https://doi.org/10.22319/rmcp.v11i4.5182

Article

Presence of *Hymenolepis nana* and *diminuta* in rodents of the Las Pinas citadel, in Milagro, Ecuador, and its risk for public health

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Abstract:

Hymenolepidiosis is a zoonosis of worldwide prevalence, especially in children, and it is caused by rodent cestodes called *Hymenolepis (H) nana* and *Hymenolepis diminuta*. It is very common in developing countries with hot, temperate and dry climates. The life cycle of *H. nana* does not require intermediate hosts, and its usual transmission is fecal-oral (by ingestion of infective eggs); and infection of *H. diminuta* occurs through ingestion of tenebrionid arthropods with the larval form (cysticercoids). The objective of this study was to determine the presence of *H. nana* and *H. diminuta* in the “Las Piñas” citadel, in

the city of Milagro (Ecuador) and to make the public health risk known, through informative talks. For this research, the rodents were captured with the help of Tomahawk and Sherman traps with non-toxic baits (meat, mortadella, fish, bread). A descriptive, prospective cross-sectional study with qualitative approach, carried out between February 1st and July 30th, 2018, analyzed fecal samples using direct methods and flotation-centrifugation with a supersaturated saline solution. Out of 87 captured and processed rodents, 20 cases (22.99 %) were determined for *Hymenolepis nana*, and 10 cases (11.49 %), for *H. diminuta*. This was the first report of *Hymenolepis nana* and *diminuta* in rodents in the country. It can be concluded that the presence of these parasites at the study site is evident and may become a serious public health problem, due to the risk of transmission to the inhabitants of the sector.

Keywords: Trapping, Coproparasitoscopic methods, Parasitism in rodents, Public health.

Received: 05/12/2018

Accepted: 03/09/2019

Introduction

Infectious agents transmitted from animals to humans account for the majority of new pathogen outbreaks worldwide[1], with over one billion cases of human disease attributable to zoonotic diseases each year, making the identification of wild reservoirs of zoonotic pathogens a public health priority[2].

Rattus norvegicus (brown rat) and *Rattus rattus* (black rat) are known reservoirs of bacteria, viruses and zoonotic parasites of veterinary importance[3,4]. Helminthiasis affects 20 % of the Latin American population and is considered a neglected disease, infecting approximately 3.8 billion people worldwide[5]. These infections are common in rural populations and overcrowded areas, especially in countries with tropical and subtropical climates, associated with poverty and marginalization, and do not receive adequate national or international attention[6,7]. The social determinants of these diseases include poor housing conditions (without adequate roofs, walls, or floors), lack of access to safe drinking water, basic sanitation and hygiene, low income, poor education, and barriers to accessing health services in general and primary health care in particular[7,8].

Hymenolepidiasis is a globally prevalent parasitism caused by cestodes of the genus *Hymenolepis* and *Rodentolepis* (Hymenolepipidae: *Cyclophyllidea*). The life cycles of these parasites involve humans, rats and mice as definitive hosts, and arthropods (Tenebrionids) as intermediate hosts. The presence of tenebrionids in the houses and unhealthy conditions generated by the lack of basic services and environmental and socio-

economic factors favor the development of the disease in hot and humid areas, causing greater affectations to the child population[9,10].

Rats and mice act as definitive hosts of Hymenolepis, and the occurrence of this parasite in humans is usually transmitted by fecal-oral route, by egg ingestion (*H. nana*); however, occasionally it can also be transmitted by ingestion of an arthropod, which will thus complete its life cycle (*H. diminuta*)[11,12]. It has been estimated that 20 million people in the world are infested with these two parasites[13]. However, both parasites share some epidemiological characteristics, such as prevalence in children from marginalized areas with poor hygiene habits, sanitary conditions and overcrowding[12].

Ecuador is a country with a great variety of climates with four delimited regions: coast, sierra, east and insular region. The "Las Piñas" citadel is located on the Ecuadorian coast; it is characterized by a tropical climate in addition to high percentages of moisture due to its rivers and plains. The citadel has a marginal urban sector with 2,500 houses, where it is possible to find unoccupied houses; sugarcane, cocoa, and banana plantations, and pastures; in addition, there are ditches and septic wells. On the other hand, it does not have sewage, and few homes have drinking water; therefore, it meets the necessary conditions to have the presence of rodents that represent a health risk[14]. In addition, the presence of *Hymenolepis nana* and *diminuta* in rodents has not been reported in the country. Rodents must be reported, as they are potential sources of parasites that may cause public health problems as a result of their transmission to humans. On the other hand, the purpose of this study is to inform public health authorities and health professionals about cases of Hymenolepidiasis in rodents, as well as to inform the population and guiding them in prevention efforts.

Material and methods

Study area and period

The study was conducted in the urban-marginal citadel called "Las Piñas", located in the northern part of the canton Milagro, province of Guayas, on the Ecuadorian coast, at the geographical coordinates 2° 7' 0" S and 79° 36' 0" W. The community "Las Piñas" has 12,000 inhabitants; its climate is tropical-humid, with a marked difference between winter and summer, and with temperatures ranging from 22 to 36 °C[14, 15].

Survey

Each one of the selected households was visited, explained about the study and the risk of parasitosis in their environment, and once they gave their consent and signed a consent form for themselves and for the minors, a directed survey was applied, after which a sterile vial was given to each person.

The survey included the following questions: Do you know about hymenolepidiasis? What is the source of your drinking water? How are excreta handled in your home? Are intra- or peridomestic rodents present? Do you store farinaceous foods (rice, corn, barley, etc.)? Are there tenebrionids (beetles, fleas, weevils, etc.) in the farinaceous food deposits? Do you have a sewer system?

Sampling

Before carrying out the study, permission was requested from the authorities of the Faculty of Veterinary Medicine and Zootechnics (FMVZ) of the University of Guayaquil to carry out the study in the Microbiology Laboratory of the FMVZ; permission and collaboration were obtained as well from the "Las Piñas' New Horizons" Improvement Committee ("Nuevos Horizontes de Las Piñas"). In addition, the research methodology was analyzed and approved by the Research Coordination of the FMVZ.

A descriptive, transversal and prospective study was carried out between February 1 and July 31, 2018; 70 homes with a total population of 320 people were researched between winter and summer, at an approximate temperature of 27 to 32 °C.

During the research, 87 rodents were sampled from three selected areas: (1) rodents in inhabited houses, vacant lots, ditches, and garbage dumps; 2) ditches and garbage dumps, and 3) Community Police Unit (CPU), ditches, garbage dumps, and vacant lots. It is important to mention that concentrations of garbage were found in all the researched areas. On the other hand, the survey was conducted with 90 people from the sector, divided into 30 for each one of the three abovementioned sectors.

Rodent Capture

Rodents were captured with the help of Tomahawk and Sherman traps and non-toxic baits (meat, bologna, fish, bread) taking recommended biosecurity measures. These traps were strategically placed in "Las Piñas" which is an urban-marginal citadel, which has places at risk such as: garbage dumps, ditches, pastures, and in the homes of certain community members who claim to have rodents[16].

Those rodents that were captured alive were euthanized with pure chloroform soaked in cotton, according to the method suggested by the CICUAL of the School of Veterinary Medicine and Animal Husbandry of the University of Guayaquil. In addition, fipronil was sprayed at 0.15% before proceeding with the necropsy, as a biosafety rule for the professionals who performed it.

Once the animals were captured, they were transported alive to the Microbiology Laboratory of the FMVZ of the University of Guayaquil, where the necropsy was

performed on them and the sample was extracted to be later analyzed using the techniques reported by Aluja and Constantino[17,18].

Laboratory analysis

The samples were analyzed using direct methods and sedimentation with saturated salt solution[17,19], then examined under the optical microscope with 10X and 40X objective lenses.

The parameters to be followed during the necropsy for the removal of the gastrointestinal tract from the rodents were those reported by de Aluja and Constantine[18]. In addition, the Travassos qualitative technique was applied in order to obtain adult parasites[18,20]. The mucous membranes of already washed organs were checked for adult or juvenile helminths attached to, or underneath the mucous membrane.

Results

After setting up and baiting the traps at the different study sites, it was waited for a period of 12 h. The traps were subsequently checked, and the rodent species were taxonomically identified[16,17]; a total of 87 rodents (40 *Rattus rattus* and 47 *Rattus norvegicus*) were thus captured and analyzed using the direct coproparasitic method and sedimentation with saturated salt solution. 20 (22.99 %) of the rodents were positive for *H. nana*, and 10 (11.49 %) were positive for *H. diminuta*.

Furthermore, it was possible to identify the distribution of the parasite in the rodent species studied: *H. nana* 12 (100 %) and *H. diminuta* (0 %) in *Rattus rattus*, and *H. diminuta* 10 (55.5 %) and *H. nana* 8 (44.5 %) in *Rattus norvegicus.*

Cases of *Hymenolepis nana* and *diminuta* were found in all the study areas. In area 1, there were a total of 4 cases of *H. nana* and 2 cases of *H. diminuta*. In area 2, there were 7 cases of *H. nana* and 3 cases of *H. diminuta*. In area 3, a total of 9 cases of *H. nana* and 5 cases of *H. diminuta* were determined (Table 1).

Table 1: Total number of parasites per area

	Area 1 (%)	**Area 2 (%)**	**Area 3 (%)**	**Total**	**%**
Hymenolepis nana	4 (4.59)	7 (8.04)	9(10.34)	20	22.97
Hymenolepis diminuta	2 (2.29)	3 (3.44)	5(5.74)	10	11.47

In addition, 90 people were surveyed with questions about the risk of transmission of diseases from rodents to humans, all of whom said that they did not know about Hymenolepidiasis; 60 individuals (66.67 %) said they consumed water from drums and

30 (33.33 %) mentioned buying water from tankers. All respondents reported that they discarded their excreta through septic tanks. In the case of rodent excreta, the respondents indicated that they assumed that they fell to the ground.

As for the presence of intra and peridomestic rodents, 32 individuals (35.55 %) reported seeing intradomestic rodents; 48 individuals (53.33 %) reported seeing peridomestic rodents; 10 individuals (11.11 %) reported seeing no rodents inside or outside their home. On the other hand, only 17 individuals (18.88 %) declared to have in their home deposits of farinaceous food. Likewise, 13 individuals (14.44 %) reported having seen tenebrionids in their deposits of farinaceous food located in their homes. Regarding the sanitary situation, 70 surveyed individuals (77.78 %) reported not having drinking water, and all 90 said that they did not have a sewerage system.

As for the capture sites, in area 1, cases of intestinal parasites were determined in rodents that roamed areas such as inhabited houses, vacant lots, ditches and garbage dumps. In area 2, intestinal parasites were determined in rodents that prowled in ditches and garbage cans. In area 3, cases of intestinal parasites were detected in rodents around the Community Police Unit (CPU); ditch, garbage dump and vacant lots.

In order to estimate the number of houses affected by the close presence of rodents, a radius of action of 40 to 50 m was used for the species *Rattus rattus*, and of 30 to 45 m for *Rattus novergicus* [21].

The study of impact on the population showed that the perimeter of affectation of area 1 where positive rodents were found comprised an average of 10 to 18 houses, which suggests a direct damage of 10 to 18 families respectively. In area 2, the radius of action of the traps where positive rodents were found included 15 to 18 houses. In Area 3, it comprised 10 to 25 houses.

Discussion

The estimated prevalence of *Hymenolepis nana*, of 22.99 %, is higher than that determined in Costa Rica (0.97 %)[22], in Cuba (2.56 %)[23], in Peru (6.8 %)[17], in Brazil (8.8 %)[24], and in Argentina (8.2 %)[19]. Likewise, low prevalences of *H. nana* have been registered in countries of other continents, such as 2.5 % in Iran[25], 3.3 to 10.3 % in China, and 3.3 to 4.1% in the Netherlands[26]; however, higher prevalences have been recorded in Taiwan (21.8 %)[26], Brazil (35.7 %)[27] and Italy (100 %)[26]. It should be noted that the coastal region of Ecuador is an area where there is a high, constant environmental temperature throughout the year, due to the presence of two annual seasons (winter/summer), which are characterized by high humidity and the presence of moderate to torrential rains in the former, and low rainfall and high environmental temperatures in the latter.

The 10.64 % of determined *Hymenolepis diminuta* is less than the one expressed in Cuba with 11.5 %[23], in Argentina with 12.2 %[19], in Peru between 25.7 and 43.8 %[28] and in Costa Rica with 43.68[22]. Also, low prevalences of *H. diminuta* were determined in countries of other continents, such as Taiwan, with 6.3 %[26], and Iran, with 1.7 %[25], in contrast with prevalences (10.64 %) above that found in countries such as China (27.8 %)[26], Iran (38.8 %)[25], The Netherlands (10.2 to 50 %), Serbia (30.5 %), and India (62.5 %)[26].

Notably, in all the studied areas there were cases of *H. diminuta* and *H. nana*, zoonotic parasites, regarding which the surveyed individuals said they had no knowledge of the disease they produce. On the other hand, 33.33 % mentioned buying water from tankers. All the individuals said that they discarded their excreta through septic tanks; 35.56 % said they saw rodents in their homes, and 53.33 % said they saw rodents in their homes. Likewise, 18.88 % mentioned having in their homes deposits of farinaceous food, which are the main source of tenebrionids, intermediate hosts of the *H. diminuta*[29], which may transmit the parasites to humans, especially in the winter season, when the number of vectors increases[25].

The 77.78 % of the respondents mentioned that they do not have drinking water, and also all the respondents stated that they do not have sewage, which is a potential risk for the increase of rodents in the face of the present increase in population[21]; the latter, in turn, are important indicators of neglected parasitosis in vulnerable populations[7,30].

Finally, cases of intestinal parasites were determined in rodents of inhabited houses, ditches, garbage dumps, plots of land and vacant lots, which are places where there is greater proliferation of these mammals[21].

Conclusions and implications

This study determined the presence of *H. diminuta* and *H. nana* in rodent feces from the "Las Piñas" citadel in the Milagro canton, and concluded that the presence of these helminth parasites is evident at the study site, which constitutes a public health problem and involves a risk of new cases. On the other hand, emphasis is placed on promoting an in-depth epidemiological study to identify the most vulnerable members within the family nuclei, for the development of awareness campaigns aimed at age groups at risk of suffering from the parasite.

Acknowledgements and conflict of interest

The authors are grateful for the collaboration of the Faculty of Veterinary Medicine and Animal Husbandry of the University of Guayaquil and the Committee for the Improvement of New Horizons of "Las Piñas', whose participation and openness to this study made it possible for us to reveal the data presented herein.

Literature cited:

1. Han BA, Schmidt JP, Bowden SE, Drake JM. Rodent reservoirs of future zoonotic diseases. Proc Nat Academy Sci. United States of America. 2015;112(22):7039-7044.

2. Karesh WB, Dobson A, Lloyd-Smith JO, Lubroth J, Dixon MA, Bennett M, *et al*. Ecology of zoonoses: natural and unnatural histories. Lancet (London, England). 2012;380(9857):1936-1945.

3. Franssen F, Swart A, van Knapen F, van der Giessen J. Helminth parasites in black rats (*Rattus rattus*) and brown rats (*Rattus norvegicus*) from different environments in the Netherlands. Infect Ecol Epidemiol 2016;6:1-14.

4. Reperant LA, Hegglin D, Tanner I, Fischer C, Deplazes P. Rodents as shared indicators for zoonotic parasites of carnivores in urban environments. Parasitology 2009;136(3):329-337.

5. Acuña A, Calegari L, Cuto S, Lindner C, Rosa R, Salvatella R. Helmintiasis intestinal. Manejo de las Geohelmintiasis http://www.higiene.edu.uy/parasito/parasitologia_archivos/GEOHELMI%20para%20medicos.pdf 2003; 1(1):[42].

6. Kenyon PA, Roses PR. Regional approaches to neglected tropical diseases control in Latin America and the Caribbean. Institute of Medicine Forum on Microbial Threats. Washington, DC. USA: National Academies Press; 2011.

7. WHO. Investing to overcome the global impact of neglected tropical diseases. EEUU: STAG-NTD; 2015.

8. Zonta ML, Navone GT, Oyhenart EE. Parasitosis intestinales en niños de edad preescolar y escolar: situación actual en poblaciones urbanas, periurbanas y rurales en Brandsen, Buenos Aires, Argentina: Parasitol Latinoam 2007;62:54-60.

9. Llop A, Valdés M, Zuazo J. Microbiología y parasitología médicas. 1a Ed, La Habana-Cuba: Editorial de Ciencias Médicas; 2001.

10. Hernández W. Determinación de la presencia de *Hymenolepis nana* e *Hymenolepis diminuta* en roedores sinantrópicos, en la comunidad Los Lirios, Masagua, Escuintla, Guatemala [Tesis]. Guatemala: San Carlos de Guatemala; 2016.

11. Mikhail MW, Metwally AM, Allam KA, Mohamed AS. Rodents as reservoir host of intestinal helminthes in different Egyptian agroecosystems. J Egyptian Soc Parasitol 2009;39(2):633-640.

12. Martínez I, Gutiérrez M, Aguilar J, Shea M, Gutiérrez M, Ruíz L. Infección por *Hymenolepis diminuta* en una estudiante universitaria. Rev Biomed 2012;23(1):61-64.

13. Rossomando MJ, Márquez W, Prado J, Chacón N. Epidemiología de himenolepiosis y otras parasitosis intestinales en una comunidad suburbana de Escuque, Trujillo-Venezuela. Rev Fac Med 2008;31:101-110.

14. Municipio-Milagro. Características ecológicas del cantón Milagro y descripción de la ciudadela "Las Piñas". Pazmiño B, editor. Municipio del cantón Milagro. 2018.

15. Milagro-Map. Mapa satelital del cántón Milagro. 2018.

16. Hancke D, Navone GT, Suarez OV. Endoparasite community of *Rattus norvegicus* captured in a shantytown of Buenos Aires City, Argentina. Helminthologia 2011;48(3):167.

17. De Sotomayor R, Serrano E, Tantaleán M, Quispe M, Casas G. Identificación de parásitos gastrointestinales en ratas de Lima Metropolitana. Rev Inv Vet Perú 2015;26(2):273-281.

18. Aluja A, Constantino F. Técnicas de necropsia en animales domésticos. 2da. ed. Mexico: Editoral el Manual Moderno; 2002.

19. Fitte B, Robles MR, Dellarupe A, Unzaga JM, Navone GT. *Hymenolepis diminuta* and *Rodentolepis nana* (Hymenolepididae: Cyclophyllidea) in urban rodents of Gran La Plata: association with socio-environmental conditions. J Helminthol 2018;92(5):549-553.

20. Leguia G, Casas E. Enfermedades parasitarias y atlas parasitológico de camélidos sudamericanos. Lima: Editorial de Mar; 1999.

21. OPS. Manual para el control integral de roedores. Colombia: Ministerio de Salud y Protección Social y OPS; 2012.

22. Vives N, Zeledón R. Observaciones parasitológicas en ratas de San José, Costa Rica. Rev Biol Trop 1957;5(2):173-194.

23. Companioni-Ibañez A, Atencio-Millán I, Cantillo-Padrón J, Hernández-Contreras N, González-Rizo A, Núñez-Fernández F. Prevalencia de endoparásitos en roedores sinantrópicos (Rodentia: Muridae) en una localidad de La Habana, Cuba. Rev Cubana Med Trop 2016;68:240-247.

24. Simoes RO, Luque JL, Gentile R, Rosa MC, Costa-Neto S, Maldonado A. Biotic and abiotic effects on the intestinal helminth community of the brown rat *Rattus norvegicus* from Rio de Janeiro, Brazil. J Helminthol 2016;90(1):21-27.

25. Arzamani K, Salehi M, Mobedi I, Adinezade A, Hasanpour H, Alavinia M, *et al*. Intestinal Helminths in Different Species of Rodents in North Khorasan Province, Northeast of Iran. Iranian J Parasitol 2017;12(2):267-273.

26. Yang D, Zhao W, Zhang Y, Liu A. Prevalence of *Hymenolepis nana* and *H. diminuta* from Brown Rats (*Rattus norvegicus*) in Heilongjiang Province, China. Korean J Parasitol 2017;55(3):351-355.

27. Chagas CRF, Gonzalez IHL, Favoretto SM, Ramos PL. Parasitological surveillance in a rat (*Rattus norvegicus*) colony in Sao Paulo Zoo animal house. Ann Parasitol 2017;63(4):291-297.

28. Abad D, Chávez A, Pinedo R, Tantaleán M, González O. Helmintofauna gastrointestinal de importancia zoonótica y sus aspectos patológicos en roedores (*Rattus* spp) en tres medioambientes. Rev Inv Vet Perú 2016;27(4):376-750.

29. Makki MS, Mowlavi G, Shahbazi F, Abai MR, Najafi F, Hosseini-Farash BR, *et al*. Identification of *Hymenolepis diminuta* Cysticercoid Larvae in Tribolium castaneum (Coleoptera: Tenebrionidae) beetles from Iran. J Arthropod-borne Diseases 2017;11(2):338-43.

30. World Health Organization. (WHO). Neglected tropical diseases: hidden successes, emerging opportunities. USA 2009. http://www.who.int/neglected_diseases/resources/9789241598705/en/.