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Dog Population Structure in Areas of Occupational Competency in the Cuauhtemoc Locality, Mexico City, 2009

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Abstract: This study is aimed to characterize the dog population in Cuauhtemoc an urban locality in Mexico city, considering housing marginalization indices as well as demographic and health-related variables. Having determined a minimum sample size of 1033 surveys based on a stratified random sampling proportionally distributed in three socioeconomic strata (low, middle and high marginalization index), complete house blocks (conglomerates) were selected and surveyed. In total, 1129 surveys were applied in high, middle and low marginality areas (140, 608 and 381 surveys, respectively). The predominant property type in low marginality venues were individual houses with a lower number of inhabitants per separate living area thus, a lower human:dog ratio (6.47:1) was found in this stratum. Additionally, spaying/neutering (39%) and vaccination were more frequent in low marginality areas than in other strata. The population pyramid profile was compatible with a growing young population with a high reproductive potential. Sterilization and vaccination rates, as well as deworming were low in general. Our results highlight the need to strengthen educational campaigns for a responsible dog ownership, emphasizing reproductive, vaccination and deworming control programs.

INTRODUCTION

Nowaday's dog evolved from the wolf about 100,000 years ago and for the last 30,000-40,000 years this species has lived in close proximity to mankind[1]. Since, then the usefulness of dogs to the human society has increased the value of this association, strengthening affective bonds between man and dog and resulting in benefits for both species. However, this close relationship could turn into a risk, particularly when there is a lack of guidance and adequate knowledge about what responsible dog ownership means. This could favor an uncontrolled increase in dog population and with it a rise in the transmission rates of important public health diseases, like rabies and other zoonoses[3]. Not less important are the environmental problems caused by the presence of dogs in public places, like aggressive behavior, street defecation, traffic accidents, poor urban image and the proliferation of harmful animal species[1-5].

Several studies on dog populations have measured variables like the number of dogs in a given area, age, sex, breed population structure, human:dog (h:d) ratio per household; rates of fertility, mortality, birth and annual growth; health status and the current status of vaccination and deworming programs[2, 5-12].

In the 1990's, a population of 1.2-4 mln dogs was estimated in Mexico; of these animals, a high concentration was observed in Mexico city with a ratio of 6-7 humans per dog (h:d) in the same period of time a h:d ratio of 4.4:1 was found in the locality of Iztapalapa[2], 4.5:1 in the locality of Tlahuac and up to 9:1 in Coyoacan[12]. Since, 2000 studies conducted in Mexico city localities such as Alvaro Obregon estimated this ratio in 4.68:1-6.6:1, along with some marginality-related indicators[2]; another study in the locality of Tlahuac yielded a 7:1 ratio[14, 15].

A h:d ratio of 6-7 inhabitants per dog is often used to devise public health programs addressed to the dog population in Mexico city. As an example, health authorities in the Cuauhtemoc locality use a ratio of 6.9 inhabitants per dog. This choice could result in a lack of accuracy in estimations, since, the locality is not homogeneous in cultural, socioeconomic, nor educational terms. Thus, more precise and reliable information, that considers the local differences is required to plan, execute and evaluate health programs implemented by the Cuauhtemoc Sanitary Authority (JSC).

The area served by the JSC is subdivided into Base Geographical Areas (BGAs) which are categorized, according to its marginalization level as high, medium or low-marginalization BGAs. The criteria defining marginalization levels in Mexico are established by the National Population Council (CONAPO), considering variables like education level, household type and services, population density and income level (CONAPO, 2010). Low and very low marginalization indices are prevalent in Mexico city and the areas regarded as highly or very highly marginalized are scarce in the city (Fig. 1).

This study is aimed to estimate the dog population structure in the Cuauhtemoc Sanitary Area (CSA) both globally and by marginality level stratum as well as some indices specific to the area that can be used to implement and evaluate programs targeting the dog population in the CSA.

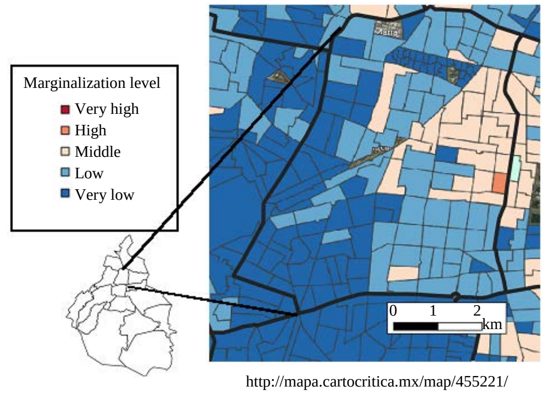

Fig. 1: Base Geographical Areas (BGAs) by marginality level (Cuauhtemoc locality, Mexico city, Mexico)

MATERIALS AND METHODS

This study was conducted in the Cuauhtemoc locality, covering 2.2% of the total surface in Mexico city. Human population was 521 348 in 2005; there are 34 burrows, 2627 house blocks and 149,755 private homes[16].

Sample design

Sampling frame: This study was based on information gathered by the JSC, considering the BGAs under its jurisdiction (74 out of 153), the number of house blocks by BGA, the number of houses by BGA and by house block. BGAs were classified by the JSC, according to its marginalization index.

Questionnaire preparation: The questionnaire was designed following the guidelines issued by the WHO and WSPA[17, 18, 2]. Variables per household included: marginality index, housing type, number of inhabitants, gender and age whether they lived with dogs and the number of dogs per household. The variables regarding dog population were: sex, breed, age, reproductive condition, current status of anti-rabies vaccination, deworming and *Leptospira* spp. bacterine administration. The test and questionnaire were validated by previously applying 20 interviews.

Determining minimum sample size: The Minimum Sample Size (MSS) was determined by the following equation for stratified sampling[19]:

$$n = \frac{\sum_{i=1}^{L} \frac{N_i p_i q_i}{W_i}}{\frac{N^2 B^2}{Z^2} + \sum_{i=1}^{N} N_i p_i q_i}$$

Where:

- n = The No. of households to be sampled
- L = The No. of strata
- N_i = Size of the population in the ith stratus
- p_i = Prevalence or ratio of households with dogs in the ith stratus
- q_i = $1-p_i$
- N = Total population size
- B = Estimated error
- Z = Reliability coefficient
- W_i = Specific weight of the ith stratus

The estimated frequency of households with at least one dog in high, middle and low-marginality areas,as well as a possible non-response rate of 10% were chosen based in data reported by Lopez *et al*.[2]. A 95% confidence level and a 3% error were considered. Sampled households were proportionally assigned by stratum, considering the household percentage in each stratum.

House block selection: Once, he number of questionnaires (samples) per stratum was determined, the number of house blocks to be surveyed was calculated by dividing the number of questionnaires in each stratum by the mean number of households per block. House blocks were selected by Simple Random Sampling (SRS) and only blocks with households were considered. All households in a block were visited. The information was obtained by direct interview and retrieved from JSC files.

Statistical analysis: Data were analyzed with Epi Info v.3.5.4 (Centers for Disease Control and Prevention, Atlanta, GA) and Excel 2007 (Microsoft Co., Redmond, WA). Differences among strata were analyzed with a Chi-squared test y Kruskal-Wallis. Differences were regarded as significant for $p<0.05$.

RESULTS AND DISCUSSION

Housing type: A total of 1129 households were surveyed. Of these, 12.4% were in the high-marginalization stratum, 53.85% were in middle-marginalization stratum and 33.75% were in the low-marginalization stratum. Condominium apartments were the most frequent housing type (80.69%), followed by houses (12.40%) (Table 1).

Human/dog ratio: In total, 4308 people were counted in the surveyed households; the number of inhabitants per household ranged from 1-13 with a mean of 4. Dogs were detected in 32.2% (364) of households. A higher presence of dogs was observed in the middle-marginalization stratum (53.8%) than in other strata.

A total of 576 dogs were counted. The number of animals per household ranged from 1-11, with a mean of 1 (64.01% of the houses). The h:d ratio was 7.48:1. The highest h:d ratio was found in the high-marginality stratum, with 10.79:1 (Table 1 and 2).

Sex and reproductive condition: With respect to dog sex, more males were counted (313, 54.72%) than females (259, 45.28%) which results in a 1.21:1 ratio. The percentage of spayed females was higher (33.59%) than that of neutered males (17.89%). Globally, 24.8% of dogs had been spayed/neutered when the visit took place (Table 3). No difference was observed in male-female ratio among strata ($P = 0.9759$) but sterilization frequency tended to increase as marginality indices decreased, being higher in the low marginality stratum ($p <0.05$).

Age: The age group with the highest frequency was 0-2 years (29.17%) a mean age of 4 years and a mode of 3 years old were determined. Dog age ranged from 1 month-17 years. No significant differences in age were found among strata (Kruskal-Wallis test, $p = 0.087$) (Fig. 2).

Anti-rabies vaccine: About 90% (520) of dog owners stated that their dogs had been vaccinated against rabies but only 22.05% (127) of dog owners produced a certificate, being current in only 18.06% (104) of dogs. The frequency of anti-rabies vaccination was significantly higher in the low-marginality stratum ($p<0.05$).

Deworming: According to the owners, 71.53% (412) of dogs had been dewormed but only 18.58% (107) proved this by producing a health certificate. It is worth mentioning that deworming certificates were current in 11.28% (65) of dogs. No significant differences were observed in deworming frequency nor in the current validity of those treatments among strata ($p = 0.1024$ and 0.4129, respectively).

Table 1: Housing types by marginality level and frequency of households with a dog in the Cuauhtemoc Sanitary area, Mexico city, 2009

		Type of housing			
Marginality stratum	Total (%)	Apartment (%)	House (%)	Other (%)	Households with a dog (%)
High	140 (12.4)	104 (74.3)	8 (5.7)	28 (20.0)	34 (24.3)
Middle	608 (53.8)	493 (81.1)	74(12.2)	41 (6.7)	213 (35.0)
Low	381 (33.7)	314 (82.4)	58 (15.2)	9 (2.4)	117 (30.7)
Total	1129 (100.0)	911 (80.7)	140 (12.4)	78 (6.9)	364 (32.2)

Table 2: Number of dogs per household by marginality stratum and human:dog (h:d) ratio, Cuauhtemoc Sanitary area, Mexico city, 2009

	Number of dogs per household (Cumulative %)					
Marginality stratum	1	2	3	Total inhabitants	Total dogs	h:d ratio
High	21 (61.8)	7 (82.3)	4 (94.1)	615	57	10.79:1
Middle	143 (67.1)	48(89.7)	15 (96.7)	2398	319	7.52:1
Low	69 (58.9)	32 (86.3)	10 (94.9)	1295	200	6.47:1
Global	233 (64.0)	87 (87.9)	29 (95.9)	4308	576	7.48:1

Table 3: Dog sex, reproductive status and male-female (m:f) ratio by marginality stratum, Cuauhtemoc Sanitary Jurisdiction, Mexico city, 2009

Marginality stratum	Males	Sterilized (%)	Females	Sterilized (%)	m:f ratio
High	30	1 (3.3)	26	4 (15.4)	1.15:1
Middle	174	19 (10.9)	142	41 (28.9)	1.22:1
Low	109	36(33.0)	91	42 (46.1)	1.20:1
Global	313	56 (17.9)	259	87 (33.6)	1.21:1

Table 4: Preventive interventions in dogs in surveyed households by marginality stratum, Cuauhtemoc Sanitary Area, Mexico city, 2009

		Marginality stratum			
Intervention	Application totals n = 576	High; n = 57; No. (%)	Middle; n = 319; No. (%)	Low; n = 200; No. (%)	Significance p-value
Anti-rabies vaccination	127 (22.0)	13 (22.8)	55 (17.2)	59 (29.5)	0.0046
Deworming	107 (18.6)	10 (17.5)	47(14.7)	50 (25.0)	0.013
Leptospira spp. bacterine	69 (11.9)	3 (5.3)	28 (8.8)	38 (19.0)	0.006

Percentages were calculated with respect to the sample size in each stratum

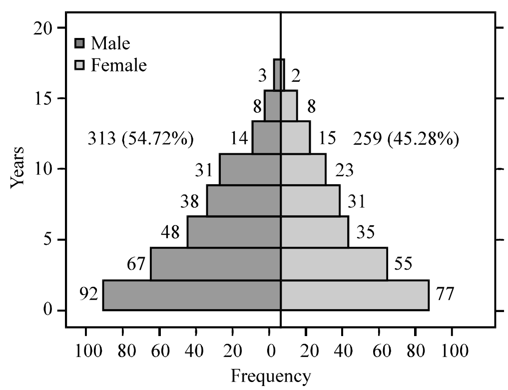

Fig. 2: Dog population structure by age and sex, Cuauhtemoc Sanitary Area, Mexico city, 2009; (Information about age was available for 25 dogs (12 males and 13 females). These animals were not included in Fig 1 but were not included in the total count)

Leptospirosis bacterine: *Leptospira* spp. bacterine was applied to 11.98% (69) of dogs but the immunization was current in only 7.82% (45). Both bacterination frequency and current validity increased as marginality index decreased ($p<0.05$) (Table 4).

Apartments were the housing type most frequently surveyed (80.69%) this result is in agreement with the 2005 population and housing census in which apartments were reported as the most common housing type in the Cuauhtemoc locality (70.91%).

The number of housings with one dog found herein was lower than those reported in the Alvaro Obregon locality in Mexico city[2] as well as in Merida, Yucatan (72.8% in the city and 63.6-71.1% in rural areas)[5] or in Mexicali, Baja California (54%)[20]. The numbers found in the high-marginality stratum were similar to those reported in Santiago de Chile (20.3%)[2]. The number of households with one dog in the middle marginality stratum and (albeit in a lesser degree) in the low marginality stratum were similar to those reported in Ireland (35.6%) and the USA (37.2%), according to AVMA-2007[10].

The finding of only one dog in most households was in agreement to data reported in Ireland (76.2%)[10], the Bahamas (55%)[7], Mexicali (56.4%)[20]) and the Alvaro Obregon locality[2]. This is consistent with the predominant housing type in the Cuauhtemoc locality (apartments) due to space constraints[10, 11].

With respect to the h:d ratio, both the global value of 7.48:1 and those found in each stratum were similar to those reported by the WHO and the World Society for the Protection of Animals (WSPA) of 6:1-10:1 for cities in America and Europa[17].

The h:d ratio estimated by the Cuauhtemoc Sanitary Authorities and used to plan dog health campaigns was similar to the values found herein in the middle marginality (7.5:1) and the low-marginality stratum (6.47:1) which suggests that resource allocation based on this h:d ratio is acceptably efficient.

With respect to dog sex, the similar male-female ratio found herein is in a greement with studies conducted in Ireland[11]; Merida[13] and the New Providence Island in the Bahamas[8], although, higher male frequencies were found in higher marginality areas in the Alvaro Obregon[2] and Tlahuac localities[14] and in San Martin de los Andes, Argentina[5].

With respect to dog age, the finding that most animals were in the 0-2 years-old range (24.5-35.09%) is in agreement with data reported in the locality of Alvaro Obregon, although, higher frequencies of younger dogs were reported in the latter locality (40.73-41.75%). This would indicate that the dog population in Alvaro Obregon is younger than that in Cuauhtemoc. Disaggregated data support this observation, since, the mean age in the three strata was also lower in Alvaro Obregon mean age in high and middle-marginalization strata was 2.6 years mean age in low-marginalization stratum was 2.7[2] than in this study (high-marginality stratum, 3.67; middle-marginality, 4.0 and low-marginality, 5.0).

With respect to dog breed, the finding of poodles as the most abundant breed (38.6%) was in agreement with data reported in 2007 from rural areas in Yucatan. In the same study this breed was the third most frequent in Merida, after mixed-breed and Maltese dogs[5]. Mixed-breed dogs were the second most abundant breed in this study (up to 20%) in contrast with data reported in Mexicali 68.39%[19] and in the Tlahuac locality, both in the burrows of Zapotitla (54%) and Mixquic 72%[13] where mongrels were the most frequent phenotype.

As expected, a higher percentage of neutered/spayed dogs was found in the low-marginality stratus, a result similar to that reported in San Martin de los Andes, Argentina[4]. On the other hand, sterilization rates up to 75% are often reported in developed countries[8] while the frequency of this intervention is lower in developing countries where cost is often a limiting factor[5] .

Several studies have reported low sterilization rates, similar to those found herein. Some researchers suggest that at least 70-90% of animals in a given area should be prevented from reproducing to stabilize dog population[7].

With respect to preventive interventions, information on anti-rabies vaccination and deworming was gathered. A statement by the owner on having vaccinated and dewormed their dogs was recorded and whether the owner produced a current vaccination certificate. Contrasting oral statements by owners with written evidence (current certificates) allowed us to estimate the possible increase in bias by owner misinformation. A study conducted in Mexicali also included information provided orally by dog owners[20].

Our finding of a higher percentage of vaccinated dogs in low and medium-marginality strata (29.50%) was similar to reports in the Alvaro Obregon locality[2] and Mexicali[20]. A relationship between anti-rabies vaccination and family income was suggested in the latter study: A vaccination rate of 59% was observed in families with a monthly income ≤300$ but the rate was 82% when monthly income was ≥900$.

With respect to the frequency of dewormed dogs found herein it was lower than in Alvaro Obregon[2], San Martin de los Andes 63%[4] and Roseau, Dominica 80%[6].

Regarding leptospirosis bacterination, the tendency herein found of higher bacterination rates as marginality decreased was similar to that reported by Alvaro Obregon[2] and Yucatan[5].

The dog population profile in the Cuauhtemoc locality corresponded to a young population with a high reproductive potential, similar to those reported in other studies on dog populations in big cities.

The results herein reported stress the need of reinforcing educational campaigns to favor a responsible dog ownership with an emphasis on reproductive control, vaccination and deworming as well as the need of communicating the benefits of these interventions and improve their coverage. Our results can help the local health authorities to plan, implement and evaluate these much-needed activities.

CONCLUSION

Educational programs stressing the importance of dog vaccination and deworming as a continual practice instead of an isolated action are much needed in the general population. Such programs will improve the prevention of zoonotic diseases.

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