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Epidemiological Survey of Zoonotic Parasites in Rats and House Shrews in Selected Areas of Dar es Salaam, Tanzania

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Abstract

Rodents are known carriers of intestinal parasites that pose significant risks to human health. In Tanzania, little is understood about the prevalence of parasitic zoonoses in rodents inhabiting human dwellings and the public awareness of these diseases. This study assessed the prevalence of intestinal and ectoparasites in rats and house shrews and the awareness of parasitic zoonoses among residents of Dar es Salaam. Rats and house shrews were captured from urban households in Ubungo and peri-urban households in Kivule. Ectoparasites were collected using fur-rubbing toothbrushes, while intestinal contents were examined microscopically for parasites. The study further investigated the knowledge and practices related to parasite transmission risks among household heads in houses where rats and shrews were captured using the questionnaire. The parasite prevalence was analyzed using a chi-square test and intensities with t-test. A total of 200 rats were examined (88 from Kivule and 112 from Ubungo), revealing a 96% overall prevalence of intestinal parasites. Prevalence was 100% in Kivule and 93% in Ubungo. Between two wards, *Hymenolepis nana* (64.3%) and *Hymenolepis diminuta* (60.7%) were predominant in Ubungo ($p < 0.008$), while *Ascarid* sp. (50%) and *Strongyloides* sp. (40.9%) were more common in Kivule ($p < 0.02$). Co-infections among *Ascaris* spp., *H. nana*, *H. diminuta*, and *Strongyloides* sp. were observed, with the most common combination being *H. nana* and *H. diminuta* (18%). Co-infections involving three species occurred in 4% and those with four species in 2% of cases. Ectoparasites, including fleas, mites, and ticks, were infrequent. Among 200 respondents from households where rats or shrews were captured, 76% saw them visit clean dishes, and 69% did not re-wash the dishes. Only 45% were aware of rodent-borne diseases, and 61% reported frequent childhood diarrhoea. These findings highlight the significance of rats and house shrews as reservoirs and vectors of zoonotic and non-zoonotic parasites in urban and peri-urban settings.

Keywords: Rodents; Parasites; Zoonoses; Dar es Salaam city; Transmission factors

Introduction

Parasitic diseases affect 3.5 billion people globally, with 450 million showing symptoms and over 200,000 deaths annually (Feleke et al. 2023). Vulnerable groups include children due to poor hygiene awareness and immunocompromised individuals, due to reduced immunity (Al-Yousofi et al. 2022). About 60% of cases occur in tropical and subtropical regions, where poverty, poor sanitation, and warm climates promote transmission (Short et al. 2017, Gizaw et al. 2019, Hajare et al. 2021).

Rats and house shrews are important vectors and reservoirs of zoonotic diseases, acting as hosts and transmitters of various pathogens, including viruses, bacteria, protozoa, and helminths (Banda et al. 2023). Their role in the transmission of zoonotic parasites is largely attributed to their high adaptability to diverse environments, including urban settings, which increases the risk of parasite spillover to humans (Ramatla et al. 2019). The house shrew (*Suncus murinus*), a member of the family Soricidae and order Eulipotyphla, is native to Asia and has been introduced to parts of Africa, including urban areas of Tanzania, likely through trade activities (Varnham 2006, Walsh 2007). These shrews have been identified as reservoirs of human parasites (Rahman et al. 2018, Li et al. 2024).

Zoonotic parasites from rats and shrews may be transmitted to humans through direct contact or by ingestion of food or drinks contaminated with their saliva, urine, or feces (Priyanto and Ningsih 2014). Transmission can also occur via parasite eggs or cysts carried on their feet or fur, as well as through a bite from an ectoparasite that harbor infectious agents (Azimi et al. 2020). During both diurnal and nocturnal foraging, rats and shrews may defecate in areas where human food is stored, further increasing the risk of parasitic infection (Archer et al. 2017).

Several studies from different parts of the world, including Tanzania, have identified human-infecting parasites in rats and shrews, such as *Giardia muris*, *Trichomonas*, *Toxoplasma gondii*, *Cryptosporidium* spp., *Taenia taeniaeformis*, and *Ascaris* (Mgode et al. 2014, Gholipoury et al. 2016, Katakweba 2018, Archer et al. 2017, Sulieman et al. 2019, Mawanda et al. 2020, Azimi et al. 2020, Dahmana et al. 2020, Tijjani et al. 2020, Shilereyo et al. 2022, Thomas et al. 2023, Issae and Katakweba 2024, Msoffe et al. 2025). These studies reported parasite prevalence in rodents ranging from 40% to 100%, underscoring the need for surveillance of rodent-borne zoonotic parasites to help control their transmission.

Ectoparasites such as fleas, ticks, and lice can cause anaemia, irritation, and transmit diseases like babesiosis and theileriosis (Islam et al. 2021). In urban settings, parasite distribution is influenced by the degree of urbanization, which affects habitat suitability (Werner and Nunn 2020). Peri-urban areas often support higher parasite diversity due to more varied environments, whereas fully urbanized areas tend to be less suitable for parasites with complex life cycles, such as soil-transmitted helminths (Werner and Nunn 2020). Control strategies should therefore be adapted to the level of urban development.

In Tanzania, research on zoonotic parasites in rats and shrews has primarily focused on rural areas, reporting intestinal and tissue protozoan and helminth parasites in rats and in *Crocidura* species of shrews (Mgode et al. 2014; Katakweba 2018; Thomas et al. 2023; Issae and Katakweba 2024, Msoffe et al. 2025). However, similar studies are lacking in urban areas, particularly those involving the house shrews in Dar es Salaam. Ectoparasites have also been documented in wild rats from rural settings (Kilonzo et al. 1997, Makundi et al. 2015, Shilereyo et al. 2022, Jakoniko et al. 2024, Kessy et al. 2024, Musese et al. 2024). Despite these findings, factors that may lead to indoor transmission of infections from rats and shrews to humans remain poorly understood.

Given their role as reservoirs of zoonotic parasites and their close contact with people in urban areas, it is important to assess the extent of these infections and associated risks. This study investigated intestinal parasites and ectoparasites in house rats and shrews in Dar es Salaam and assessed community awareness and practices related to indoor transmission of rat and shrew-borne parasites to humans.

Materials and Methods

Study sites

The study was conducted in Dar es Salaam, Tanzania's largest city (6.7924°S, 39.2083°E), focusing on two wards: Ubungo (urban) and Kivule (peri-urban) (Figure 1). Dar es Salaam, with a population exceeding 5 million (URT-NBS 2022), experiences a tropical warm and humid climate, with average temperatures ranging from 23°C to 32°C and relative humidity around 77.9% (Nyembo et al. 2022). These conditions are known to support the transmission of parasitic diseases (Bryant and Hallem 2018). The classification of the wards as urban and peri-urban is based on socioeconomic status and population density. In Ubungo, five sampling sites were selected in densely populated, unplanned settlements dominated by residential areas and crop trading. In contrast, the sampling sites in Kivule were located on the outskirts of the city, characterized by lower-density settlements where residents are primarily engaged in small-scale farming, local businesses, and animal husbandry.

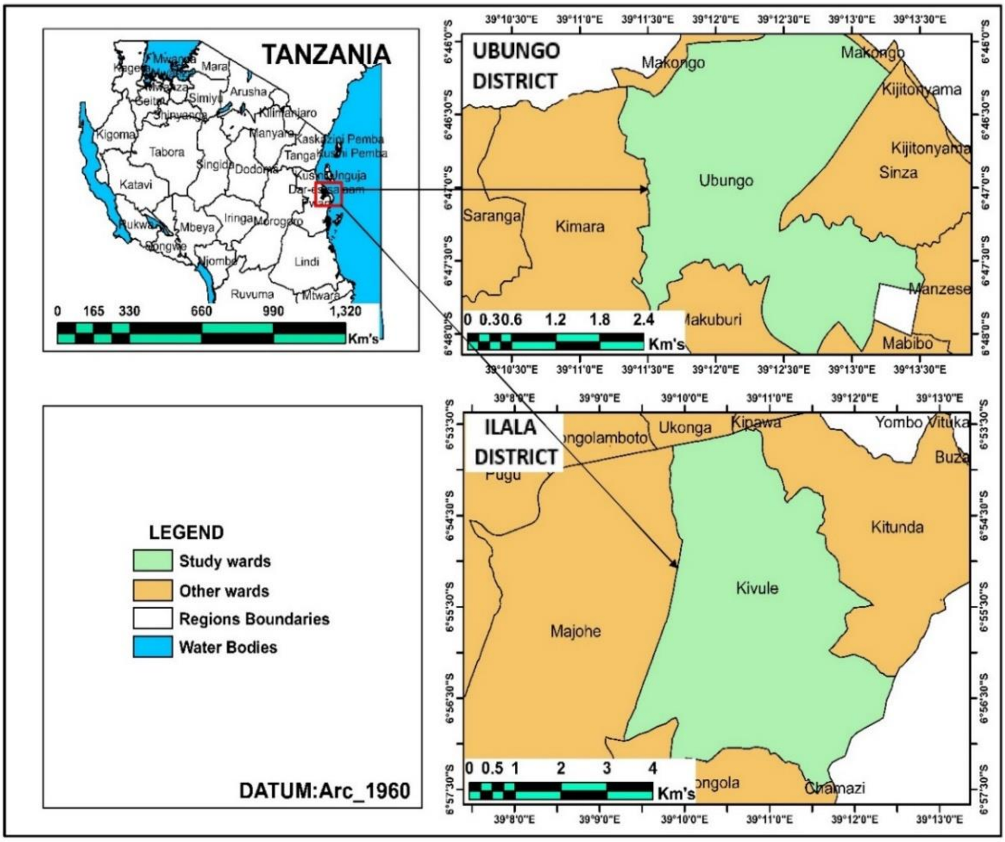

Figure 1: A map of Dar es Salaam showing location of the study sites

Study design and procedures

This cross-sectional survey was conducted in the Ubungo and Kivule wards of Dar es Salaam. Five streets (Mitaa) as sampling points were purposively selected in each ward based on preliminary field visits and interviews with residents to identify areas with visible signs of rodent activity. In Ubungo, the selected streets were Kibangu, Riverside, Ubungo Maziwa, Makoka, and External. While in Kivule, they were Magole, CCM, Mbondole, Fremu Kumi, and Mwembeni. In each selected household, a single Sherman© live animal trap (Sherman Traps Inc., Tallahassee, FL, USA) was placed indoors at locations identified by residents as frequently visited by rodents. Traps were baited with fried fish, coconut, and peanuts, and each trap was capable of capturing only one animal per trapping day.

The sample size estimation for animals to be captured was based on previous studies investigating rodent and shrews' parasites (Mgode et al. 2014, Coomansingh-Springer et al. 2019), which used sample sizes between 90 and 170 individual animals. Animal collection was conducted over 16 trapping nights, with trapping carried out once every four days to allow time for cleaning traps, preparing baits, and selecting new households.

On each collection night, 20 households (10 per ward) were selected using systematic random sampling by identifying approximately 20 eligible houses around the same sampling point in each ward. Trapping began at a randomly selected house and continued at every after 2 houses. This procedure was repeated with new households on each collection night. The trapping period spanned two months, from late March to late May 2023, involving a total of 320 households; this number of households was not pre-established but was guided by the need to capture 200 rats or shrews, depending on trapping success. Each selected street (Mtaa) was visited on at least three collection nights, with a different house sampled on each trapping night.

Each morning of collection, the captured animals were transported to the University of Dar es Salaam for parasite analysis. Animal identification was conducted based on observations of external morphological features and habitat characteristics (Varnham 2006, Shiels and Veitch 2013). Animals were anesthetized with isoflurane and humanely euthanized using chloroform. Ectoparasites were collected by brushing the fur into petri dishes and examined under a stereo microscope.

Following the protocol by Herbreteau et al. (2012), intestinal contents were obtained through dissection (Figure 2). Briefly, the animal was pinned ventral side up, disinfected, and a midline incision was made to expose the internal organs. The intestines were removed, and their contents were squeezed, weighed, and prepared for microscopic examination. Cysts, eggs, and larvae were concentrated using the formal-ether concentration (FEC) technique and examined under a microscope at 40× magnification (Garcia et al. 2018, Rai et al. 1996). Adult worms were identified using a stereo microscope.

Figure 2: Types of house rats and house shrew captured and dissected. A = *Rattus rattus*, B= *Suncus murinus*, C= Dissected rat, D= Abdominal content from dissected animal with adult tapeworm.

Data collection on demographics and potential indoor transmission factors of rodent parasitic zoonoses

A questionnaire survey was used to collect demographic information (age, education level, and family size) and to assess factors potentially contributing to indoor transmission of parasites by rats and shrews. These included awareness of rat or shrew parasites, the number of rodents or shrews seen in the house, places visited by rodents or shrews, hygienic practices, and control measures for rodents or shrews. One person aged 18 years or above from the household, the head of the household or a representative was selected for the survey. The questionnaire was self-administered in Swahili a common language to all Tanzanians. The survey was only conducted in households where a trap had successfully captured a rat or shrew. Verbal consent was obtained before the beginning of the survey and enrollment in the study was voluntary.

Study clearance and ethical consideration

The study was approved by the University of Dar es Salaam Research Committee. Verbal consent was obtained from the heads of households for both trap placement and participation in the questionnaire. All captured rats were anesthetized and humanely euthanized in accordance with ethical guidelines.

Data management and analysis

Data were entered into Microsoft Excel (Microsoft Corporation 2019)and cleaned to correct omissions and recording errors. The data was analyzed with IBM SPSS® Statistics version 28 (IBM Corp., Armonk, NY, USA). During analysis, the data were confirmed to follow the normal distribution. Then the proportion data, such as prevalence (the number of infected individual rodents or shrews divided by the total number examined x 100), chi-square test was used as parametric test. For continuous data, such as parasite intensity (calculated as the total number of parasites divided by the number of infected individuals), analysis of variance (ANOVA) was applied when comparing more than two independent groups, and Student's *t*-test was used for comparisons between two independent groups. Parasite diversity was assessed using the Shannon–Wiener diversity index *(H')*, calculated as $H' = -\Sigma (pi \times \ln pi)$, where *pi* is the proportion of individuals belonging to the *i*th species relative to the total number of individuals. Descriptive results were calculated as the mean (obtained by dividing the sum of all observations by the number of observations) of each parameter and are presented in tables. The significance level was set at $p < 0.05$.

Results

Rats and house shrews captured, and parasite prevalence between the study sites.

A total of 200 animals were captured, including 112 from Ubungo (urban) and 88 from Kivule (peri-urban). The captures comprised 58% *Rattus rattus* (n = 116) and 42% *Suncus murinus* (house shrew) (n = 84). House shrews were found only in Ubungo, where they made up 75% of the captures in that ward. Among the captured animals, 68% (n = 136) were male and 32% (n = 64) were female. The overall prevalence of intestinal parasites was 96%, with infection rates of 100% in Kivule and 93% in Ubungo. Detailed parasite data are presented in Table 1, and morphological features are shown in Figure 3.

Seven intestinal parasite species were identified. *Hymenolepis nana* had the highest prevalence (44%, n = 88), followed by *H. diminuta* (40%, n = 80), *Ascaris* spp. (32%, n = 64), and *Strongyloides* sp. (20%, n = 40). *Trichuris* sp., *Moniliformis* sp., and *Coccidia* sp. showed the lowest prevalence. Co-infections were also recorded. Two-species co-infections included *H. nana* and *H. diminuta* (18%, n = 36), *Ascaris* spp. and *H. nana* (8%, n = 16), *Ascaris* spp. and *H. diminuta* (6%, n = 12), *Ascaris* spp. and *Strongyloides* sp. (8%, n = 16), *H. nana* and *Strongyloides* sp. (4%, n = 8), and *H. diminuta* and *Strongyloides* sp. (2%, n = 4). Three-species co-infection (*Ascaris* spp., *H. nana*, *H. diminuta*) was found in 4% (n = 8), while four-species co-infection including *Strongyloides* sp. occurred in 2% (n = 4).

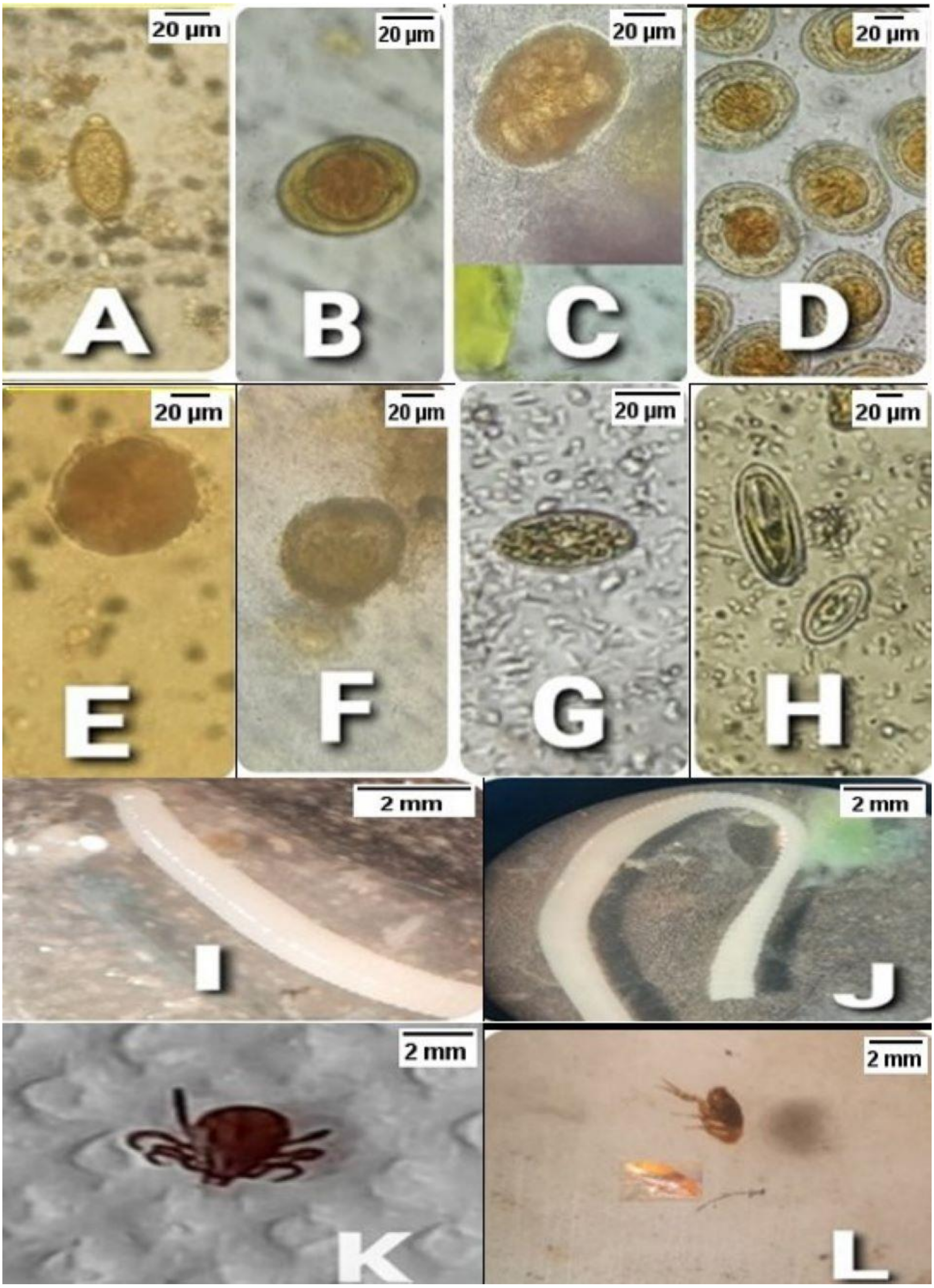

Figure 3: Eggs and adult worms observed from the captured rats and house shrew. *A= Trichuris* sp. *egg, B =H. nana egg, C: Strongyloides* sp. *egg, D = H. diminuta eggs, E &F = Ascarids* spp. *egg, G: Coccidia* sp. oocyst*, H = Moniliformis* sp. *eggs, I & J=* Adult *Hymenolepis* sp., K = Tick, L = Fleas

H. nana and *H. diminuta* were significantly more prevalent in Ubungo ($p < 0.008$), whereas *Ascaris* spp. and *Strongyloides* sp. were more common in Kivule ($p < 0.02$).

Ectoparasite prevalence was 20%, with no significant difference between the wards. However, parasite diversity was significantly higher in Kivule ($p < 0.00001$).

Table 1: Prevalence and diversity of intestinal and ectoparasites in the house rats and house shrews found inside houses in urban and peri-urban areas of Dar es Salaam

Parasite species	Location		Statistics
	Kivule (peri-urban)	**Ubungo (urban)**	
Endoparasites	**n/N (%)**	**n/N (%)**	
All intestinal parasites	88/88 (100)	104/112 (92.9)	$\chi^2_{(1)}$=0.22 , p= 0.201
H. nana	20/88 (22.7)	68/112 (60.7)	$\chi^2_{(1)}$=28.9 , p= 0.00008
H. diminuta	8/88 (9.1)	72/112 (64.3)	$\chi^2_{(1)}$=62.5 , p= 0.007
Ascarid spp.	44/88(50)	20/112 (17.8)	$\chi^2_{(1)}$=23.4 , p= 0.016
Strongyloides sp.	36/88 (40.9)	4/112 (3.6)	$\chi^2_{(1)}$=42.9, p= 0.001
Trichuris sp.	8/88 (9.1)	0/112 (0.0)	$\chi^2_{(1)}$=1.79, p= 0.189
Moniliformis sp.	4/88 (4.5)	0/112 (0.0)	$\chi^2_{(1)}$=0.36, p= 0.44
Coccidia sp.	8/88 (9.1)	0/112 (0.0)	$\chi^2_{(1)}$=1.96, p= 0.189
Ectoparasites			
All ectoparasites	16/88 (18.2)	24/112 (21.4)	$\chi^2_{(1)}$=0.32, p= 0.532
Rat fleas	12/88 (13.6)	20/112 (17.9)	$\chi^2_{(1)}$=0.65, p= 0.498
Ticks	0/88 (0.0)	4/112 (3.6)	$\chi^2_{(1)}$=1.3, p= 0.56
Mites	4/88 (4.5)	4/112 (3.6)	$\chi^2_{(1)}$=0.8, p= 0.691
Parasite diversity of rats and house shrews between study sites			
Location	**Shannon Weiner index**	**t-test**	**P-value**
Urban	1.088	13.78	<0.00001
peri-urban	1.687		

Prevalence of intestinal parasites (by species) in rats and shrews

The overall prevalence of at least one intestinal parasitic infection was similar between *Rattus rattus* (96.6%) and *Suncus murinus* (95.2%) ($p = 0.815$) (Table 2). However, the prevalence of *Hymenolepis nana* (71.4%) and *Hymenolepis diminuta* (66.7%) was significantly higher in *Suncus murinus* compared to *Rattus rattus* ($p = 0.001$), while *Ascaris* spp. (44.8%) and *Strongyloides* sp. (31.1%) were more prevalent in *Rattus rattus* ($p < 0.03$). Male individuals had a slightly higher overall parasite prevalence (97.1%) than females (93.8%), though not statistically significant. Female had a significantly higher prevalence of *Hymenolepis diminuta* (62.5%) compared to males (29.4%) ($p = 0.026$). *Strongyloides* sp., *Trichuris* sp., *Coccidia* sp., and *Moniliformis* sp. were only recorded in male.

Table 2: Prevalence of intestinal parasites (by species) in rats and shrews

Parasite species	Prevalence n/N (%)		Statistics
	Rattus rattus	***Suncus murinus***	
Any of all intestinal parasites	112/116 (96.6)	80/84 (95.2)	$\chi^2_{(1)}$=0.22, p= 0.815
H. nana	28/116 (24.1)	60/84 (71.4)	$\chi^2_{(1)}$=44.2, p= 0.001
H. diminuta	24/116 (20.7)	56/84 (66.7)	$\chi^2_{(1)}$=42.9, p= 0.001
Ascaris sp.	52/116 (44.8)	16/84 (19)	$\chi^2_{(1)}$=20.4, p= 0.02

Strongyloides sp.	36/116 (31.0)	4/84 (4.8)	$\chi^2_{(1)}$=23.5, p= 0.022
Trichuris sp.	8/116 (6.9)	0/84 (0.0)	$\chi^2_{(1)}$=2.1, p= 0.219
Coccidia sp.	8/116 (6.9)	0/84 (0.0)	$\chi^2_{(1)}$=1.89, p= 0.219
Moniliformis sp.	4/116 (3.4)	0/84 (0.0)	0.39

Parasite prevalence according to the sex of an animal (rats and shrews)

Parasite species	Sex and Prevalence n/N (%)		Statistics
	Female	**Male**	
Any of all intestinal parasites	60/64 (93.8)	132/136 (97.1)	$\chi^2_{(1)}$=0.09, p= 0.578
Ascarid sp.	12/64 (18.8)	56/136 (41.2)	$\chi^2_{(1)}$=1.9, p= 0.168
H. nana	36/64 (56.3)	52/136 (38.2)	$\chi^2_{(1)}$=1.89, p= 0.231
H. diminuta	40/64 (62.5)	40/136 (29.4)	$\chi^2_{(1)}$=19.9, p= 0.026
Strongyloides sp.	0/64 (0.0)	40/136 (29.4)	$\chi^2_{(1)}$=23.5, p= 0.013
Trichuris sp.	0/64 (0.0)	8/136 (5.9)	$\chi^2_{(1)}$=1.85, p= 0.458
*Coccidia s*p.	0/64 (0.0)	8/136 (5.9)	$\chi^2_{(1)}$=1.62, p= 0.458
Moniliformis sp.	0/64 (0.0)	4/136 (2.9)	$\chi^2_{(1)}$=1.79, p= 0.488

The intensity of parasite infection in the study sites

The intensity of the most zoonotic parasites in rats and house shrews was higher in urban areas (range: 38–382 eggs per rat or shrew intestinal content) compared to peri-urban areas (range: 6–52 eggs per animal intestinal content). Among all the identified parasites, *Hymenolepis nana* and *Hymenolepis diminuta* were the only species that showed statistically significant differences in intensity between the two study sites (p = 0.002).

Table 3: Intensity of the intestinal parasites in rats and house shrews between study sites

Parasite species	Location	Mean egg intensity	Standard deviation	Statistics
Ascaris	Ubungo (urban)	38	52.656	
	Kivule (peri-urban)	18	15.239	$t_{(198)}$ = 0.77, p= 0.262
H.nana	Ubungo (urban)	382	1235.237	
	Kivule (peri-urban)	6	4.349	$t_{(198)}$ = 2.4, p= , p= 0.02
H.diminuta	Ubungo (urban)	163	173.636	
	Kivule (peri-urban)	10	0	$t_{(198)}$ = 5.9, p= 0.002
Strongyloides sp.	Ubungo (urban)	250		
	Kivule (peri-urban)	9.11	15.536	
Trichuris sp.	Ubungo (urban)	0		
	Kivule (peri-urban)	52.5	67.175	

Demographics and risks for indoor transmission of rodents and shrewborne parasites

Among the 320 households selected for animal trapping, however, only 200 respondents from homes where rats and shrews were captured were enrolled to the study: 88 from Kivule and 112 from Ubungo (Table 4). The majority of respondents were aged between 18–29 years (39%) and had attained primary education (47%). Most households consisted of 1–3 children (68%) and 1–3 adults (78%). A significant number of respondents (86%) reported seeing between 1 and 15 rats or shrews daily, primarily in kitchens and food storage areas (58%). Furthermore, 76% observed rodents or shrews accessing clean dishes, and 69% admitted they did not re-wash them afterward. Nearly half of the respondents (45%) were unaware of rat- and shrew-borne zoonoses, with most associating these animals mainly with plague (34%). Awareness of rodents or shrew-related zoonotic diseases was significantly higher among those with higher levels of education ($p = 0.028$) and also varied by age group ($p = 0.026$). Frequent diarrhoea was reported among 61% of children, and 82% of households used poison or traps as a method of rodents or shrews control.

Table 4: Factors that may lead to the indoors transmission of rats or shrews parasites to humans

Variables	Attribute	Frequency	Percentage (%)
How many rats and/shrews do you normally see inside and around the house per day	1-5	80	40
	6-15	92	46
	16-30	28	14
Which areas in the house do rats or shrews prefer to visit	All places	24	12
	Food store	32	16
	Foodstore + Kitchen	54	27
	Kitchen	62	31
	Kitchen + Living room	14	7
	Living room	14	7
Do rats or shrews visit clean food dishes?	No	48	24
	Yes	152	76
Are dishes re-washed after being visited by rats or shrews?	No	168	84
	Yes	32	16
Are you aware that rats or shrews could transmit zoonotic parasites?	No	90	45
	Yes	110	55
Do you know diseases transmitted by rats or shrews?	I don't know	130	65
	Plague	68	34
	Worms	2	1
Do your children experience diarrhoea frequently?	No	78	39
	Yes	122	61
How do you control rats or shrews in your house	Poison	108	54
	Poison+traps	56	28
	Poison+filling holes	14	7
	Traps	8	4
	Others	14	7

Awareness of rats or shrew-borne zoonoses by site, age, and education

Variable	Variable attribute	No n(%)	Yes n (%)	P-value

Study site	Ubungo	49 (43.4)	63 (56.6)	0.73
	Kivule	41 (47)	47 (53)	
Age (Years)	18-29	26 (33.3)	52 (66.7)	0.026
	30-39	34 (70.8)	14 (29.2)	
	40-49	12 (35.3)	22 (64.7)	
	>50	18 (45)	22 (55)	
Education	Not attended school	12 (100)	0 (0)	0.028
	Primary education	44 (46.8)	50 (53.2)	
	Secondary education	24 (38.7)	38 (61.3)	
	University	10 (31.3)	22 (68.8)	

Discussion

This study highlights the prevalence of intestinal and ectoparasites in house rats and shrews, the practices and awareness of people on rodent or shrews zoonoses in Dar es Salaam's urban and peri-urban areas. The study reveals a high prevalence of parasites in house-dwelling rats and shrews across both urban and peri-urban areas of Dar es Salaam, highlighting a significant potential for the transmission of zoonotic parasites to humans. The parasite prevalence observed aligns with findings from previous studies conducted in Tanzania (Cullin et al. 2017) and in other regions globally (Tung et al. 2013; Carrera-Játiva et al. 2023), particularly with respect to zoonotic parasites. However, the prevalence recorded in this study was considerably higher than that reported in other investigations within Tanzania (Issae and Katakweba 2024; Msoffe et al. 2025) and in other parts of Africa and Asia (Mbaya et al. 2011, Mohd Zain et al. 2012, Rahman et al. 2018, Coomansingh-Springer et al. 2019, Sulieman et al. 2019).

On the other hand, the overall prevalence of ectoparasites in this study was lower than that reported in studies conducted in rural areas, conserved forests, and national parks in Tanzania (Shilereyo et al. 2022, Kessy et al. 2024, Musese et al. 2024), as well as in various regions around the world (Eslami et al. 2018; Gholipoury et al. 2016, Maaz et al. 2018; Mawanda et al. 2020, Mohd-Qawiem et al. 2022). Nevertheless, our findings are consistent with a study conducted in urban settings in Malaysia (Blasdell et al. 2022). The lower prevalence of ectoparasites in the urban environment may be attributed to their intolerance of highly disturbed habitats (Maaz et al. 2018) and/or the widespread use of insecticide-based mosquito control interventions, such as insecticide-treated nets (ITNs), aerosol sprays, and fumigation campaigns (Matiya et al. 2022). Our study found no significant difference in the overall prevalence of intestinal parasites between urban and peri-urban areas, although prevalence was slightly higher in the latter. When comparing species, *H. nana* and *H. diminuta* were significantly more common in the urban area of Ubungo. In contrast, *Ascarid* spp. and *Strongyloides* sp. were more prevalent in the peri-urban area of Kivule. Similar patterns of high prevalence for these soil-transmitted nematodes have also been reported in rural areas of Tanzania (Ribas et al. 2013, Thomas et al. 2023, Msoffe et al. 2025). These differences likely reflect environmental conditions. *Ascarid* spp. and *Strongyloides* sp. require warm, moist soil for embryonic development (Brooker et al. 2006), which is often lacking in highly urbanized areas covered with concrete surfaces. In contrast, the presence of grain beetles in urban grain stores, which serve as intermediate hosts for *H. diminuta*, and *H. nana*'s ability to autoinfect may contribute to their higher occurrence in urban settings (Brar et al. 2021).

We also observed greater parasite diversity in peri-urban areas. Species such as *Trichuris* sp., *Moniliformis* sp., and *Coccidia* sp. were found only in these areas. This diversity may be supported by a more favorable environment for maintaining parasite reservoirs and sustaining transmission (Blasdell et al. 2022; Gliga et al. 2020, Rahman et al. 2018).

In this study, house shrews (*Suncus murinus*) were found only in the highly urbanized area (Ubungo), where they made up the majority of captured individuals. Their dominance suggests a strong adaptability to urban environments. *Suncus murinus*, originally native to Asia, was likely introduced to Dar es Salaam through trade (Varnham 2006, Walsh 2007). These shrews thrive in urban areas, often outcompeting rats due to their resistance to rodenticides and their flexible and opportunistic feeding habits (Varnham 2006). Their varied diet, which includes scavenging, feeding on invertebrates, and even preying on rats and snakes (Varnham 2006), may increase their exposure to intestinal parasites (Rahman et al. 2018).

In contrast, this study recorded most of *Rattus rattus* in peri-urban areas than in the urban site. The lower presence in urban environments may reflect competition from shrews (Varnham 2006, Walsh 2007). Additionally, more males than females were captured, likely due to their greater activity and wider home ranges, which increase their chances of encountering traps (Mohd-Qawiem et al. 2022, Tijjani et al. 2020).

This study also compared parasite prevalence between *Rattus rattus* and *Suncus murinus*, as well as between sexes. There was no significant difference in overall parasite prevalence between the two species. However, house shrews exhibited high infection levels with *H. nana* and *H. diminuta,* consistent with findings from previous studies (Tung et al., 2013, Rahman et al., 2018). In contrast, they were rarely infected with *Ascaris* spp. and *Strongyloides* sp., likely due to the environmental unsuitability for these parasites, which require warm and moist soil for development (Brooker et al. 2006).

Rattus species carried all seven identified parasite species, with particularly frequent infections of *Ascarid* spp. and *Strongyloides* sp. This may be attributed to the peri-urban environment, which provides favorable moist and warm soil conditions for the survival and transmission of these parasites (Salam and Azam 2017). Although males had a higher infection rate than females, the difference was not statistically significant, possibly due to the smaller number of females captured. Higher infection in males has been reported in other studies in Tanzania (Issae and Katakweba 2024, Msoffe et al. 2025), and may be linked to the immunosuppressive effects of testosterone (Tijjani et al. 2020). Overall, the high parasite intensities observed in this study indicate a significant risk of environmental contamination with infective stages of shrews or rodents' zoonotic parasites.

Most parasites identified in rats and shrews in this study are zoonotic, posing a health risk to urban populations. In particular, *H. nana* and *H. diminuta* are common cestodes that cause hymenolepiasis, a disease affecting millions globally and associated with symptoms such as diarrhoea, fever, weight loss, jaundice, and fatigue, especially in children and immunocompromised individuals (Tijjani et al. 2020; Cabada et al. 2016, Archer et al. 2017).

In addition to cestodes, a variety of intestinal nematodes were observed. Although species such as *Ascarid* spp., *Strongyloides* spp., and *Trichuris* spp. are generally not infectious to humans, some have been reported in human hosts (Mawanda et al. 2020, Archer et al. 2017). Rats have also been identified as potential reservoirs for *Strongyloides stercoralis*, a known human pathogen (Cullin et al. 2017), and may contribute to the mechanical transmission of *Ascaris lumbricoides* (Archer et al. 2017). These nematodes are part of the soil-transmitted helminths group, widely distributed in tropical and subtropical regions (Bethony et al. 2006).

In this study a low occurrence of *Moniliformis* sp. and *Coccidia* sp. was also recorded. Although *Moniliformis* can cause acanthocephaliasis in humans (Mathison et al. 2021), the *Coccidia* oocysts found were likely unsporulated *Eimeria* spp., common in rodents and considered non-zoonotic (Mohebali et al. 2017).

This study also documented ectoparasites such as fleas, ticks, and mites, which are not host-specific and can transmit various human diseases. Fleas, including *Xenopsylla* spp. and *Ctenocephalides* spp. are vectors of plague, murine typhus, and rickettsiosis. Ticks such as *Rhipicephalus* spp. and *Ixodes* spp. spread babesiosis, Lyme disease, and rickettsiosis. Mites like *Ornithonyssus* spp. are associated with tularemia, Chagas disease, and borreliosis (Islam et al. 2021, 2023). Together, these findings highlight the significant zoonotic threat posed by rats and shrews in urban environments and emphasize the need for continuous surveillance and effective control strategies.

This study further explored knowledge and practices among the respondents of the survey concerning shrews and/ or rodent-borne diseases in homes affected by rodent or shrew infestations. All respondents reported frequent encounters with rodents or shrews, especially in kitchens and food storage areas, aligning with findings from previous studies (Salmón-Mulanovich et al. 2016, Issae et al. 2023). Many respondents noted that rats and house shrews accessed food-serving dishes that were not subsequently washed, a practice that increases the risk of zoonotic disease transmission. This behavior may stem from limited awareness, as a significant number of respondents were unaware that rodents or shrews can transmit diseases (Kusumarini et al. 2022, Issae et al. 2023). When asked to name specific rodent or shrew-borne illnesses, only a few mentioned worms, while others cited plague. The observed low awareness level may contribute to the frequent reports of childhood diarrhoea. Although childhood diarrhoea can be caused by different other factors, the role of rodent or shrew-borne parasites in those instances of diarrhoea should not be underestimated. Knowledge of rodent or shrew-related health risks appeared to be higher among younger individuals and those with formal education, likely due to better access to health information (Issae et al. 2023). Overall, the findings highlight a substantial risk of rodent or shrew-borne zoonoses in urban households, particularly those with easy access for rats and shrews, and emphasize the need for targeted health education.

Conclusion

This study reveals a high prevalence and diversity of zoonotic intestinal and ectoparasites in house-dwelling rats and shrews in urban and peri-urban areas of Dar es Salaam, indicating a significant risk of transmission to humans. Key zoonotic species such as *H. nana*, *H. diminuta*, *Ascarid* spp., and *Strongyloides* spp. were identified, along with various ectoparasites. The study also found limited awareness of rodent or shrew-borne diseases and poor hygiene practices, such as not rewashing dishes after rodent or shrew contact, based on the findings from the survey. It is important to note that this information was collected specifically from households where trapping was successful, which may contribute to the higher rate of reported hygiene concerns. These findings highlight the urgent need for integrated rodent or shrew control, improved sanitation, and targeted health education to reduce the public health risks posed by rodents and shrews in urban environments.

Declaration of Competing Interest

The authors declare that they have no competing interests.

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