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Cross-Sectional Study of Intestinal Helminthes and Blood Parasites of Brown Rat (*Rattus Norvegicus* Berk.) Trapped Within Dutsin-Ma Metropolis, Katsina State, Nigeria

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Abstract :A study was carried out from the period of April to August, 2016 in and around Dutsin-Ma town to identify and determine prevalence of gastrointestinal and blood parasites in brown rat (*Rattus norvegicus*). During the research, a total of one hundred and sixteen 116 brown rats were trapped and captured. From the sampled rats used, 52 (44.83%) were males and 64 (55.17%) were females. Seventy-two (72) brown rats were recorded positive with the overall prevalence of (62.07%). A slightly higher prevalence of infection was noted in the males (63.46%) compared to the female (60.94%) rats. A slightly higher prevalence of infection was also recorded in the adults than the immature/juvenile sub-adult of the rat samples. The differences in infection rates by sex and that of adult and immature/juvenile sub-adult of the experimental brown rats were statistically insignificant ($P > 0.05$). But, higher prevalence of the parasites was recorded at the gut region (59.48%) than the blood (2.59%) which is statistically significant ($p < 0.05$). The gastrointestinal parasites were collected from the gut regions to include: stomach, small (ileum) and large intestine and rectum; while blood ones were collected from the heart of rats sampled. The parasites were recorded in accordance with the gastrointestinal parts and blood region (heart) of these brown rats. Prevalence of individual parasites species recorded from the gut regions (stomach, small intestine, large intestine and rectum) are: *Hymenolepis diminuta* (12.93%), *Hymenolepis nana* (7.76%), *Ascaris lumbricoides* (6.90%), *Trachura trichuris* (12.07%), *Strongyloides stercoralis* (14.66%), *Taenia saginata* (5.17%). *Schistosoma haematobium* (2.59%) was the only blood parasites collected from the heart. Among these parasites, *Strongyloides stercoralis* has the highest prevalence of (14.66%) and *Schistosoma* with the least (2.59%) prevalence. The infected parts of intestinal regions show symptoms of perforation and blockages by the parasites. There was significant difference ($p < 0.05$) between the parasite species. The abundance and prevalence of different parasites revealed in this study can pose a tremendous risk of transmitting helminthiasis and other zoonotic diseases to human population. Public lecture and enlighten campaign on the dangers of dumping garbage, refuse and sewage and should be encouraged.

Keywords: prevalence; gastrointestinal; helminth; brown rat; blood; *Taenia*; *Strongyloides*

Introduction

Brown rat (*Rattus norvegicus* Berk), is a cosmopolitan rodent with a wide distribution in urban and suburban-rural habitats, commonly found living near sources of food and water, such as refuse and drainage ditches, streams or sewers. Because of the high ability to harbor many zoonotic agents, brown rats play a significant role as definitive and/or intermediate hosts for vector-borne animal and human diseases (Easterbrook, 2007).

The impact of household rats (*Rattus* spp.,) on human race has caused untold suffering and lot of economic damages than any other vertebrate pests. The best known rat species are Black Rat (*Rattus rattus*) and Brown Rat (*Rattus norvegicus*). The group is generally known as the Old World rats or true rats, and originated from Asia (Randall et al., 2003). Rats are bigger than most Old World mice, which are their relatives, but seldom weigh over 500 grams in weight (Soliman, et al., 2001).

Rats are the most commonly found rodents in the city and its surrounding areas. With rare exceptions, the brown rat lives wherever humans live, particularly in urban areas (Traweger, et al., 2006).

In view of the diversity and zoonotic nature of helminthes, rats can readily facilitate parasites transmission to humans and other susceptible animal hosts. Increased rodent population in an area can be directly related to the increased zoonotic diseases in human population (Fragaszy, et al., 2003). *Capillaria hepatica* is a nematode parasite of wild rodents and other mammals that is worldwide in distribution. Adult worms colonize the liver of the host and cause a serious liver disorder, which may be found both in humans and animals. These parasites could be accidentally transmitted to humans by ingestion of embryonated eggs. Up to date about 40 cases of human infections had been reported (Camargo et al., 2010).

Apart from economic lost that rodents produce, they are responsible for transmitting bacterial, viral, rickettsial and parasitic diseases. The worldwide distribution and public health importance of parasitic diseases infecting rodents have attracted the attention of several investigators (Forbes et al., 2002).

Establishing the context, the damages and economic losses suffered by humans due to rodents, and the importance of sanitation, it is necessary to fight rodents in order to reduce the amount of contamination and occurrence of serious illness and to create a healthy city.

Similarly, one of the concerns of health care providers is the contamination caused by both wild and domestic rats. Given the importance of rodents in terms of transmission of disease-causing agents, including parasites, to humans, studying the potential for transmission of these agents in each geographical region is essential for health. This is because in recent years, there have been reports of increased levels of infestation of domestic premises by commensally brown rats and increased complaints to local authorities of rat infestations (NPTA, 2001).

Intestinal helminthes parasites of many rodents, especially household and bushy rats produced a weakened host's immune system, thereby increasing their susceptibility to secondary infections resulting in the nutritive devaluation of rats' population (Waugh et al., 2006).

In the study area, rats live at the expense of humans, invade their dwelling, eat their food and upset their comfort and frequently may transmit diseases to humans. There is a wide abundance distribution of different rats' species, especially in neighboring rural areas of Dutsin-Ma town, and consumption of variety of foods as well as materials of human and animal origin, had contributed immensely to their exposure to contaminants and other parasitic infections.

1.1 AIM

The aim of this study is to investigate and determine the parasitic load of intestinal helminthes and blood parasites associated with Brown rats.

1.1.2 OBJECTIVES

The present study was undertaken to:

i. Determine the prevalence of intestinal parasites in the brown rats

ii. Determine the intensity of intestinal and blood parasites in brown rats

iii. Investigate factors that might influence the transmission of helminthes parasites in brown rats

2. MATERIALS AND METHODS

2.1 STUDY AREA

Dutsin-Ma (Lat 12^0 27'01.18" N/ Long 7^0 29'.29" E) Local Government covers an area of 527 km squares and has a population of 16, 971, at the 2006 census (NIPOST. 2009). Total annual rainfall around Dutsin-Ma is about 800mm. The inhabitants of the Local Government Area are predominantly Hausa and Fulani by tribe, with their main occupations as farming and animal rearing (NIPOST. 2009).

2.2 SAMPLES COLLECTION

Brown rats of both sexes (male and female) were trapped using local snap traps. Brown rats used for the study were collected during the Month of May, June and July 2016 from different areas of Dutsin-Ma metropolis, Katsina State, Nigeria. Positions considered in catching the rats include: New markets, Livestock farms, Households, Hayingada, Dutsin-Ma dam sites, Dutsin-Ma Rock, Students hostel in the Federal University Dutsinma main campus, under bridges and Old empty bungalows.

The habitats occupied by brown rats might be different in terms of location and burrowing patterns, which is related to food items, storage site and holes beneath the land. Some brown rats were caught alive using un baited snap trap used by setting up the traps with ground nut cake and fried fish pieces near houses/residential places and in farm lands around evening or at night hours as shown by (Ekeh & Ekechukwu, 2009). Rats for the required specimens were caught/trapped and then brought to Biology laboratory of the Federal University Dutsin-Ma, Katsina State, Nigeria, for analysis.

2.3 MEASUREMENT OF RAT SAMPLES

The rat samples were weighed using a standard lever balance, measured lengthwise (from nose tip to tail base). The length was also taken/measured using meter rule to the nearest 0. 00cm. The sexes (male and female) of the experimental animals/rats were determined by examining the reproductive organs which will easily be determined externally as shown by (Katataranovski et al., 1976).

2.3.1 DISSECTION OF RAT SAMPLES

Freshly killed samples of brown rats were, arranged on dissection boards and anesthetized using chloroform/formaldehyde solution; later dissected using sharp/burnt straight blade dissecting knife and coarse scissors, and then tongs were removed together with the contents of gut and abdominal cavity regions/viscera. The alimentary canal was also removed in portions (Katataranovski et al., 1976). All fecal matters were packed in to a cleaned Petri dish containing physiological saline (0.85 % NaCl), examined and identified under the dissecting microscope AO 40 (Bawa et al., 2014).

2.4 IDENTIFICATION OF INTESTINAL HELMINTHES PARASITES

The contents of each portion in the intestine were washed with saline solution and inspected for the presence of parasitic helminthes with aid of biconvex hand lens and binocular dissecting microscope (stereoscopic dissecting microscope; paramount psm 12-25%). Each parasitic helminthes recovered during the research work were preserved in 70% alcohol, 10% glycerol. The helminthes worms would be sorted out, washed and left in tap water for sometimes to relax the muscles (particularly cestodes). Some of the worms (particularly nematodes) were stained in acetocarmine for easy viewing through the internal structures. Permanent preparations were made and microphotographs taken. All recovered gut parasites were identified to species level (Ajayi et al., 2007). Identification of the parasites was based on morphology and configuration of specimens by comparison with museum types specimens as described by (Anderson, 1992).

2.5 IDENTIFICATION OF BLOOD PARASITES

Blood sample were taken from their hearts using a needle and syringe, and thin smear were prepared with a drop of blood. The blood smear was fixed on to a glass slide by immersing it in pure methanol for one minute. Then the slide was immersed in a solution of 1 part Giemsa stock to 20-30 parts buffered water (p^H 7.0-7.2) 20-30% Giemsa stain solution for 20-30 minutes, then finally flushed with water and left to air dry. The slide will be mounted and examined under light microscope (Labomed L x 300 LED Series) at x 100 magnification under oil immersion for identification (Pietro-Caramello, 2000). Each slide was examined for gametocytes and schizogonic cycle stages.

2.6 DATA ANALYSIS

Data collected were coded and entered into Microsoft Excel spread sheet. Statistical analyses were performed using SPSS, software packages. Percentage was used to calculate prevalence. Data were statistically analyzed using chi-square. In all cases, 95% confidence interval (CI) and $p < 0.05$ were considered for statistically significant differences.

3. RESULT

A total of 116 brown rats (*Rattus norvegicus*) were freshly captured, in which 52 (44.83%) were males and 64 (55.17%) were females. Among all, seventy-two brown rats 72 (62.07%) were infected with one or more parasites. A slightly higher prevalence of infection was noted in the males compared to the females (table 1). The difference in infection by sex of the sampled rats was statistically insignificant ($P > 0.05$).

A total number of seven (7) different parasites species were found, namely: *Hymenolepis diminuta, Hymenolepis nana, Ascaris lumbricoides, Trichuris trichiura, Strongyloides stercoralis, Taenia saginata,* and

Schistosoma haematobium. The helminthes parasite species were found to invade the gut regions, other gastrointestinal parts. Hence, the blood ones invade the fluids content of the rats.

TABLE 1. Distribution of intestinal and blood parasites by sex of brown rats

Parasites	Total male rats	Infected	(%)	Total female rats	Infected	(%)	X^2	P value	Df
Intestinal									
Hymenolepis diminuta	52	6	11.54	64	9	14.06	0.16	0.6	1
Hymenolepis nana	52	3	5.77	64	6	9.38	0.52	0.45	1
Ascaris lumbricoides	52	4	7.69	64	4	6.25	0.09	0.7	1
Trichuris trichiuris	52	8	15.38	64	6	9.38	0.09	0.323	1
Strongyloides stercoralis	52	7	13.46	64	10	15.63	0.1	0.74	1
Teania saginata	52	4	7.69	64	2	3.13	1.22	0.26	1
Blood									
Schistosoma haematobium	52	1	1.92	64	2	3.13	0.16	0.68	1
Total	52	33	63.46	64	39	60.94			

X^2 = chi-square, Df = degree of freedom and (%) = prevalence

Data on the quantity of infection of gastrointestinal and blood parasites in adult and immature/sub-adult brown rats are presented in table 2. A slightly higher prevalence of infection was noted in the adult than the immature/juvenile sub-adult, which is statistically insignificant ($p > 0.05$).

TABLE 2. Prevalence of intestinal and blood parasites in adult and immature sub-adult brown rats

Parasites	Total rats examined	Infected	Non infected	Prevalence	X^2	P value
Intestinal						
Hymenolepis diminuta	116	15	101	12.93		
Immature	45	4	41	8.89	1.066	0.587
Adult	71	11	60	15.49		
Hymenolepis nana	116	9	107		0.122	0.941
Immature	45	3	42	6.67		
Adult	71	6	65	8.45		
Ascaris lumbricoides	116	8	108	6.90	0.688	0.709
Immature	45	2	43	4.44		
Adult	71	6	65	8.45		
Trichuris trichiura	116	14	102	12.07	0.701	0.704
Immature	45	4	41	8.89		
Adult	71	10	61	14.08		

Strongyloides stercoralis	116	17	99	14.66	0.103	0.950
Immature	45	6	39	13.33		
Adult	71	11	60	15.49		
Teania saginata	116	6	110	5.17	4.379	0.112
Immature	45	1	44	2.22		
Adult	71	5	66	7.04		
Blood						
Schistosoma haematobium	116	3	113	2.59	1.952	0.377
Immature	45	0	45	0.00		
Adult	71	3	68	4.23		

$X^2 = (p > 0.005)$

Considering the overall prevalence and occurrence of the parasite species (62.07%), it could be deduced that gastrointestinal regions possessed the highest prevalence of (59.48%) than the blood (2.59%) which has the lowest prevalence table 3. This shows that is it is statistically significant ($P < 0.05$).

Table3. Prevalence and Occurrence of gastrointestinal and blood parasites in brown rats

Parasites	Total rats examined	Infected	Non infected	Prevalence
Intestinal				
Hymenolepis diminuta	116	15	1 01	12.93
Hymenolepis nana	116	9	107	7.76
Ascaris lumbricoides	116	8	108	6.90
Trichuris trichiura	116	14	102	12.07
Strongyloides stercoralis	116	17	99	14.66
Teania saginata	116	6	110	5.17
Blood				
Schistosoma haematobium	116	3	113	2.59
Total	116	72	44	62.07

Chi-square value (X^2) = 17, p. value = 0.009, and Degree of freedom = 6

Fig.1 *Strongyloides* larvae

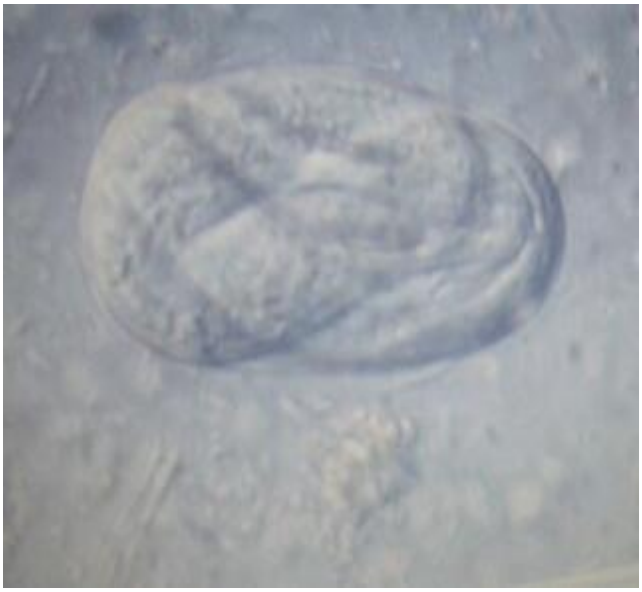

Fig.2 *Strongyloides* egg

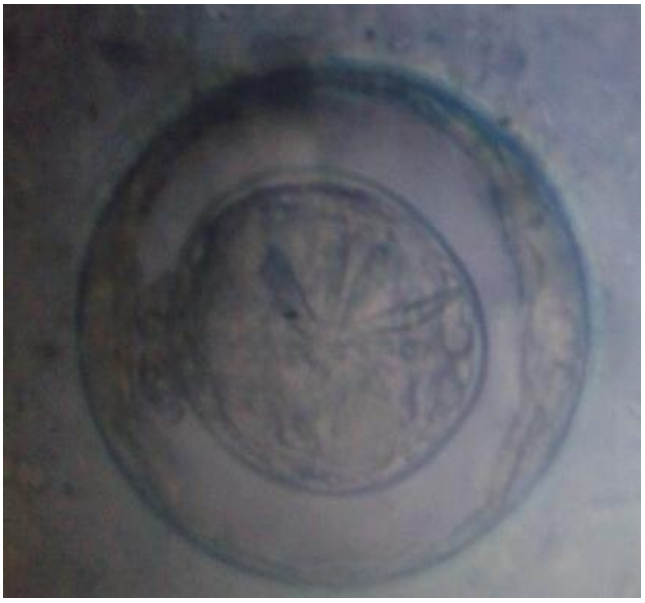

Fig. 3 *Hymenolepis diminuta* egg

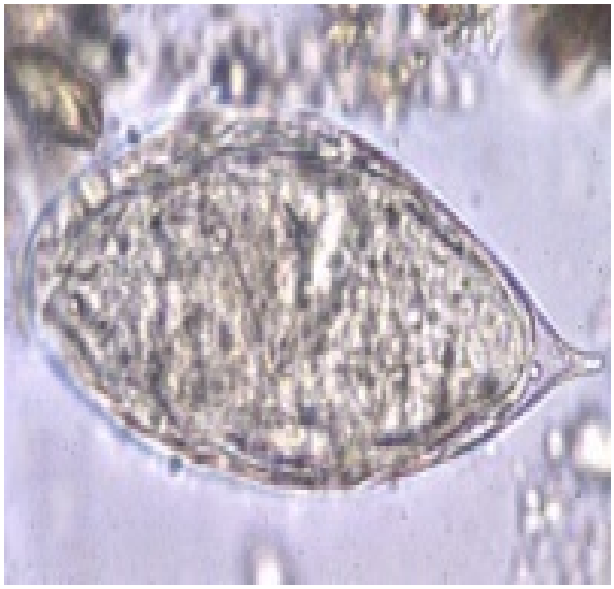

Fig. 4 *Schistosoma haematobium egg*

Fig. 5 *Ascaris* larvae

4. DISCUSSION

The most obvious finding to emerge from the present study revealed that stores for food items, underneath markets roofing, bridge sides or water ways, farm lands and gardens, student hostels, incinerators/dust bins, water canals/gutters in houses and abandoned bungalows are responsible harbors for the Brown rats (*Rattus norvegicus*). These areas are responsible sites for the rats to invade or favor or influence the parasites in the susceptible rats. In urban ecosystems, brown rats have a role as collectors of edible garbage and as food for mammal and bird predators (Mahida, 2003). This work also corresponds with the work of (Figgs, 2011) who reported that the gradual increase in human population and development of towns along with human population have resulted in an increase of garbage and refuse which create a favorable condition for the proliferation of rats, and rarely remain uninfected or harbor just a simple species infection in nature.

Our study revealed the extent of intestinal parasites population among brown rats in Dutsin-Ma Metropolis. The public health implication is important when it is remembered that some people used rats as veritable sources of food protein in and around their home gardens, farmlands and some bushy sites of the surveyed area. The brown rat in rural areas is seen predominantly as a storage pest living on the supplies of harvested cereals, root crops and also on livestock feeds that can be found in farm buildings (Cowan et al., 20003). These results are in agreement with those obtained by (Figgs, 2011); (Ajayi et al., 2007).

It has been reported in the present study that a total prevalence (62.07%) of parasites was recorded with *Strongyloides* having the highest incidence (14.66%) population, followed by *Hymenolepis diminuta* (12.93%), *Trichuris trichiura* (12.07%), *Hymenolepis nana* (7.76%), *Ascaris lumbricoides* (6.90%), *Taenia saginata* and *Schistosoma haematobium* (2.59%) in the experimental animals. A higher (59.48%) prevalence was recorded from the gastrointestinal regions (small intestine/ileum) because; almost about six parasites out of seven were found in the mucosa of the gastrointestinal regions (stomach, small intestine, large intestine and rectum). While an extremely lower prevalence (2.59%) was noted in blood, collected from heart of the sampled rats, with only single parasite specie recorded.

However, the lower prevalence of blood parasite reported in this study could be explained by the fact that, the rats might have feed from the definitive host, especially from those (rats) trapped under bridges and near garbage and incinerators. This shows that is it is statistically significant ($P < 0.05$). However, differences exist between intestinal helminthes and blood parasites in terms of the regions harbored. This report is in line with the work of (Garedaghi and Amir, 2012) who reported that gastrointestinal parasites were found in 100% of the rats' population in which nematodes such as *Trichuris* sp. (96.7%), *Globocephalus* sp. (86.7%), *Squamostrongylus* sp. (70%), *Strongylus* sp. (83.3%), *Strongyloides* sp. (93.3%) are prevalent. In line with the

revealed work, (Baert et al., 2012) reported that gastrointestinal regions harbor more parasites than the blood region of rats' species. Similar investigations were carried out by many authors in other regions of the world. In Malaysia for instance (Bellocq et al., 2003) reported 59.9% of brown rats infected with helminthes parasites. Likewise, in Iran (Baert et al., 2012) reported 70.74% in infected Gambian rats with high incidence in the intestinal region, but less in the heart region. In Abeokuta metropolis, south western Nigeria 54.1% of rats' population was found to be infected (Traweger & Slotta-Bachmayr, 2005).

These reports could also be explained by the fact that most of gut regions have blockage, even the small and large intestine contained lot of hatched eggs from these helminthes. Increase of these parasites might exist due to weaken immune system of the parasites (immune compromised). Because, some of the mature adult helminthes produce eggs in the gut regions of the feces and their larvae may infect the rats through penetration of the skin.

Differences in prevalence seen in many parts of the study area could possibly be due to change in the population of rats and environmental influence practices. Their habitat suitability might include buildings constructed between waterways, compost heaps and the position and holes of the land. According to (Egbunu and Dada, 2016) food, vegetation, natural soil and shelter are essential factors for brown rat habitat. The high prevalence or intestinal parasites in the rats might also be attributed to low level of sanitation in the study area. This may depend on the feeding habits of the brown rats and their dwelling areas, thus; near water ways, farmlands, garbage or swage disposals and incinerators.

It has been established in this research that male rats are highly infected (63.46%) than the female (60.94) ones; the difference is statistically insignificant ($P > 0.05$). This could be discussed by the fact that infected males have wider regions or host susceptibility than uninfected males, and that the home range of males tends to overlap which could increase their exposure to infection, whereas the females show a stronger less vulnerable targeted regions or host susceptibility. (Paul et al., 2016) claimed that nematodes were more prevalent (72%) than platyhelminthes (52%) in the rat population, and overall prevalence of helminthes parasites was 84% higher in male rats and 40% which is less in female rats. This correlates with the work done in Maiduguri, Nigeria where 8.2% are positive for helminthes infection, but higher in adult (7.1%) than young (1.1%) rats (Nieder et al., 1982). Another hypothesis assumes that among mammals the larger bodies of males are easier targets for endo-parasites (Stojcevic et al., 2004). It could also be deduced that, a slightly higher prevalence of infection which was noted in the adult than the juvenile sub-adults, as a result it is statistically insignificant ($P > 0.05$). This report is in line with the work of (Bawa et al., 2014) who recorded higher prevalence of parasites in adults than the immature sub-adults in emin's pouch rat (*Cricetomys emini*).

This research reported host susceptibility in relation to the target regions or organs for the distribution of the parasites. It indicated that helminthes parasites are more prevalent in the gut regions of ileum/small intestine followed by the stomach, large intestine and then rectum. This could be explained by the fact that stomach and intestine organs or regions have higher parasitic load because of the digested food materials which might be absorbed directly into the body walls of the parasites. Hence, the higher the number of rats in the surveyed area, the greater the risk of contracting zoonotic diseases, and the more parasitic load encountered in their gut regions. (Arneberg, 2002) found that increased rodent population in an area could be directly related to increased zoonotic diseases in human population.

CONCLUSION

The current research found that parasitic load of intestinal helminthes (*Hymnolepis diminuta, Hymnolepis nana, Trichuris trichiura, Ascaris lumbricoides*, *Strongyloides stercoralis*, *Taenia saginata*) that invade most of the gut regions- stomach, large intestine, small intestine and rectum; while *Schistosoma haematobium* was observed in the heart to invade a blood portion of the vein in the experimental brown rats. However, the research recorded higher prevalence and occurrence of intestinal parasites (59.48%) than the blood parasites

(2.59%) These parasites are medically important because they transmit some of the most important infectious diseases of animals, and they remove considerable quantity of blood fluids and proteins from their host, and because of some wounds (blockage of intestine), which they produce, are not only irritating their hosts but also open room to the secondary infections.

ETHICAL APPROVAL

Before the commencement of the research, an approval was gotten from the ethical committee of Katsina State Ministry of Health, Nigeria. All authors hereby declare that all experiments have been examined and approved by the appropriate ethics committee and have been performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki.

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