Revista de Medicina Veterinaria

Volume 1 | Number 46 Article 11

2023-04-27

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Citación recomendada

Méndez-Mancera VM y Buitrago-Medina DA. The domestic pigeon (Columba livia) and its association with self-perceived respiratory and skin morbidity in a neighborhood of Bogotá. Rev Med Vet. 2023;(46):. doi: https://doi.org/10.19052/mv.vol1.iss46.11

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The domestic pigeon (*Columba livia)* and its association with self-perceived respiratory and skin morbidity in a neighborhood of Bogotá*

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Abstract

With their food and shelter seeking habits, pigeons are often found in places where humans are present. However, these shared spaces can host public health risks for the transmission of zoonoses. Therefore, we sought to explore the existing relationship between the presence of domestic pigeons (*Columba livia*) and self-perceived respiratory and skin morbidity in individuals in a neighborhood of Bogotá, Colombia. We conducted a cross-sectional neighborhood survey from February to May, 2014. Random and probabilistic sampling based on a list of dwellings was conducted. All of the dwellings in the neighborhood, as well as all the inhabitants at home during the survey, were included. A univariate and bivariate descriptive analysis was carried out, to establish statistical relationships based on use of the chi-square test and prevalence ratios. Also, a negative binomial regression model was used to determine the relationship between some pigeon exposures and the number of self-perceived symptoms. Respiratory and skin self-perceived symptoms were surveyed, along with the conditions in the dwellings and the presence of pigeons and their droppings. Altogether, 27.4% of those surveyed reported pigeon droppings within their dwellings or outside of them, and 33.1% stated they had experienced contact with pigeon droppings. The presence of sick pigeons around the houses was associated with self-reported headaches, rhinorrhoea and sneezing. Similarly, droppings inside dwellings were associated with a range of self-reported symptoms, such as fever, dry cough and sneezing. The self-perception of respiratory and skin symptoms, and their association with the presence of pigeons may indicate that zoonotic transmission of pathogens has occurred in the respondents, despite the limitations of the study. Contact with domestic *Columba livia* pigeons or their droppings has previously been identified as a transmission route for zoonotic microorganisms.

Keywords: *Columba livia*; pigeons; self-perceived morbidity; pigeon droppings; public health; zoonoses.

* Research article.

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Cómo citar este artículo: Méndez-Mancera VM, Buitrago-Medina DA. The domestic pigeon (*Columba livia)* and its association with self-perceived respiratory and skin morbidity in a neighborhood of Bogotá. Rev Med Vet. 2023;(46): e1457. Disponible en: https://doi.org/10.19052/mv.vol1.iss46.11

Recibido: 31 de marzo de 2022. Aceptado: 15 de julio de 2022. Versión Online First: 27 de abril de 2023. Publicación final: 31 de mayo de 2023

La paloma domestica (*Columba livia)* y su asociación con la morbilidad respiratoria y dérmica autopercibida en un barrio de Bogotá

Resumen

Con sus hábitos de búsqueda de alimento y refugio, las palomas se encuentran usualmente en lugares con presencia humana. Sin embargo, estos espacios compartidos pueden albergar riesgos para la salud pública por la transmisión de zoonosis. Por tanto, en el presente estudio se explora la relación existente entre la presencia de palomas domésticas (*Columba livia*) y la morbilidad respiratoria y cutánea autopercibida en individuos de un barrio de Bogotá, Colombia. Se realizó una encuesta transversal en el barrio, de febrero a mayo de 2014. Fue ejecutado un muestreo aleatorio y probabilístico, basado en una lista de viviendas. Se incluyeron todas las viviendas del barrio, así como todos los habitantes que se encontraban en el hogar durante la encuesta. Además, se realizó un análisis descriptivo univariante y bivariante, para establecer relaciones estadísticas basadas en el uso de la prueba de chi cuadrado y la razón de prevalencia. Asimismo, se utilizó un modelo de regresión binomial negativa, para determinar la relación existente entre algunas exposiciones a las palomas y el número de síntomas autopercibidos. Se preguntó sobre los síntomas respiratorios y cutáneos autopercibidos, así como por las condiciones de las viviendas, y la presencia de palomas y sus excrementos. En total, el 27,4 % de los encuestados declaró que había excrementos de palomas adentro o afuera de sus viviendas, y el 33,1 % declaró haber estado en contacto con excrementos de palomas. Fue observado que la presencia de palomas enfermas alrededor de las viviendas, se relacionó con dolores de cabeza, rinorrea y estornudos autoreportados. Igualmente, se hizo notorio que los excrementos dentro de las viviendas se asociaron con una serie de síntomas autoreportados, como fiebre, tos seca y estornudos. La autopercepción de los síntomas respiratorios y cutáneos, y su asociación con la presencia de palomas, pueden indicar que se ha producido una transmisión zoonótica de patógenos en los encuestados, a pesar de las limitaciones del estudio. Asimismo, el contacto con palomas domésticas *Columba livia* o sus excrementos se ha identificado previamente como una vía de transmisión de microorganismos zoonóticos.

Palabras clave: *Columba livia*; palomas; morbilidad autopercibida; excrementos de paloma; salud pública; zoonosis.

Introduction

Pigeons are domesticated birds, and their interactions with humans are generally considered to be beneficial to both animal species. However, altered availability of food and demographic and population changes have produced new challenges for the pigeon population, especially related to its adaptation to new urban spaces. Thus, many urban areas have been affected by nests located on the upper parts of houses and other buildings, and in public spaces such as plazas and monuments (1, 2). This situation also involves the accumulation of waste materials in these places, because pigeons produce large amounts of fecal droppings, which constitutes a significant public health risk from the various types of infectious agents present in them (e.g. viruses, bacteria and fungi) (1, 3, 4). Likewise, it is important to bear in mind that the presence of *Columba livia* pigeons also poses an additional public health risk, because of its role as a reservoir and transmitter of ectoparasites (5) and zoonotic diseases such as psittacosis (6, 7, 8, 9), salmonellosis (10, 11) and influenza (2, 12, 13), among others. Transmission of these diseases may occur through direct contact with, or inhalation of infected aerosols (14). For example, since 1966, at least 500 cases of pigeon-transmitted psittacosis have been reported worldwide (15). Therefore, the diseases transmitted by *C. livia* can significantly impact human and animal health, via the morbidity and mortality they can cause, as well as the economic and social costs of disease treatment and public health actions to control pigeon populations (15, 16).

The objective of the current study was to explore self-perceived respiratory and skin morbidity in the Molinos II neighborhood community of the Rafael Uribe Uribe Locality-18, in Bogotá, Colombia, and its relationship with the presence of the domestic pigeon (*Columba livia*).

Materials and methods

This is an analytical, cross-sectional, observational epidemiological study, which explores the relationship between self-perceived respiratory and skin symptom morbidity, and the presence of domestic pigeons or their droppings. The study was carried out in the Molinos II neighborhood of Bogotá, Colombia, from February of 2014 to May of 2015. The data was collected from August to December, of 2014. The study was performed in relation to the constant complaints from the community to the local health authority regarding the nuisance caused by pigeons in the abovementioned neighborhood. The target population comprised 1,500 residential units from socioeconomic strata 2 and 3, which were defined as the units of analysis, and all dwellings located in the described area were included. A sampling frame was developed by constructing a map detailing the distribution of the dwellings, and a spreadsheet list on which each of the dwellings was identified using a unique code. Based on the identification codes and the generation of random numbers, a simple random sample was drawn, proportional to the distribution of residential units per building. The sample was calculated by considering a symptom prevalence of 50%, an error rate of 3%, and a confidence interval of 95%. Information was collected on the sociodemographic characteristics of the inhabitants, the presence of respiratory symptoms (coughing, sneezing, and eye tearing, among others) and skin symptoms (pruritus, eczema), as well as the presence of pigeons (or contact with their droppings) in the dwellings or common areas, and the structural characteristics of the dwelling. The dependent variables were defined, as the presentation of the described symptoms, and the independent variables were pigeon contact, dwelling characteristics, and the remaining characteristics of the included population. The disease variables of the individuals were captured via self-reporting, along with visual inspection of the dwelling by the surveyor. For mite identification, a picture of the ectoparasites was included in the survey, and shown to the each individual when the question was asked. The data collection instrument was a semi-structured survey reviewed by an external group of professionals to verify its appearance and content. Additionally, a pilot test was performed on 15 family units with similar characteristics, so as to adjust the items and determine the usefulness of the instrument. Selection

bias was controlled by randomizing the residential units and replacing any excluded units, using the initial randomization method. The environmental information reported by the participants was compared with the observations from the residential unit. The data collectors were trained in instrument application through practical and theoretical instructions. The survey was applied to the subjects without their awareness of the proposed hypothesis of the researchers, so as to avoid influencing their answers, which is why the instrument was designed to first ask about their health status, and then to report on the environmental variables, including those related to the presence of pigeons.

While the qualitative variables were described using absolute and relative frequencies with a 95% confidence intervals (CIs), the quantitative variables were described by the mean, median, standard deviation, quartiles, asymmetry and kurtosis, and the Kolmogorov-Smirnov test was used to determine normality. The bivariate analysis was carried out using contingency tables, calculating the p-value through the chi-square test and prevalence ratios with 95% Cis, to determine the associations of the variables related to pigeons with the reported symptoms. The association of the quantitative variables with the outcomes was determined using the Mann-Whitney U test. The alpha-level for the tests was 0.05. Negative binomial regression multivariate analysis was performed using the number of symptoms presented by the subject as a dependent variable, and environmental exposures as independent variables.

Results

Altogether, 370 people from an equal number of residential units were surveyed. The characteristics of the participants are described in table 1.

Most of the surveyed were women housewives, employees, and those with a secondary school level of education. The average age of those surveyed was 45 years (range, 14-89 years), 75% were aged below 59 years, and 25% were aged younger than 31. The educational level of the population was predominantly secondary school, amounting to almost 55% of the surveyed subjects.

Table 1.Sociodemographic characteristics of the individuals surveyed in the Molinos neighborhood of Bogotá, Colombia

Variable	Categories	n	%
Sex	Female	255	68.9
	Male	111	30.0
Occupation	Housewife	144	39.2
	Student	30	8.2
	Employee	141	38.4
	Retired	23	6.3
	Other	29	7.9
Educational level	No studies	8	2.2
	Primary	83	22.5
	Secondary	202	54.7
	University	42	11.4
	Other	34	9.2

Source: own work

Among the dwelling characteristics, 72.2% had 3 bedrooms, and the average area of the residential units was 45.2 m^2 (95%, CI 44.9-45.6), with a minimum of 40 m^2 and a maximum of 72 m^2. The mean length of time those surveyed had lived in their dwelling was 12 years (95%, CI 11.0-13.3). Other indoor and outdoor characteristics of the dwellings are shown in table 2.

Table 2. Indoor and outdoor characteristics of the homes surveyed in the Molinos neighborhood of Bogotá, Colombia

Aspect	Variable	n	%	95% CI	
Indoors	Dampness in the dwelling	114	31	26.2	35.9
	Pigeon feeders	15	4.1	2.2	6.6
	Household pets	117	31.7	26.9	36.7
	Pets with erythema	15	13.3	7.6	20.9
	Sick pigeons	239	65.1	60	69.9
	Pigeon droppings	101	27.4	22.9	32.3
	Open windows	235	63.7	58.5	68.6

Aspect	Variable	n	%	95% CI	
Outdoors	Park use	209	56.9	51.7	62
	Contact with pigeon droppings in parks	122	33.1	28.2	38.1
	Recreational contact with pigeons	86	23.3	19	27.9
	Playing in the park	158	90.8	85.4	94.6
	Eating in the park	9	18	8.5	31.4
	Resting in the park	73	68.2	58.5	76.8

Source: own work

An important finding was that a third of those surveyed had experienced contact with pigeon droppings, and close to 25% had recreational contact with these birds. With regard to the self-perception of respiratory and skin effects in those surveyed, a little more than one third stated having respiratory symptoms within the previous year. However, when asked about specific symptoms, there was an almost 50% of prevalence of most symptoms. Information relating to symptoms lasting between 10 and 14 days, showed that dry cough and sneezing were the most commonly reported symptoms. With regard to having been diagnosed by a physician with clinical respiratory signs within the previous year, an almost 30% prevalence was reported. A similar proportion of individuals mentioned having been diagnosed with a respiratory disease in the previous year. In contrast, the self-perception of skin symptoms in those surveyed was generally lower than for the other mentioned symptoms, but at least one in ten reported having them. Self-perceptions of respiratory and skin symptoms in those surveyed are shown in table 3.

A study of the symptoms based on the sociodemographic and dwelling characteristics, as well as on the presence of pigeons, showed that reported or observed dampness was significantly linked with an increased self-perceived morbidity of symptoms. These symptoms included any of the following: headache, itchy eyes, fever lasting 10 to 15 days, photophobia, respiratory difficulty within the last year, physician-confirmed respiratory disease requiring ventilator support, neck, shoulder and arm eczema, pruritus, or visible skin mites ($p<0.05$).

Table 3. Self-perceptions of respiratory and skin symptoms in people surveyed in the Molinos neighborhood of Bogotá, Colombia

Aspect assessed	Symptoms / Clinical signs	N	%	95% CI	
Self-perception of symptoms related to respiratory disease	Respiratory symptoms in the last year	122	33	28.2	38
	Headache	198	54	48.2	58.6
	Rhinorrhea	184	50	44.5	54.9
	Eye itching	163	44	38.9	49.2
	Sneezing	215	58	52.8	63.1
	Tearing	138	37	32.2	42.4
Self-perception of symptoms lasting from 10 to 14 days	Fever 10-14 days	52	14	10.7	18
	Dry cough 10-14 days	92	25	20.5	29.5
	Chills 10-14 days	49	13	9.9	17.1
	Sneezing 10-14 days	88	24	19.5	28.4
	Bone pain 10-14 days	78	21	17.0	25.5
	Photophobia	44	12	8.7	15.6
Respiratory symptoms in the last year (medically diagnosed by a physician)	Respiratory difficulty in the last year	128	35	29.7	39.6
	Ventilator support in the last year	65	25	19.5	30.2
	Respiratory disease diagnosis in the last year	80	33	27.1	39.3
Self-perception of skin symptoms	Neck eczema	78	21	17.0	25.6
	Intense skin itching	87	24	19.3	28.2
	Mites seen on the skin	54	15	11.1	18.6

Source: own work

With regard to educational levels, individuals with a primary school education had a greater frequency of self-perceived skin symptoms such as eczema, pruritus and visible mites ($p<0.05$), whereas those with no education reported more frequently rhinorrhea, respiratory disease diagnosis, eczema or pruritus ($p<0.05$). In addition, the occupations of those surveyed were associated with some of the symptoms. For example, housewives more frequently reported having had eczema, and the participants classified as employees and the retired mentioned being affected by pruritus more frequently than others. With regard to pigeon exposure, those who mentioned recreational contact with these

birds, reported more frequently than others having had a dry cough, bone pain and respiratory difficulty within the last year. They also reported having received ventilator support and a respiratory disease diagnosis. Recreational contact in these individuals was also associated with eczema and visible skin mites. In cases where sick pigeons were observed or reported around the dwelling, those surveyed reported more frequent headaches, rhinorrhea, eye itching, sneezing, tearing, bone pain and respiratory difficulty, as well as having received ventilator support, a diagnosed respiratory disease, eczema, and visible skin mites. In the same way, outdoor recreational activities, such as resting in the park, were related to more frequent reports of eye itching, respiratory difficulty within the last year, a respiratory disease diagnosis, skin eczema and visible skin mites.

A key aspect of the survey was contact with pigeon droppings in the home or in public spaces. Thus, those who reported having contact with pigeon droppings in the park more frequently reported eye itching and respiratory difficulties within the last year, a respiratory disease diagnosis, and having eczema and skin mites. Therefore, reports or observations of droppings within dwellings were linked with a greater frequency of symptoms such as fevers, dry coughs, chills, sneezing, bone pain, photophobia, respiratory difficulties within the last year, ventilator support, respiratory disease diagnoses, eczema, and skin mites: the latter of which was associated with the most reported symptoms, when compared with those who had not seen dropping. Information on the associations identified for each of the symptoms is shown in table 4.

Table 4. Relationships between respiratory and skin symptoms / clinical signs and the study variables, including dwelling characteristics and reported pigeon presence

Symptoms or clinical history	Variables	Yes		No		PR*	95% CI	P-value
		N	%	N	%			
Headache	Report of dampness	74	64.9	40	35.1	1.34	1.11-1.31	0.003**
	Dampness observed	52	61.9	32	38.1	1.33	1.06-3.91	0.019**
	Report of sick pigeons	140	58.6	99	41.4	1.31	1.05-1.64	0.010**
	Observation of household pets	79	57.2	59	42.8	1.3	1.01-1.68	0.034**
Rhinorrhea	Educational level (No studies)	1	12.5	7	87.5	0.23	0.03-1.52	0.038**
	Report of sick pigeons	136	56.9	103	43.1	1.55	1.20-1.99	0.000**
	Report of pigeon droppings	59	58.4	42	41.6	1.25	1.02-1.55	0.040**
Eye itching	Dampness observed	44	52.4	40	47.6	1.32	1.00-1.73	0.053**
	Report of sick pigeons	119	49.8	120	50.2	1.51	1.14-2.00	0.002**
	Report of pigeon droppings	59	58.4	42	41.6	1.52	1.22-1.91	0.000**
	Contact with droppings in parks	63	51.6	59	48.4	1.28	1.02-1.62	0.035**
Sneezing	Report of sick pigeons	153	64	86	36	1.32	1.07-1.61	0.004**
Tearing	Report of sick pigeons	98	41	141	59	1.34	0.99-1.82	0.047**
Fever 10-14 days	Report of dampness	22	19.3	92	80.7	1.69	1.01-2.81	0.043**
	Dampness observed	20	23.8	64	76.2	2.13	1.21-3.74	0.008**
	Report of pigeon droppings	23	22.8	78	77.2	2.17	1.31-3.58	0.002**
Dry cough	Highest floor level	30	35	55	65	1.62	1.12-2.33	0.011**
	Report of pigeon droppings	40	40	61	60	2.07	1.46-2.97	0.000**
	Pigeon droppings observed	29	40	44	60	1.62	1.10-2.38	0.015**
	Recreational contact with pigeons	30	34.9	56	65.1	1.61	1.12-2.33	0.012**

Symptoms or clinical history	Variables	Yes		No		PR*	95% CI	P-value
		N	%	N	%			
Chills for 10-14 days	Report of pigeon droppings	27	26.7	74	73.3	3.39	2.01-5.73	0.000**
	Pigeon droppings observed	19	26	54	74	2.75	1.52-4.99	0.001**
Sneezing for 10-14 days	Report of pigeon droppings	33	32.7	68	67.3	1.61	1.11-2.33	0.012**
Bone pain for 10-14 days	Report of sick pigeons	60	25.1	179	74.9	1.89	1.15-3.09	0.008**
	Sick pigeons observed	40	29	98	71	2.06	1.22-3.48	0.004**
	Report of pigeon droppings	39	38.6	62	61.4	2.71	1.84-3.98	0.000**
	Pigeon droppings observed	31	42.5	42	57.5	3.05	1.94-4.80	0.000**
	Recreational contact with pigeons	26	30.2	60	69.8	1.67	1.11-2.51	0.015**
	Resting in the park	13	17.8	60	82.2	0.5	0.25-0.98	0.047**
Photophobia	Dampness observed	16	19	68	81	2.27	1.18-4.37	0.012**
	Report of pigeon droppings	19	18.8	82	81.2	2	1.15-3.48	0.013**
	Pigeon droppings observed	15	20.5	58	79.5	2.46	1.27-4.78	0.006**
Respiratory difficulty in the last year	Report of dampness	50	43.9	64	56.1	1.44	1.09-1.91	0.011**
	Dampness observed	39	46.4	45	53.6	1.51	1.09-2.07	0.013**
	Report of pigeon containers	9	60	6	40	1.79	1.15-2.78	0.034**
	Pigeon containers observed	7	63.6	4	36.4	1.83	1.13-2.96	0.050**
	Report of sick pigeons	101	42.3	138	57.7	2.08	1.43-3.02	0.000**
	Sick pigeons observed	63	45.7	75	54.3	2	1.36-2.93	0.000**
	Report of pigeon droppings	56	55.4	45	44.6	2.08	1.60-2.71	0.000**
	Pigeon droppings observed	39	53.4	34	46.6	1.88	1.37-2.58	0.000**
	Contact with droppings in parks	55	45.1	67	54.9	1.54	1.17-2.03	0.002**
	Recreational contact with pigeons	41	47.7	45	52.3	1.56	1.18-2.08	0.003**
Ventilator support	Report of dampness	30	33.3	60	66.7	1.64	1.08-2.49	0.019**
	Dampness observed	22	33.3	44	66.7	1.95	1.18-3.24	0.009**
	Report of sick pigeons	52	31	116	69	2.23	1.28-3.89	0.002**
	Report of pigeon droppings	31	39.2	48	60.8	2.12	1.41-3.19	0.000**
	Pigeon droppings observed	20	35.7	36	64.3	2.14	1.28-3.57	0.004**
	Recreational contact with pigeons	20	37.7	33	62.3	1.76	1.14-2.71	0.014**
	Resting in the park	15	30	35	70	4.6	1.14-18.9	0.011**
Respiratory disease diagnosis	Educational level (No studies)	4	80	1	20	2.56	1.30-5.03	0.037**
	Observed state of windows (Open)	41	37.6	68	62.4	1.82	1.08-3.09	0.017**
	Highest level in the building	11	20.4	43	79.6	0.55	0.31-0.97	0.025**
	Dampness observed	26	42.6	35	57.4	1.67	1.10-2.55	0.018**
	Report of sick pigeons	63	42.3	86	57.7	2.4	1.48-3.89	0.000**
	Sick pigeons observed	40	43.5	52	56.5	2.25	1.37-3.71	0.001**
	Report of pigeon droppings	30	48.4	32	51.6	1.76	1.24-2.51	0.002**
	Pigeon droppings observed	21	47.7	23	52.3	1.8	1.18-2.73	0.009**
	Contact with droppings in park	33	41.8	46	58.2	1.47	1.02-2.10	0.038**
	Recreational contact with pigeons	23	46.9	26	53.1	1.6	1.11-2.33	0.018**
	Resting in park	16	36.4	28	63.6	2.25	0.92-5.50	0.055**

Symptoms or clinical history	Variables	Yes		No		PR*	95% CI	P-value
		N	%	N	%			
Welts on the neck, shoulders and arms	Educational level (No studies)	3	37.5	5	62.5	3.84	1.05-13.9	0.040**
	Educational level (Primary)	24	28.9	59	71.1	2.96	1.10-7.97	0.016**
	Occupation (Housewife)	41	28.7	102	71.3	1.68	1.07-2.63	0.019**
	Report of dampness	33	29.2	80	70.8	1.64	1.11-2.43	0.013**
	Dampness observed	25	30.1	58	69.9	1.79	1.13-2.85	0.013**
	Report of sick pigeons	59	248	179	75.2	1.67	1.04-2.67	0.027**
	Report of pigeon droppings	33	33	67	67	1.95	1.33-2.88	0.001**
	Pigeon droppings observed	22	30.6	50	69.4	1.66	1.04-2.65	0.034**
	Contact with droppings in parks	35	28.7	87	71.3	1.64	1.11-2.42	0.013**
Intense skin itching at night	Educational level (No studies)	4	50	4	50	5.12	1.60-16.35	0.005**
	Educational level (Primary)	25	30.1	58	69.9	3.08	1.15-8.28	0.012**
	Occupation (Retired)	10	43.5	13	56.5	2.18	1.23-3.87	0.013**
	Occupation (Employee)	28	19.9	113	80.4	1		
	Report of dampness	38	33.6	75	66.4	1.74	1.21-2.50	0.003**
	Dampness observed	32	38.6	31	61.4	2.22	1.46-3.38	0.000**
	Recreational contact with pigeons	29	34.1	56	65.9	1.66	1.14-2.42	0.010**
	Play in the park	39	24.8	118	75.2	1.32	0.46-3.80	0.588
	Eating in the park	2	22.2	7	77.8	0.7	0.19-2.57	0.574
	Resting in the park	22	30.1	51	69.9	1.13	0.58-2.20	0.697
Have seen insects crawling on his/her skin	Educational level (Primary)	6	7.2	77	92.8	0.37	0.13-0.99	0.042**
	Report of dampness	26	23	87	77	2.08	1.28-3.39	0.003**
	Dampness observed	20	24.1	63	75.9	2.39	1.34–4.28	0.003**
	Report of sick pigeons	45	18.9	193	81.1	2.68	1.35–5.32	0.002**
	Sick pigeons observed	29	21.2	108	78.8	2.68	1.32–5.42	0.003**
	Report of pigeon droppings	30	30	70	70	3.33	2.05–5.42	0.000**
	Pigeon droppings observed	22	30.6	50	69.4	3.43	1.91–6.15	0.000**
	Contact with droppings in parks	27	22.1	95	77.9	2.01	1.23–3.28	0.004**
	Recreational contact with pigeons	21	24.7	64	75.3	2.11	1.29–3.46	0.003**

*Prevalence ratio. ** $p<0.05$.
Source: own work

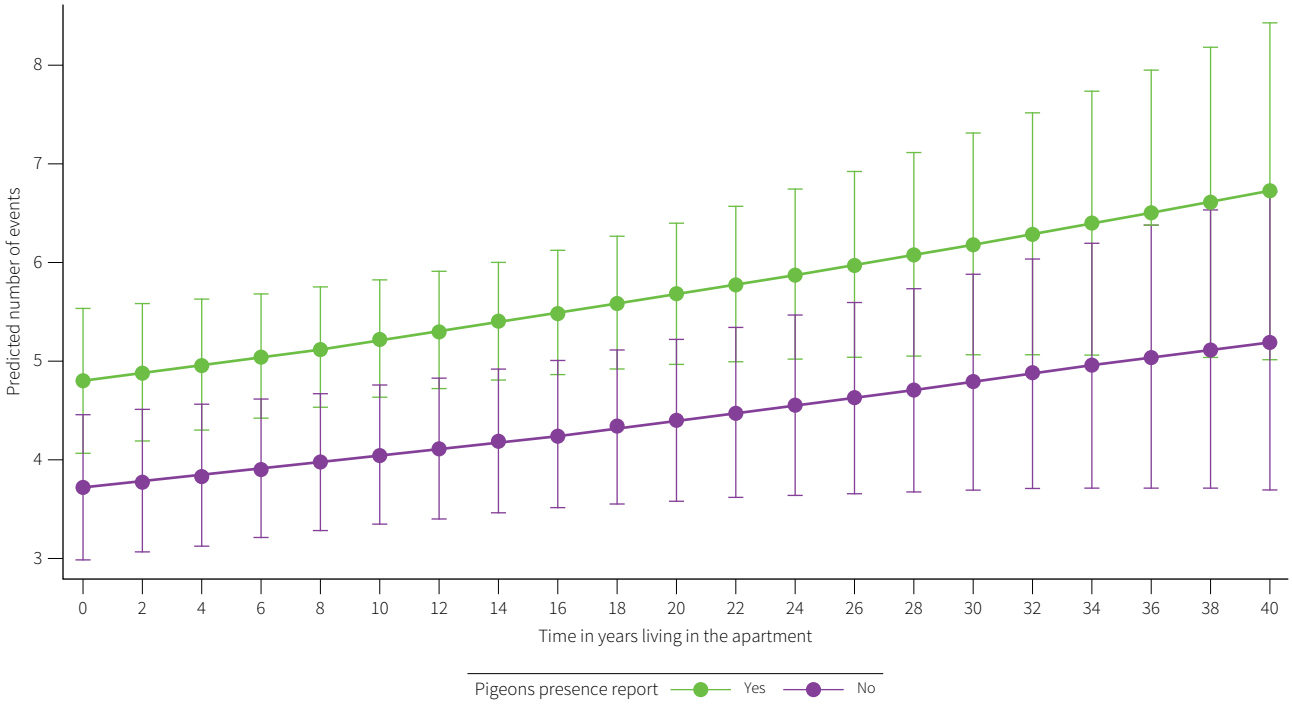
The negative binomial regression model showed that reports of sick pigeons, and length of time the participants had lived in the dwelling, were associated with an increase in the number of reported symptoms (figure 1).

In addition, the incidence rate ratio (IRR) showed that the report of dampness, the report of sick pigeons, the length of time subjects had lived in the dwelling and the report of pigeon droppings, were associated with an increase in the number of symptoms (table 5).

Discussion

The current study surveyed several population groups in the Molinos neighborhood of Bogotá. Most defined themselves as female, housewives or employees, high school educated, and aged between 14 and 89 years. According to the 2014 census for the locality Rafael Uribe Uribe, women represent 50.8% of the population; thus, although the current study showed a greater concentration of women, a similar concentration was

Figure 1. Number of symptoms in relation to time in the dwelling according to report of pigeon presence



Source: own work

Table 5. Variables associated with the number of symptoms reported in the survey of the Molinos neighborhood of Bogotá, Colombia

Variables	b	p	IRR	95% CI		%
Report of dampness	0.233	0.02*	1.26	1.04	1.54	26.2
Report of sick pigeons	0.256	0.02*	1.29	1.05	1.59	29.2
Highest floor level	0.021	0.85	1.02	0.82	1.27	2.2
Length of time subjects had lived in the dwelling	0.008	0.05*	1.01	1.00	1.02	0.8
Report of pigeon droppings	0.347	0.00*	1.41	1.14	1.75	41.5
Cons.	1.120	0.00*	3.07	2.50	3.76	

Source: own work

observed. With regard to educational levels, the survey found that 59% of the population between 16 and 25 years of age studied, and 5% of those over 26 did not study. More than half of the participants finished secondary school, the remainder having other levels of schooling. One study (17) reported that middle-income families make significant economic efforts to involve their children in educational processes, which could explain the educational findings in our survey population. Also, in low-income families, women are the ones who carry out the majority of household activities, which is why they are more frequently found at home, and this explains the greater participation of women in our survey.

In terms of housing, the mean area of the dwellings was 45.2 m^2, with 3 bedrooms, and the inhabitants had lived in their dwellings for 12 years (95%, CI 11.0-13.3). In general, the community tended to keep their house windows open and dry their clothes outdoors, probably resulting in contact with pigeons and their droppings, and possibly explaining the annoyance of the inhabitants to being exposed to dirt on the buildings and clothes, and the possible contamination from feathers, fecal material, nest residue, and egg shells. Consistent with this, Bernal et al. (18) showed that among people living near a pigeon population, 12% perceived *C. livia* to be a species that can damage the urban infrastructure. However, disease-related risks were not frequently mentioned in their study, and those that were mentioned were mainly related to allergies and ectoparasites.

Most of the target population reported that they use parks and green spaces for rest and recreation. When surveyed, two out of ten respondents reported eating in the parks during recreational times and, consequently, a third of those surveyed reported having been in contact with pigeon droppings when they used these areas. One European study (6) reported that the density of *C. livia* was of concern to the local population, who viewed the damaging effects of their droppings on the environment. Direct contact through the manipulation and feeding of these birds was also mentioned as problematic, because more than half of psittacosis cases occur via exposure to zoonotic pathogens, with transient contact being mentioned in approximately 40% of these cases (6).

The surveyed group reported the presence of fecal material from pigeons in the residential units, a concern to the inhabitants. They also mentioned that pigeons are fed by the community, using containers placed in the windows of their homes. Also, a study from 2011 (19) reported that the provision of grains, fruit peel, vegetables and food scraps to pigeons contributes to an increasing pigeon population size, because colony growth is closely related to food supply. This is worrying because direct contact with pigeons increases the risk of contracting pigeon transmitted diseases such as *Chlamydophila psittaci* (6, 7, 20), *Cryptococcus neoformans* (21, 22), microsporidiosis and *Cryptosporidium*, among others (11, 13, 19, 23, 24, 25, 26, 27). Similarly, other studies have reported the presence of pigeon feces in areas where people live as the principal factor associated with respiratory symptomatology. Indeed, one study (9), which detected and characterized *Chlamydophila psittaci* in asymptomatic pigeons (*C. livia*) in central Thailand, reported an incidence of 10.8%, similar to the percentage reported for European populations. This suggests that pigeons may expel this bacterium into the environment through their feces and be responsible for psittacosis in humans (9). The transmission of *Chlamydophila psittaci* as a zoonotic disease is a cause of concern in humans because, just as was found in the current study, a greater prevalence of respiratory and skin symptoms is seen in populations exposed to pigeons and their droppings, than other populations, a statistically significant finding. Although no direct causal relationship between pigeons and humans living in close proximity has been established, the clinical picture may be that of the transmission of mild zoonotic infectious agents.

Likewise, contact with pigeon droppings in the park was one of the statistically significant variables linked with various clinical signs and symptoms such as a diagnosis of respiratory disease, neck, shoulder and arm eczema, eye itching, and visible skin mites. This suggests that the presence of pigeon droppings is linked with a greater prevalence of symptom self-perception. Consistent with this, contact with pigeon droppings in residential and open spaces was described in the first report on the environmental prevalence of *Cryptococcus neoformans* (a species of yeast) in pigeon feces in Mecca, Saudi Arabia (28). That study showed that pigeon droppings can be deemed a potential source of this yeast, with it being identified in 34% of 112 pigeon-dropping samples; and, with their high organic material content (particularly urea and creatinine) indicating that pigeon droppings are the main environmental source for the transmission of *Cryptococcus neoformans* (28). The same study found that more than 30% of the

people experienced respiratory symptoms within the last year, the most frequent of which was sneezing, followed by headache, rhinorrhea and eye itching, which affected close to one in every two study participants.

In the current study, one in every five persons surveyed reported neck, shoulder or arm eczema during the previous year. A similar situation was seen for severe nighttime skin itching, with a slightly greater proportion reporting this symptom. Visible skin mites were reported by almost 15% of those surveyed, according to the results of a 2008 study (29), where people exposed to large populations of pigeons reported on experiencing various skin lesions, such as papules with an erythematous base predominantly on the neck, arms, and upper chest, as well as broken skin caused by scratching from intense itching. The lesions were caused by *Ornithonyssus sylviarum* and *Dermanyssidae gallinae* ectoparasites, and other *Ornithonyssus* spp. In all cases, a common factor was identified during the first consult, or later consults (when the community were asked to investigate) of pigeon nests close to their bedrooms (windows, terraces, balconies, ventilation pipes or ducts), canopies, roofs, and garden trees or vines where they would usually sit, with reports of some people being able to feel the mites crawling on their skin, while some others reported feeling "little animals crawling" on their skin, without being able to see them. This indicates that skin symptoms may result from the presence of pigeon mites. This relationship shared commonality with some of the variables included in the current study; however, not all of the variables were explored, nor was an association established with other possible causes of the skin symptoms.

In the current study, many of those surveyed observed sick pigeons, another element that was significantly associated with a greater self-perception of symptoms such as rhinorrhea, eye itching, sneezing, tearing, bone pain, respiratory difficulty, previous ventilator support, a diagnosis of respiratory disease, and neck, shoulder and arm eczema, as well as skin mites. Therefore, the potential impact on the community health is not just a result of fecal contamination, but also of the presence of sick pigeons in the environment. One study (30) evaluated the incidence and prevalence of *Chlamydophila psittaci* in messenger pigeons, as well as its potential zoonotic transmission to pigeon enthusiasts in six Peking districts in China. The authors suggested that exposure and zoonotic transmission of *Chlamydophila psittaci* potentially occurs via the presence of pigeons, putting human lives at risk (30). Similarly, the recreational contact with pigeons that was reported by 23.3% of our surveyed population, was linked to an increased self-perception of symptoms such as dry cough, bone pain, respiratory difficulty, previous ventilator support, being diagnosed with a respiratory disease, intense nighttime skin itching, and visible skin mites. Furthermore, skin symptoms such as neck, shoulder and arm eczema, intense nighttime skin itching, and visible mites on the skin, were highly prevalent with statistically significant differences in subjects who had recreational contact with pigeons, contact with pigeon droppings in the park, or reported observing pigeon droppings within the home. Taken together, these findings suggest that pigeons may harbor ectoparasites that can infest the population and cause skin problems which require priority treatment, because many ectoparasites (e.g., *Argas reflexus*, a European pigeon tic) are allergenic and cause serious anaphylactic reactions in people, as well as being capable of transmitting other pathogens to them (5).

In the current context, the problem of overpopulation of the *Columba livia* pigeon continues to exist. According to the District Pigeon Care Unit, an entity belonging to the District Institute for Animal Protection and Welfare, during the days of attention and identification of pigeons in city squares for quantification of birds and qualification of their living conditions, the result for the year 2021 has been the overpopulation of pigeons.

In Colombia, zoonotic diseases transmitted by *C. livia* have gained relevance given the negative aspects of population density, and their occupation of large urban spaces, both of which lead to larger amounts of droppings, and causing discomfort for human residents and damage to public property. This study was able to relate

the self-perception of respiratory and skin diseases to the presence of pigeons and their milieu, as also found in studies from around the world, ratifying their role as the principal factor involved in the presentation of zoonotic diseases (2, 7, 21, 31) caused by *C. livia*.

The present study only describes data reported by the study participants. Given that the study's inference capacity is limited to the included participants, the reported prevalence represents the subjects' self-perception of their symptoms, and, therefore, does not represent an objective measurement of the same. The observed relationships should not be assumed to be causal processes, because the way the study was designed involved the measurements being taken once only, with no follow up on pigeon exposure, or the presence of symptoms. Additionally, the observations reported by the participants may have been affected by memory, although repeated inquiries were made to obtain truthful answers. Other causes of the symptoms presented in the study participants were not considered, and will need to be addressed by further studies. In order to establish causality in the statistical relationships observed, it is highly recommended to develop new studies with a higher degree of evidence.

The relationship of human morbidity with exposure to pigeons and their droppings should focus on the prevalence of pathogens in their feces, the usual mechanisms of transmission and the social characteristics that allow this type of interactions (social determinants of health).

Declarations

Ethics approval and consent to participate

This study was approved by the Ethics Committee of Universidad de La Salle, with the N°50, on May 16, 2014. Approval included the consent to participate format that was used, and the consent to participate form was signed by all participants.

Consent for publication

Not applicable.

Availability of data and materials

The datasets generated and analyzed in the current study are not publicly available, but are available in an anonymized form from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

Funding

This study was financed voluntarily by the researchers, and the surveyed subjects were not compensated.

Authors' contributions

Viviana Méndez Mancera and Daniel Buitrago Medina participated in the planning, execution, data analysis, and manuscript development and writing. All authors have read and approved the final manuscript

Acknowledgements

The authors thank the Molinos II neighborhood community, the working team and data collectors, as well as the survey participants, whose cooperation and patience allowed the necessary information to be gathered. Likewise, we thank the Masters' of Veterinary Science professors at the Universidad de La Salle for their support and suggestions. We also thank Sandra Cheesman, PhD, from the Edanz Group (www.edanzediting.com/ac), for editing a draft of this manuscript, and the Universidad del Rosario for the translation services.

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