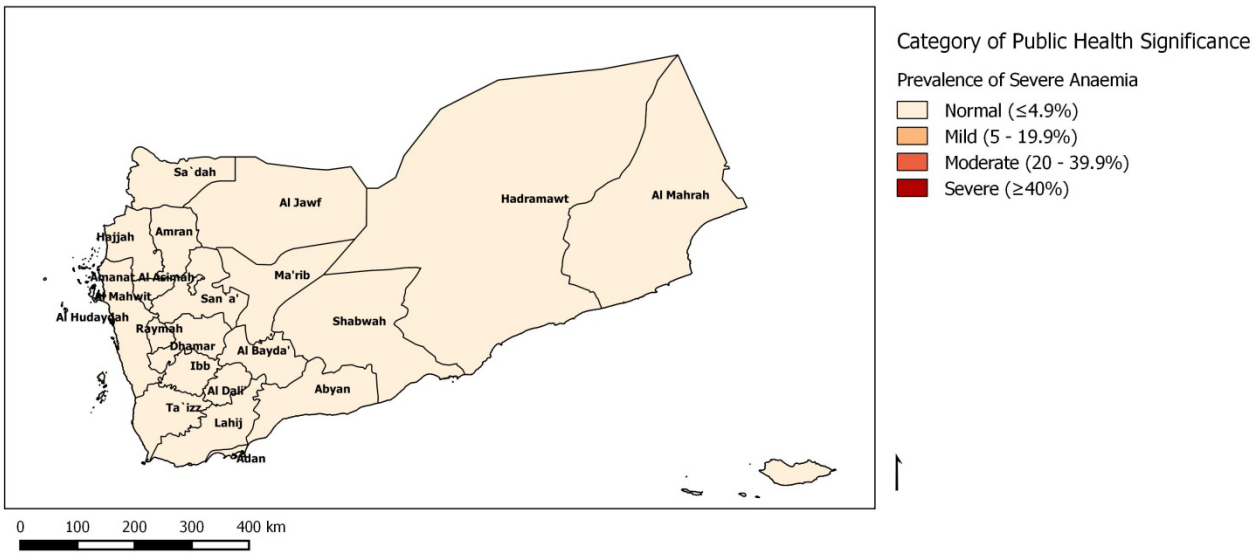
A)



B)



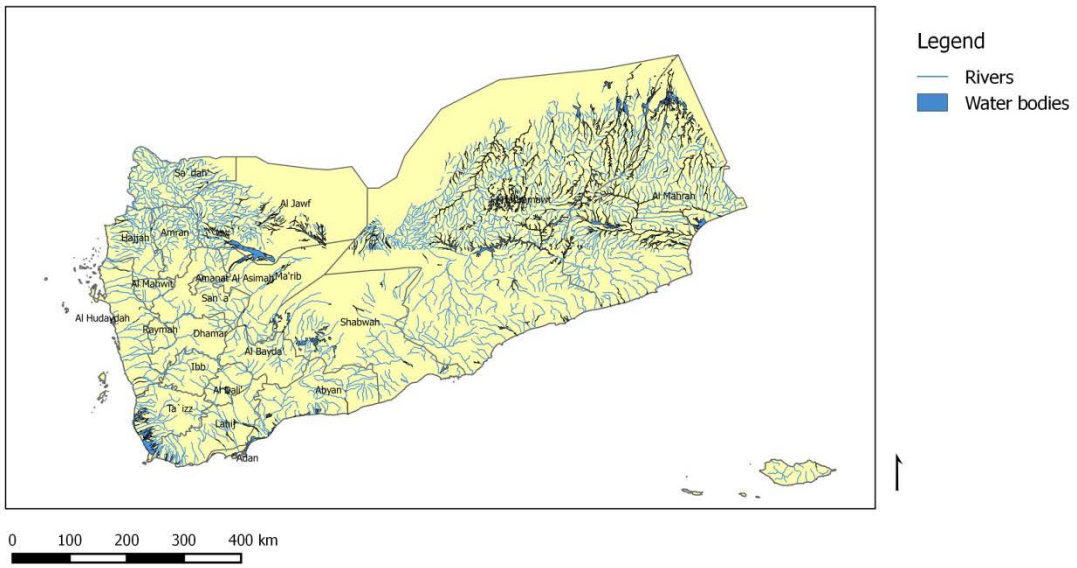
Prevalence map of at least moderate anaemia infection at the A) Governorate level and B) District level in Yemen (2014)



Prevalence map of severe anaemia infection at the governorate level in Yemen (2014)

Appendix 10: Maps of distribution of water bodies in Yemen

Map of Water Distribution in Yemen



Map of Perennial Water Distribution in Yemen