Original Article

Cross-sectional study on the knowledge about pet ownership, zoonoses and practices of pet owners in the North of Portugal

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Short title: **Knowledge and practices of pet owners in the North of Portugal**

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Simple Summary

Pet ownership is common in most countries, however there are few published studies that address pet owners' knowledge about zoonoses, pet contact practices and awareness of zoonotic disease risks from pets. The aim of this study was to assess household knowledge, attitudes and risks related to pet ownership and zoonoses in the

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North of Portugal. A questionnaire was developed to gather information regarding participants' demographic characteristics; types of pets in the household and their importance to the family; pet contact-related attitudes; knowledge about zoonoses, high-risk groups, pathways of disease transmission and disease protection measures. It was observed that most participants considered pets an important part of the family. Nevertheless, high-risk practices were recurrent and pet owners' knowledge was limited. These results reinforce the importance of further studies to better understand the existing gaps in knowledge about pet ownership and zoonoses and strengthen the need to adopt the One Health concept.

Abstract

Pet ownership is common in modern society. In Portugal, 38% and 31% of all households own, at least, one dog or cat, respectively. Few studies have ascertained the knowledge of pet owners about pet ownership and zoonoses, and none of them was carried out in Portugal. The aim of the present study was to assess household knowledge and practices related to pet ownership and zoonoses in the North of Portugal. A questionnaire was completed by 424 pet owners, during November 2019 to February 2020. Most respondents (97.2%) considered pets as an important part of the family, especially women (p = 0.036); 73.1% allowed their pets free access to indoors; 41.3% denied sharing the bed with their pets and 29% assumed they did it daily; 20.3% reported never kissing their pets/pets licking their faces; 73.6% considered animals as potential sources of diseases to humans, but only 25.9% reported knowing the definition of zoonoses; 96.9% considered important the role of veterinarians in protecting public health. The low level of knowledge of pet owners and the occurrence of high-risk behaviors indicate a need to strengthen

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communication between veterinarians, physicians, pet owners and the general public to reduce the risk of acquisition and transmission of zoonoses.

Keywords: Knowledge; One Health; Pet ownership; Pets; Portugal; Public Health; Zoonoses

1. Introduction

Pet ownership is common in modern society, although there are differences depending on the continent and country [1–4].

Dogs and cats are the most frequent owned pets, nevertheless, other species are gaining more attention in household environment worldwide [5]. According to the European Pet Food Industry (FEDIAF), in 2019, 85 million European Union households (38% of all households) owned one pet animal, at least. Cats represented the top pet, followed by dogs, birds, small mammals, ornamental fishes and reptiles. In Portugal, 38% and 31% of all households own, at least, one dog or cat, respectively. These represent around 2 050 000 owned dogs and 1 500 000 owned cats [4].

Several studies have reported that animal ownership or interaction with animals may contribute to improve overall quality of life, including physical, social and psychological health [6–9]. Nevertheless, any health benefits must be evaluated considering several variables, including age, gender and socioeconomic status, but also the time spent with each pet and the bond that is fostered between owners and their pets, which is naturally different between members of the same household [8].

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Despite the benefits, there are potential hazards associated with pet ownership and interaction with animals. Rabbits and rodent ownership during pregnancy and childhood seems to be linked to increased risk of non-atopic asthma [10,11]. There are studies reporting that early exposure to dogs and cats at home can predispose to pet allergies [12]. Allergies to dogs and cats affect 10 to 20% of the population worldwide and are a major risk factor in the development of allergic rhinitis and asthma [13–15]. Animal bites are extremely common and a serious public health problem [8,16]. Dogs are responsible for most reported bites in humans, especially in children [17]. Bites and scratches may lead to complex injuries, both physically and psychologically, but rarely to death. Low-income countries, where dog-control laws are seldom decreed or enforced, are estimated to have higher occurrence of dog bites, scratches, and consequent fatalities, due to the prevalence of rabies and lack of access to appropriate healthcare [17].

Although the number of emerging infections from companion animals is remarkably low [18], there is potential for transmission of infectious pathogens from pets to humans (Figure 1) through skin and mucous membranes via bites, scratches or other direct contact; contact with animal saliva, urine and other body fluids and secretions; ingestion of food or drink contaminated with animal fecal material; inhalation of infectious aerosols or droplets; and through arthropods and other invertebrate vectors [19,20].

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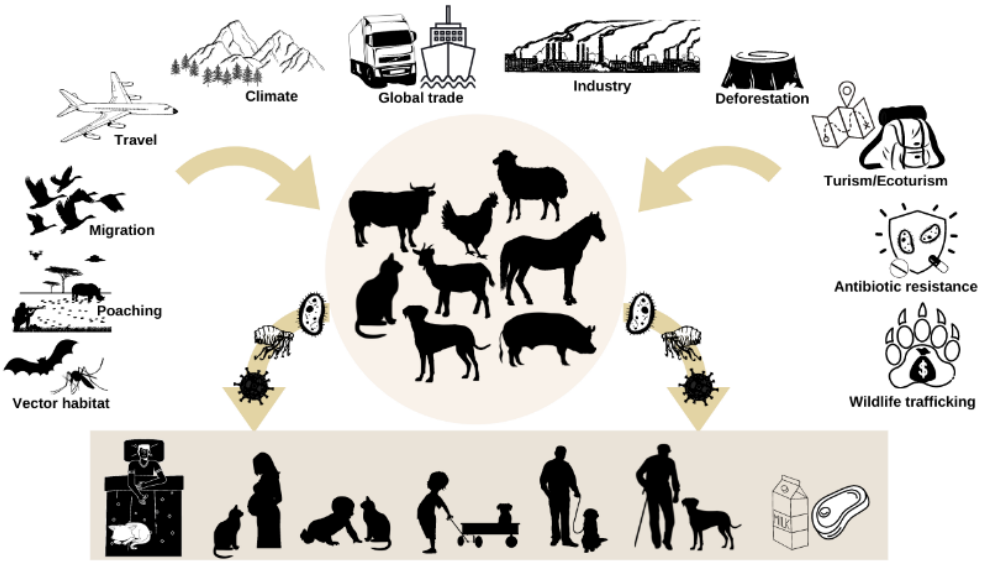
Figure 1. Factors responsible for the emergence of zoonoses and their transmission to humans.



Zoonotic agents can infect healthy people, e.g., through occupational exposure. In fact, occupational zoonoses frequently occur through close contact between animals and humans due to specific settings and professional activities [21]. Therefore, veterinarians, abattoir workers, researchers and technicians, among other professionals who handle infected animals and cultures of zoonotic agents daily, can be exposed to pathogenic agents [21,22]. However, the risk of becoming infected with a zoonotic pathogen is particularly higher for those with a compromised or incompletely developed immune system, such as neonates, toddlers/children (<5 years), elderly (>65 years), pregnant women and all the people who suffer from primary/congenital or acquired immunodeficiencies, such as the acquired immunodeficiency syndrome (AIDS), impaired immunity from cancer, chemotherapy and radiation therapy, splenectomy, diabetes mellitus, diseases of bone marrow and consequent immunosuppressive therapy for transplants, and protein-calorie malnutrition [16,20,23].

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It is not realistic to eliminate the possibility of acquiring a zoonotic disease but rather to reduce the risk. To this end, personal hygiene measures should be applied, such as hand washing; proper animal handling; diet and health care; and educational measures and awareness, especially to pet owners, children and immunocompromised people on zoonoses prevention, in order to help them make informed choices and, hopefully, interact safely with animals [8,19,24].

To date, few studies have assessed basic knowledge of pet-associated zoonoses among pet owners and, unfortunately, there are few longitudinal studies about this issue. Additionally, most of the published ones do not have enough data. More questionnaires are needed with a larger sample by region and country, in order to obtain the most reliable and real information possible about general public's household knowledge, attitudes, habits and risks associated to pet ownership and animal contact. The aim of this study was contributing to the aforementioned goal, using households with pets in the north of Portugal as study target. Moreover, this study aimed to strengthen the message of combating zoonoses by promoting awareness among tutors and the general public, as well as underlining the importance of animal care and raising consciousness of the reality of abandonment of companion animals, often associated to ignorance on the topic.

2. Materials and methods

A cross-sectional study about zoonoses and pet ownership was conducted from November 2019 to February 2020. A voluntary survey was conducted among pet owners from the North of Portugal. Individuals were eligible to participate if they

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were at least 18 years of age and had pets in their household. After agreeing to participate in the study, everyone was asked to complete an anonymous, confidential 15-minute self-administered written questionnaire on-site (available in Portuguese upon author request). The questionnaire was based on a literature review and designed to obtain information about zoonoses and pet ownership. The questionnaire consisted of closed or short answer questions. It gathered both individual and household-level data including respondents' demographic characteristics (sex, age, education level and profession); type of pets in the household and their importance to the family; pet and animal contact-related attitudes; knowledge of the term "zoonoses" and if so, examples of zoonotic diseases and sources for such information; existence of high-risk groups; pathways of disease transmission; disease protection measures and their importance; and the occurrence of animal contact and pet-associated zoonotic disease and injury. In the questions with closed-ended responses about the importance of pets in the family and the importance of protective measures, a 5-point scale answer, ranking from 1 to 5 interval scale (1 = very little important; 2 = little important; 3 = important; 4 = very important; 5 = extremely important) was used. In the question with closed-ended responses about the importance of veterinarians in protecting public health a 4-point scale answer, ranking from 1 to 4 interval scale (1 = minimum importance; 2 = some importance; 3 = very important; 4 = maximum importance) was used. In the questions with closed-ended responses about pet owners' knowledge about zoonoses and protective measures, a 5-point scale answer, ranking from 1-to 5 interval scale (1 = no knowledge; 2 = little knowledge; 3 = some knowledge; 4 = a lot of knowledge; 5 = excellent knowledge) was used.

2.1. Data analysis

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Data were entered into an Excel database (Microsoft Corp., Redmond, WA, USA) and exported and analyzed using SPSS version 27.0 (SPSS, IBM Corporation, New York, USA). For descriptive purposes, Pearson χ^2 test was conducted for each variable in the study looking at gender and ownership differences. The *t*-test was conducted in order to examine the owners' gender differences relative to the importance attributed to knowledge and practices regarding pet animals and zoonoses. Statistical significance was based on a *p*-value < 0.05.

3. Results

In the period in which the survey was applied, 424 individuals responded. Dogs were the most frequently reported owned species (72.9%; n = 309), followed by cats (52.8%; n = 224), birds (9.6%; n = 41), turtles (5.4%; n = 23), fishes (2.6%; n = 11), rabbits (1.9%; n =8), exotic animals (1.2%; n = 5), horses (0.7%; n = 3), and livestock species (0.2%; n = 1). Cats and dogs were owned by 97.6% of respondents (414/424).

3.1. Demographics

Animal owners had a mean age of 36.9 years (SD ±15.2) and a median of 33 years. The youngest respondent was 18 years old and the oldest was 80 years old. Regarding gender, 74.1% (n = 314) were female and 25.9% (n = 110) were male. In relation to academic background, 49.5% (n = 210) had higher education (attended or completed), 25.5% (n = 108) had secondary education (up to the 12th year of schooling), 10.6% (n = 45) had the 3rd cycle of basic education (up to the 9th year of schooling), 5.9% (n = 25) had the 2nd cycle of basic education (up to the 6th year of schooling), and 8.5% (n = 36) had the 1st cycle of basic education (up to the 4th year of schooling). Regarding occupation, 28.5% (n = 121) were students, 39.9% (n = 169) had an essentially

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physical professional activity, 19.1% (n = 81) had an essentially mental activity, 12.5% (n = 53) had no occupation (unemployed or retired). Most respondents lived in the urban area (58.5%; n = 248) and 41.5% (n = 176) lived in the rural area (Table 1).

Table 1. Demographics of respondents who participated in the survey (n = 424).

Characteristic	n (%)
Gender	
Female	314 (74.1)
Male	110 (25.9)
Age (years)	
Mean (SD)	36.9 (±15.2)
Median (interquartile range)	33
18–20	60 (14.2)
21–25	80 (18.9)
26–30	60 (14.2)
31–49	126 (29.7)
≥50	98 (23.1)
Education	
1st cycle of basic education	36 (8.5)
2nd cycle of basic education	25 (5.9)
3rd cycle of basic education	45 (10.6)
Secondary school	108 (25.5)
Higher education	210 (49.5)
Occupation	
Student	121 (28.5)
Essentially physical activity	169 (39.9)
Essentially mental activity	81 (19.1)
No occupation (unemployed or retired)	53 (12.5)
Residence	
Urban	248 (58.5)
Rural	176 (41.5)

SD: Standard deviation.

3.2. Opinion about the importance and benefits of having pets

Most respondents considered pets as an important part of the family (97.2%; n = 412), with most of the individuals who had this opinion being dog owners (73.1%; n = 301).

Participants (n = 412) were asked to assign the level of importance that their animals constituted for their family, where 1 was the minimum level and 5 was the maximum level. Most of the respondents considered them extremely important (level 5; 43.4%; n = 184) or very important (level 4; 30.2%; n = 128). The level 3 of importance was

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chosen by 20.3% (n = 86) of the participants, followed by level 2 (2.1%; n = 9) and level 1 (1.2%; n = 5), which correspond to little importance and very little importance, respectively.

In this study, 75.2% (n = 139) of the participants considered that benefits of having a pet outweighed the potential health risks. This opinion prevailed among women (p = 0.048) and 16.7% (n = 71) of all respondents had no opinion.

Most participants, 76.4% (n = 324), considered that having no pets (or reducing the number of pets in the household) would negatively affect their family. In contrast, 8.5% had no opinion.

3.3. Pet and animal contact-related attitudes

It was reported that 73.1% (n = 310) of the companion animals had free access to indoors of houses; 79.7% of the participants stated that their animals never ate or licked the dishes, in contrast with 2.1% of the respondents who reported that this happened daily. In addition, 24.1% of the owners admitted washing the pet food containers together with other dishes (Table 2).

Table 2. High-risk practices for the transmission of zoonotic diseases (n = 424).

Practices	Never n (%)	Sometimes n (%)	Frequently n (%)	Daily n (%)
Pet licks/eats from the owner's plate	338 (79.7)	62 (14.6)	15 (3.5)	9 (2.1)
Sharing bed with the pet	175 (41.3)	56 (13.2)	70 (16.5)	123 (29.0)
Owner kisses the pet/pet licks owner's face[1]	86 (20.3)	135 (31.8)	90 (21.2)	113 (26.7)

[1] p = 0.002. Superior among female owners.

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In this study, 41.3% of the participants denied that they or someone in the family shared the bed with their pets and 29% assumed they did so constantly. The responses "frequently" and "always" were most answered by dog owners ($p = 0.004$). Moreover, 20.3% of the respondents reported that they never kissed their pets, or their animals licked their faces. However, the majority admitted doing it, especially among female owners ($p = 0.002$) (Table 2).

In relation to contact with other animals, 54.5% (n = 231) of the owners declared that their pets had contact with other animals. About half of the owners who answered affirmatively (50.6%; n = 117) considered that these animals could be a risk for the acquisition of diseases.

3.4. Attitude towards stray animals

When asked about their attitude towards a dog or cat that they frequently found close to home, 43.4% (n = 184) of the participants answered that they would provide food and shelter. Respondents who did not have dogs at home reported having this attitude more frequently ($p = 0.046$), as well as respondents who were female ($p = 0.028$). Only 7.1% (n = 30) would take the animals to the veterinarian to assess their health status, deworming and/or vaccination. Moreover, 37.3% (n = 158) would communicate to the responsible entities (city council, municipal kennel) or to non-governmental entities (veterinary centers, animal protection associations). This attitude was statistically associated with having a dog ($p = 0.024$). In this study, 31.3% of the participants would not act.

3.5. Opinion regarding stray dogs

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The majority (85.4%; n = 362) of the respondents considered that stray dogs should be collected and treated. Most of the participants who had this opinion were female (p = 0.007). Only 1.2% (n = 5) considered that stray dogs should be euthanized, because of their potential for disease transmission. For 6.4% of respondents, stray dogs should be left freely on the streets if they were first neutered, vaccinated, and dewormed. The remaining 7% had no opinion.

3.6. Visits to the veterinarian

Participants were asked to state in what situations they took their animal to the veterinarian within a list of options. Most of the owners (93.2%; n = 395) took their pet to the veterinarian, while 6.8% (n = 29) did not. Most of them reported taking their animals to the vet for vaccination or deworming (79.2%; n = 336); due to illness (74.8%; n = 317), particularly female respondents (p = 0.036). More than a half did not take their animals to routine consultations (64.9%; n = 275). Only 6.8% (n = 29) declared going to the vet for guidance on issues related to estrus, pregnancy, and childbirth. In addition, only 13.2% of participants answered taking their pets for bathing and shearing. Four participants (0.9%) reported other options, such as cutting nails, bee sting and oral hygiene procedures as scaling and trimming rabbits' teeth.

3.7. Deworming

Most of the participants reported internally deworming their pets (90.6%; n = 384). Of these, 44.1% (n = 187) dewormed their animals every 6 months; 26.6% dewormed more often than every 6 months; 20.3% (n = 86) reported deworming annually, and 9.4% (n = 40) declared not to deworm their animals.

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Regarding external application of antiparasitic drugs, 93.9% (n = 398) of the participants reported protecting their animals against external parasites. Of these, 37.5% (n = 159) performed prevention for external parasites every 6 months; 42.5% (n = 180) applied antiparasitic drugs for external parasites more often than every 6 months; 13.9% (n = 59) reported performed prevention for external parasites annually, and 6.1% (n = 26) referred not to perform prevention for external parasites.

3.8. Zoonotic disease knowledge and educational sources

More than half of the respondents (58.7%; n = 249) were comfortable with their level of knowledge in relation to the potential diseases that may arise from the contact with animals.

Participants were asked to assign their perception of the level of knowledge they thought to have about this topic. A large part of the participants reported having no knowledge (40.8%; n = 173), followed by respondents who reported having some knowledge (36.3%; n = 154), little knowledge (11.3%; n = 48), a lot of knowledge (9.7%; n = 41) and excellent knowledge (1.9%; n = 8).

Most participants (73.6%; n = 312) considered animals as potential sources of diseases to humans. However, 8.5% (n = 36) answered negatively and 17.9% (n = 76) of the respondents admitted not knowing. Interestingly, only 25.9% (n = 110) of respondents reported knowing the definition of zoonoses. In contrast, 74.1% (n = 314) acknowledged not being aware of this concept.

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Examples of zoonoses were requested. The frequencies of the responses were as follows: rabies (13.2%; n = 56), brucellosis (7.5%; n = 32), toxoplasmosis (7.3%; n = 31), leishmaniosis (5.0%; n = 21), scabies (5.0%; n = 21), dermatophytosis (4.5%; n = 19), tuberculosis (2.8%; n = 12), salmonellosis (2.1%; n = 9); leptospirosis (1.9%; n = 8), babesiosis (1.2%; n = 5), tick fever (0.9%; n = 4), dengue (0.7%; n = 3), giardiosis (0.7%; n = 3), yellow fever (0.7%; n = 3), avian chlamydiosis (0.5%; n = 2), bovine spongiform encephalopathy (0.5%; n = 2), colibacillosis (0.5%; n = 2), malaria (0.5%; n = 2), Q fever (0.5%; n = 2), taeniosis (0.5%; n = 2), West Nile disease (0.5%; n = 2), avian influenza (0.2%; n = 1), COVID-19 (0.2%; n = 1), cryptococcosis (0.2%; n = 1), Ebola (0.2%; n = 1), ehrlichiosis (0.2%; n = 1), heartworm (0.2%; n = 1), hydatidosis/echinococcosis (0.2%; n = 1), Lyme disease (0.2%; n = 1), rickettsiosis (0.2%; n = 1) and trichinellosis (0.2%; n = 1).

Participants were asked how they have obtained information about zoonoses. For 20.3% (n = 86), it was through the academic path, followed by conversations with veterinarians (9.2%; n = 39), through the media (4.2%; n = 18), by family and friends (4.0%; n = 17), and only 0.9% (n = 4) referred having obtain information through physicians.

3.9. High-risk individuals

Most participants (68.4%; n = 290) considered that there are groups of people who are at higher risk of contracting zoonotic diseases, 22.2% (n = 94) admitted not knowing what to answer, and 9.4% (n = 40) considered that there are no high-risk individuals. The degree of risk assigned is shown in Table 3.

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Table 3. Risk score attributed by respondents to each high-risk group (n = 424).

Risk score [a]	0 n (%)	1 n (%)	2 n (%)	3 n (%)	4 n (%)	5 n (%)
Elderly	161 (38.0)	26 (6.1)	24 (5.7)	65 (15.3)	86 (20.3)	62 (14.6)
Cancer patients	156 (36.8)	17 (4.0)	16 (3.8)	33 (7.8)	79 (18.6)	123 (29.0)
Pregnant women	148 (34.9)	12 (2.8)	18 (4.2)	65 (15.3)	91 (21.5)	90 (21.2)
Children	159 (37.5)	23 (5.4)	39 (9.2)	80 (18.9)	82 (19.3)	41 (9.7)
HIV/AIDS patients	171 (40.3)	25 (5.9)	20 (4.7)	50 (11.8)	53 (12.5)	105 (24.8)
Transplant patients	159 (37.5)	12 (2.8)	12 (2.8)	46 (10.8)	71 (16.7)	124 (29.2)
Chronic disease patients	172 (40.6)	41 (9.7)	52 (12.3)	73 (17.2)	59 (13.9)	27 (6.4)

[a] 0: no risk; 1: minimum risk; 2: some risk; 3: reasonable risk; 4: too much risk; 5: maximum risk.

3.10. Transmission of zoonotic diseases

Participants were asked if they knew how animals could transmit diseases to humans, and the majority responded affirmatively (64.6%; n = 274). Of these participants, 75.9% (n = 208) considered feces as a mean to transmit zoonotic diseases, and this option was more frequently chosen by female owners ($p = 0.046$); 64.2% (n = 176) considered that transmission could occur through insect bite, having female owners selected this option more often ($p = 0.028$); the option "blood" was chosen by 56.7% (n = 155) of the respondents, followed by "physical contact" (48.9%; n = 134); 48.2% (n = 132) considered that transmission could occur through coughing and sneezing, having male owners selected this option more frequently ($p = 0.021$); 43.1% (n = 118) recognized the food route as a mean of transmitting zoonotic diseases, followed by vomit (41.6%; n = 114); 38.3% (n = 132) of the participants considered that it would be possible to transmit zoonotic diseases through fur, brushes and blankets of the animals.

3.11. Knowledge about protective measures

Participants were asked if they felt comfortable with their knowledge in relation to protective measures against zoonotic diseases, and 52.1% (n = 221) responded

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affirmatively. Subsequently, the respondents had to assign the level of knowledge they thought they had. The majority admitted not having knowledge (level 1; 47.9%; n = 203) followed by having some knowledge (level 3; 35.6%; n = 151), little knowledge (level 2; 8.7%; n = 37), a lot of knowledge (level 4; 6.1%; n = 26) and excellent knowledge (level 5; 1.7%; n = 7).

Respondents were asked to attach a level of importance to general protection measures. The highest level of importance (level 5) was assigned to primary hygiene care (41.5%), followed by frequent hand washing (38.9%) and people vaccination (33.3%) (Table 4).

Table 4. Level score attributed by pet owners to the importance of each general preventive measure (n = 424).

Level of importance [1]	0 (n; %)	1 (n; %)	2 (n; %)	3 (n; %)	4 (n; %)	5 (n; %)
Vaccination of people	208 (49.1)	6 (2.4)	9 (2.1)	13 (3.1)	47 (11.1)	141 (33.3)
Deworming of people	212 (50.0)	7 (1.7)	14 (3.3)	48 (11.3)	60 (14.2)	83 (19.6)
Primary hygiene care	203 (47.9)	5 (1.2)	2 (0.5)	7 (1.7)	31 (7.3)	176 (41.5)
Consumption of pasteurize milk	219 (51.7)	33 (7.8)	11 (2.6)	34 (8.0)	48 (11.3)	79 (18.6)
Vacuum the house frequently	208 (49.1)	2 (0.5)	21 (5.0)	50 (11.8)	61 (14.4)	82 (19.3)
Wear gloves when gardening	210 (49.5)	20 (4.7)	33 (7.8)	50 (11.8)	53 (12.5)	58 (13.7)
Frequent hand washing	205 (48.3)	4 (0.9)	1 (0.2)	11 (2.6)	38 (9.0)	165 (38.9)

[1] 0: do not answer; 1: very little important; 2: little important; 3: important; 4: very important; 5: extremely important.

Subsequently, the participants who considered themselves comfortable with their level of knowledge, had to assign a level of importance to protective measures directly associated with animals. Female owners attributed higher level of importance for 2 preventive measures: treatment of sick animals ($p = 0.019$) and not feeding raw meat to pets ($p = 0.008$). The results are shown in Table 5.

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Table 5. Level score attributed by pet owners to the importance of each preventive measure directly associated to animals (n = 424).

Level of importance [1]	0 (n; %)	1 (n; %)	2 (n; %)	3 (n; %)	4 (n; %)	5 (n; %)
Vaccination of pets	202 (47.6)	3 (0.7)	1 (0.2)	4 (0.9)	18 (4.2)	196 (46.2)
Treatment of sick animals[2]	205 (48.3)	1 (0.2)	2 (0.5)	1 (0.2)	17 (4.0)	198 (46.7)
Isolation/quarantine	212 (50.0)	13 (3.1)	8 (25.0)	25 (5.9)	40 (9.4)	126 (29.7)
Animal slaughter	229 (54.0)	63 (14.9)	34 (8.0)	39 (9.2)	32 (7.5)	27 (6.4)
Internal deworming of pets	205 (48.3)	4 (0.9)	4 (0.9)	11 (2.6)	42 (9.9)	158 (37.3)
External deworming of pets	207 (48.8)	2 (0.5)	2 (0.5)	9 (2.1)	43 (10.1)	161 (38.0)
Animal identification	207 (48.8)	14 (3.3)	7 (1.7)	27 (6.4)	44 (10.4)	125 (29.5)
Not feeding raw meat to pets[3]	210 (49.5)	9 (2.1)	9 (2.1)	31 (7.3)	40 (9.4)	125 (29.5)

[1] 0: do not answer; 1: very little important; 2: little important; 3: important; 4: very important; 5: extremely important.

[2] $p = 0.019$ (higher importance for female owners).

[3] $p = 0.008$ ((higher importance for female owners).

3.12. Concern about zoonotic diseases

When their animals become ill, 55.7% (n = 236) of the participants declared being concerned about the possibility of their pets transmitting diseases to themselves or to any member of the family. Those who answered affirmatively were asked to give a level of concern and the majority admitted being concerned (level 2; 49.2%; n = 116), followed by the owners who answered being just a little concerned (level 1; 22.9%; n = 54), very concerned (level 3; 19.1%; n = 45) and extremely concerned (level 4; 8.9%; n = 21).

3.13. Acquired diseases by pets and pet owners

Owners were questioned whether their pets have ever had a disease that could be transmitted to humans. According to the results, few animals contracted zoonotic diseases (4.0%; n = 17); 26.4% (n = 112) of the participants answered not knowing, and the majority (69.6%; n = 295) responded that their animals never had such

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diseases. Those who answered affirmatively declared their animals suffered from: dermatophytosis (n = 11), scabies (n = 2), babesiosis (n = 1), leishmaniasis (n = 1), leptospirosis (n = 1) and parasitism (n = 1).

In this survey, 2.6% (n = 11) of the pet owners confirmed that they had some diseases transmitted by animals, which were dermatophytosis (n = 6), parasitism (n = 3), brucellosis (n = 1) and scabies (n = 1).

3.14. Access to information

In this study, 87.0% (n = 369) of the respondents would like to obtain more information about zoonotic diseases, however 7.5% (n = 32) had no opinion.

Of the participants who answered affirmatively, 66.9% (n = 247) would like to have it through the media (TV, radio, social media network); 64.7% (n = 239) through veterinarians; 34.1% (n = 126) through physicians; and 33.3% (n = 123) through flyers.

3.15. The role of veterinarians

In this study, 96.9% (n = 411) of the participants considered important the role of veterinarians in protecting public health, although 3.1% (n = 13) had no opinion. No participant responded negatively.

Those who answered affirmatively were asked to assign a level of importance in which 1 represented minimum importance and 4 the maximum importance. More than half of the respondents (56.6%; n = 240) attributed the maximum level of importance.

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For 32.1% (n = 136), the role of veterinarians is very important (level 3), followed by the owners who attributed them some importance (level 2; 7.5%; n = 32) and minimum importance (level 1; 0.7%; n = 3). Female owners assigned the highest score values (p = 0.005).

3.16. Differences in the gender of pet owners relative to the importance attributed to different questions

Regarding the mean score, the *t*-test revealed that female pet owners attributed a higher value to the importance of pets in family (t = 2.103; p = 0.036). The same scenario was seen in relation to the role of veterinarians in protecting public health (t = 3.94; p = 0.000). Table 6 shows the differences between the gender of the pet owners and the importance each one attributed to different questions.

Table 6. Differences in the gender of pet owners in relation to the level of importance given to different questions (n = 424).

Questions	Female owners (n = 314)	Male owners (n = 110)	*t*-test	*p*-value
Importance given to pets in the family	4.11 (± 1.15)	3.85 (± 1.08)	2.103	0.036
Importance given to vets in the protection of public health	3.48 (± 0.78)	3.10 (± 1.11)	3.94	0.000

± standard deviation.

4. Discussion

This study aimed to characterize household knowledge, attitudes and practices related to pet ownership in the North of Portugal.

Despite the considerable increase of households with pets, the close interaction of animals with household members and the growing recognition of the potential

benefits and risks pets posed, few studies have addressed this topic [16,25–28], and none of them have been conducted in Portugal. Although limited by a small sample of the Portuguese pet owners, this study can be a useful tool to enlighten veterinarians, physicians, politicians, and other professionals as well as the general public about pet owners' knowledge and practices.

The animal ownership patterns observed were consistent with the FEDIAF report about Portugal, with most respondents having dogs, followed by cats and birds. Most of the participants considered their animals an important part of the family and they believed that benefits of pet ownership outweigh disease risks. Indeed, several studies have reported cardiovascular benefits [29], especially in the elderly hypertensive and diabetic population [30–34]. Pet ownership during pregnancy, in the first year of life and childhood seem to prevent the development of food allergy [35] and reduce the risk of wheezing (associated with cat ownership) [11], atopic asthma and aeroallergen sensitization (grass, house dust mite, cat and dog allergens) [10,36–38]. Dogs also increase opportunities for recreational walking, reducing the risk of obesity [39–43]. Pet ownership or just being in contact with animals seem to provide social support, reduce distress and anxiety and decrease loneliness and depression [6], especially among older individuals [44], children [45,46] and adolescents with autism spectrum disorder [47], immunocompromised individuals [48] and homeless people [49].

It is crucial to emphasize that few studies have ascertained the level of knowledge by pet owners about zoonoses and their prevention [16,25,28,50], and some of them have only focused on dog-associated zoonoses or zoonoses associated with endoparasites

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[51–55]. In addition, there are even fewer studies on this topic that address new companion animals (reptiles and small mammals) [56].

Pet owners, for the most part, were comfortable with their level of knowledge about zoonotic diseases, although 40.8% admitted not having knowledge. To assess zoonotic disease knowledge, respondents were asked about the definition of zoonoses. Interestingly, most respondents did not know the word or its definition. However, they considered animals as a potential source of diseases. This finding is in line with that of other studies, which reported the lack of knowledge of pet owners and/or general public [16,28,51,54]. Moreover, since a considerable part of the surveyed pet owners were comfortable with their knowledge, they are unlikely to seek information about the topic.

Pet owners who claimed to know de term “zoonoses” were asked for examples. Rabies was the most frequent zoonotic disease reported, and the same result has been previously stated in other studies around the world [16,25,26]. Portugal is a country officially rabies free since 1961, and vaccination of dogs against the disease is mandatory [57]. Perhaps this is one of the reasons for the greater knowledge of owners about this disease compared with others more common in the country, as salmonellosis, dermatophytosis or scabies.

Brucellosis was the second most reported zoonotic disease. In Portugal, brucellosis is a mandatory notifiable disease [58] that mainly affects cattle and small ruminants [59,60]. However, the situation has been improving in recent years due to eradication programs adapted to the current needs of each region. These programs are based on

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herd screening and classification, outbreak detection, animal movement control and sanitary slaughter of positive animals. Through the implementation of these measures, it has been possible to reduce the incidence of the disease in cattle and in small ruminants [57]. According to Ribeiro et al. [60], there has also been a decrease in notified cases of human brucellosis over the years, with higher number of reported cases in the North, mainly in men aged between 45 and 54 years.

There were statistically significant differences regarding the gender of the participants who referred toxoplasmosis as an example of zoonoses. In fact, only one man mentioned this zoonosis, which may suggest that women are more aware of this disease, perhaps because they are informed that childbearing women constitute a risk group. However, given the small sample and the type of questionnaire performed, it is not possible to conclude such assumption. Gargaté et al. [61] referred the lack of knowledge of the current epidemiological situation in Portugal, considering that the only toxoplasmosis national serological survey was performed in 1979/1980. This study indicated that more than 80% of the Portuguese pregnant women were susceptible to primary infection [61]. In addition, a seroepidemiological study developed in the North of Portugal emphasized the susceptibility of childbearing women to primary infection with *T. gondii*. Moreover, the study reported that risk factors for *T. gondii* infection in women were participating in soil-related activities without gloves, consumption of unwashed raw vegetables or fruit, and consumption of smoked or cured (non-cooked) processed pork products [62].

A recent study conducted in Italy [63] aimed to evaluate the knowledge of Italian women about toxoplasmosis. It resulted that the knowledge about this zoonotic disease was superficial and incomplete. It was also possible to analyze some

predictors as age, academic background, previously contracted illness and working conditions [63]. The same type of studies must be implemented in Portugal, as well as effective education and learning programs.

Most of the participants who declared to have knowledge about zoonoses admitted having acquired it through their academic path, contradicting other studies which reported veterinarians as the main source of zoonotic disease information for pet owners [16,24,26]. However, in both cases, the role of veterinarians as educators was neglected. In fact, there are several studies reporting the lack of transmission of information about zoonotic diseases and their potential hazards by veterinarians to animal owners [16,26,28,64–66]. Pet owners indicated that veterinarians only discuss this issue when asked or whenever zoonoses had been diagnosed in pets [65]. In this study, most of the respondents considered important the role of veterinarians in protecting public health. Interestingly, the majority would like to obtain information about zoonotic diseases through the media. Veterinarians were the second most chosen category. Although the difference between them is not significant, it might be prudent to rethink the way in which information is transmitted. Providing client educational materials on zoonotic diseases could be interesting [67], as well as reliable resources online [68]. Nevertheless, veterinarians will always play a central role in the promotion of pet owners' education about zoonotic diseases [24].

Findings of this study are consistent with those of others regarding the role of physicians in transmitting information about zoonoses. In fact, the limited involvement of physicians in asking about the detention of pets by their patients, advising on protective measures and discussing potential zoonotic diseases has been

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described [16,24,28,66,69–71]. This is problematic since animal contact frequently occurred in both pet and non-pet owning households, so individuals without pets but with animal contact will likely not consult a veterinarian. Moreover, veterinarians are often unaware of the health status of the pet owners and their household members [16,67]. Therefore, physicians are the most suitable health professionals to advise and inform patients on their household zoonotic disease risks [16]. Nevertheless, veterinarians should discreetly question their clients to ascertain whether they or other household members are especially vulnerable because of pregnancy, age or immunosuppression and counsel them about appropriate precautions [28].

The One Health concept is in vogue. It is essential that the veterinary and human fields join efforts to bridge the communication and information gaps that have been reported over the years [24]. These failures are felt not only among physician/patient and veterinarian/pet owner, but also among professionals in both areas. The gap between the two professions begins even during their early professional education and training [24,72], since medical and veterinary students are rarely provided with opportunities for inter-professional learning and collaboration [73]. The One Health concept foresees using their knowledge and skills to enhance clinical management of zoonoses in humans and animals, which will ultimately benefit human, animal and environmental health [24,72,73].

The growing importance of pets, especially in industrialized countries, has led to increasingly close contact with their owners [74]. Some studies have shown that between 13% and 63% of owners allowed their pets to sleep on their bed and 40% to 60% of pets were allowed to lick their owner’s face [9,28,50,51,54,74–76]. The

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results of the present study are consistent with those mentioned above. Zoonotic infections acquired by sleeping with a pet or by being licked on the face are uncommon. However, these behaviors can increase pet-associated disease risks. Bacterial infections, such as *Yersinia pestis* (plague's agent), *Bartonella henselae* (cat scratch disease), Methicillin-resistant *Staphylococcus aureus* [74] and a few cases of fatal bite wound infections by *Capnocytophaga canimorsus* [77] and *Pasteurella multocida* [78] have been documented. It has also been reported zoonotic transmission through this route for other pathogens as gastric *Helicobacter* spp. [79] and periodontal pathogens [80].

Besides the risk factors mentioned above, more than 70% of the respondents admitted that their pets had free access to the interior of the house, and they could roam indoors. Some participants reported household husbandry practices that increase zoonotic disease risk, such as allowing their pets to eat or lick their dishes; washing pet food containers with other dishes; allowing their pets to be in contact with potentially disease-carrying animals. Other studies reported these practices, but also high-risk habits, such as feed their animals with raw meat, eggs and animal product treats; wash their pets in the kitchen sink; remove pet's feces from the garden/backyard/litter box weekly or less often [50,68,81]. In Portugal, 10.1% of pets are fed homemade or with alternative diets, which are often nutritionally unbalance [68]. Furthermore, raw animal products in pet diets are a well-established risk factor for salmonellosis in dogs [50,81–83], cats [83–85] and humans. Although human salmonellosis results mostly from handling or consuming contaminated food products, it can occur due to contact with companion animals, natural pet treats and biological waste from pets consuming raw diets [82,86–88]. Moreover, reports of raw meat pet

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food containing other zoonotic foodborne bacteria as *Escherichia coli* and *Listeria monocytogenes* are increasing [88,89]. Pet owners can reduce this public health risk by not feeding natural pet treats and raw food diets to their pets [87,88]. It should also be noted that reptiles are becoming increasingly popular as pets and they are reservoirs of a wide variety of *Salmonella* serotypes [56]. High prevalence of *Salmonella* shedding by healthy reptiles and high incidence of human salmonellosis attributed to contact with reptiles have been described, especially among children younger than 5 years old [56,90–94]. Therefore, safe reptile handling recommendations must be conveyed to pet owners by physicians, veterinarians, public health professionals and industry officials through conversations, educational materials and interventions [50,56,92].

Overall, more than 90% of the respondents took their pets to the veterinarian, with the most common reasons being for vaccination, antiparasitic preventive treatment or health-issues. The same scenario was reported in other studies [3,50,68,95,96]. It is worthy to note that this study did not explore the association between demographics, animal's characteristics, and socioeconomic factors.

Most participants declared that their pets were subjected, per year, to 2 to 4 preventive treatments for gastrointestinal parasites and external parasites. A study developed in Portugal by Prata [68] showed equivalent results as well as highlighted that a considerable number of participants stated that their pets were submitted to antiparasitic preventive treatment once a year. Also, Pereira et al. [53] reported similar results concerning deworming practices by Portuguese pet owners. Contrarily, Matos et al. [51] showed a considerable high percentage of monthly ectoparasite

treatment (dogs: 50.5%; cats: 17.2%). Pereira et al. [53] assumed that this difference may be due to the population sampled or possible bias caused by face-to-face survey. However, the present study was based on face-to-face questionnaire and the same result was not obtained.

Pet-human contact is frequent, but the occurrence of pet-associated disease is low overall [16]. For most people, such contact does not translate into a high health risk situation [50]. However, there are more vulnerable individuals, who can get ill after infection, such as immunocompromised people (HIV/AIDS patients; people subjected to transplants; oncology patients receiving chemotherapy; post-splenectomy patients; chronically ill people, such as diabetes patients), children (< 5years), elderly people (> 65years) and pregnant women [9,28]. Additionally, they may have more severe complications and symptoms with longer duration [50]. In this study, the presence of high-risk individuals in the households was not determined. It was only intended to assess the participants' perception of the existence of high-risk groups. Although most respondents considered that there are people more vulnerable regarding zoonotic diseases, it is alarming that, for each risk group presented, 30-40% of respondents did not consider them more likely to develop severe clinical condition after infection. This result is in line with the lack of knowledge found about zoonoses in this study and others [16,50,97].

Younger children are recognized by their hand-to-mouth behavior. Additionally, children and people with some developmental disabilities are more prone to poor hygiene care or higher risk contact with animals, which make them particularly exposed to infection [9,97,98]. There are also situations where risk groups intersect,

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such as children with cancer or children with diabetes. A study developed by Stull et al. [97] reported that most households with immunocompromised children or children with diabetes acquired a new pet considered high-risk for infectious disease (reptiles or amphibians, rodents and exotic species). Moreover, interactions between parents and physicians/staff members about pet ownership or zoonotic disease information were generally uncommon [97]. It is supposed that households with higher risk individuals are aware of pet-associated diseases. Overall, medical staff, but also veterinarians, must guide patients/clients in pet selection, preventive measures (such as hand hygiene) and changes in animal contact to reduce health risks [97].

When questioned about the possibility of disease transmission from animals to humans, more than half (64.6%) of the pet owners in the present study answered affirmatively. However, given a list of possible pathways of transmission, it was found that participants rarely chose all options, which proves some lack of knowledge on the topic. It was encouraging to note that most of the respondents were aware that feces, arthropods and blood were important means for transmitting zoonotic diseases. Nonetheless, it was worrying to realize that only less than half were conscious about physical contact (scratches and bites), food route (raw meat, raw eggs, etc.) and fur as potential transmission pathways. It was mentioned above how raw meat and close physical contact between owners and pets (sleeping with pets, allowing pets to lick the face or wounds, bite accidents, scratches) impose animal and public health risks. In relation to fur, both dogs and cats regularly lick the anus and thereafter the fur, increasing the odds of Enterobacteriaceae on their fur or footpads [9]. The prevalence of infectious embryonated eggs of *Toxocara* spp. on dog's fur is low, however it should not be neglected [99]. A survey conducted to Overgaauw et al. [76] reported

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that in 12% and 3% of investigated dogs and cats, respectively, *Toxocara* eggs were found in fur, but not in feces. These results prove that the presence of eggs in fur is not always due to self-contamination. The significantly higher prevalence in dogs compared to cats may be due to their behavior: dogs tend to have greater soil contact (rolling around in the grass, digging, etc.), while cats have extreme grooming habits that lead to the removal of possible existing eggs [76].

Contrarily to Steele and Mor [28] , which reported that 63.9% of pet owners were not concerned, about 56% of respondents in the present study admitted being worried about the possibility of their pet contracting and transmitting a zoonotic disease.

Furthermore, few (4%) in the present study reported that their animals contracted zoonotic diseases in the past. The same answer was obtained when asked about themselves (2.6%). These results are similar to a Canadian study in which 4% of households reported getting a disease from their pet [16], and to the Australian study developed by Steele and Mor [28], in which only 2.5% of the respondents reported having caught a disease from their pet. Given the high lack of knowledge about zoonotic diseases by a considerable portion of respondents, it is expectable that this result was underestimated. Moreover, it is possible that respondents were not comfortable enough to admit it.

Routine preventive veterinary care and husbandry practices are important to reduce zoonotic diseases [50,98]. When questioned about their knowledge of measures to prevent zoonotic diseases, half of the respondents in the present study considered they had some qualifications. Furthermore, the vast majority rated all preventive measures

mentioned at their higher level. However, the other half of participants admitted not having enough knowledge to determine their importance, which is worrying and alarming. This result, once again, proves the need to inform general public about zoonoses and all their branches. Collective effort of all competent entities is essential to, once and for all, educate people and consequently keep them and their pets safe.

Some studies [16,28,50,51,54,97] reported practices performed by participants to reduce the risk of infection and spread of zoonotic diseases. However, in the present study, the respondents were not asked about their actions towards the goal mentioned above, but about the importance they attributed to each measure, so a direct comparison of the results is not feasible. Nonetheless, the importance of hand washing was unanimous.

The aim of this study was to gather information on pet owners from the North of Portugal. The survey was conducted with a convenience sample and estimated proportions may not be representative of all pet owners from the North of Portugal. The higher response proportion by females most likely relates to their willingness to participate in paper-and-pencil surveys [100].

In retrospect, the present study could have had questions about the existence of high-risk individuals in the households in order to understand whether this condition would interfere with knowledge and willingness to learn more about zoonotic diseases; open questions about preventive measures could have been performed to really look at what measures respondents apply on a daily basis; and, finally, owners could have been asked about specific common zoonoses rather than just being asked

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for the definition and some examples. In this way, it would be possible to verify in depth the knowledge of the participants about the zoonoses they had referred to.

Knowledge and practices may vary by species owned. However, since cats and dogs were owned by most of the pet owners (97.6%) and other species were seldom reported, the potential bias was minimal.

6. Conclusions

This study revealed lack of knowledge and understanding of zoonoses among Portuguese pet owners. Veterinarians and physicians must be proactive in their public health responsibilities, implementing the One Health concept and strengthening communication between both professions as well as with their clients/patients. Different ways should be used to draw people's attention to the topic of zoonoses and their prevention. Addressing the subject during consultations is essential, but not completely effective. Free online educational programs, audiovisual presentations and flyers can promote better educational ways for people with different ages, academic backgrounds, and willingness to listen and assimilate the information provided. These educational means must contain information about the most common zoonoses, transmission pathways, risk behaviors and preventive measures (promoting routine hygiene practices, such as hand washing, cleaning up dog feces or removing feces from cat litter daily, not feeding their animals with raw meat and eggs, encouraging the vaccination, and deworming of their pets, etc.) and high-risk groups (children, elderly, pregnant women and immunocompromised people). Students from medical and veterinary school should be presented to the One Health concept since the beginning of their career, improve their education about the current risks of zoonotic

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diseases, foster their team spirit as well as collaboration and interprofessional dialogue. From the scientific point-of-view, more questionnaires, pilot-studies, cross-sectional studies should be developed to frequently update the progress made. All the measures mentioned above are efforts that must be taken to disseminate knowledge and, consequently, reduce public's pet-associated disease risks.

Author Contributions

BV, ACC and LC participated in the study concept, design and questionnaire development. BV administered questionnaires to participants. BV and ACC were responsible for data analysis and data interpretation. BV performed the literature research and wrote the manuscript. APL, MCF and MS critically reviewed the manuscript. LC and ACC supervised and critically reviewed the manuscript. All authors read and approved the final manuscript.

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Institutional Review Board Statement

The study received ethical approval from the Ethics Commission of University of Trás-os-Montes e Alto Douro (No. Doc55-CE-2019).

Informed Consent Statement

All the participants signed a written informed consent form.

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Conflict of Interest Statement

The authors declare no conflicts of interest.

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