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ENTEROPARASITES IN A POPULATION IN DEPRIVED CONDITIONS FROM PROVINCE OF VALENCIA (SPAIN)

Carla Muñoz-Antoli, Rafael Toledo, and J. Guillermo Esteban

Departamento Farmacia y Tecnología farmacéutica y Parasitología, Área Parasitología, Facultad Farmacia, Universidad Valencia, 46100 Burjassot-Valencia, Spain.

Correspondence should be sent to Carla Muñoz-Antoli (https://orcid.org/0000-0003-1778-4297) at: *carla.munoz@uv.es*

KEY WORDS

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ABSTRACT

The autonomous Valencian Community (Spain) has experienced intense population growth with economic difficulties or deprivation in basic goods, ranking as the sixth Spanish autonomous region with the highest percentage of a population at risk of poverty or social exclusion. The objective of this work is to assess the level of enteroparasites in a Valencian population that meets certain deprivation conditions. A coproparasitological analysis was carried out in 460 users (children and adult relatives) of the 3 Casa Caridad schools in the province of Valencia. The parasite prevalence reached 31.7%, with a higher frequency of pathogens/potentially pathogenic species (66.4%) than non-pathogenic species (33.5%), although symptoms only appeared in 10.3% of those with pathogens/potentially pathogenic species. Of those parasitized, the presence of pathogens/potentially pathogenic species reached 20.6% in individuals living in crowded conditions and 17.5% in those living with pets. Presenting pathogens/potentially pathogenic species infection increased almost fourfold in those of southern European origin. In family groups, infection occurred among all their members, showing interpersonal parasitic transmission linked to both material deprivation and a lack of health education. Improving epidemiological surveillance, health education, and hygiene/sanitation facilities is essential to reduce or eliminate parasitic transmission among those who suffer from certain deprivation conditions.

Before the COVID-19 crisis, 21.5% of Spanish families were at risk of poverty at the national level (EAPN, 2019). According to the Spanish National Statistics Institute (INE, 2019), in 2019 the percentage of the population at risk of poverty or social exclusion (AROPE rate) stood at 27% in the Valencian Community, ranking it as the sixth Spanish autonomous region with the highest percentage above the national average. The population at risk of poverty, i.e., presenting either deprivation or material deficiencies, and/or with low intensity of employment, is considered when measuring the social exclusion of a population. Thus, the main profiles of social exclusion would be inhabitants of marginal neighborhoods and depressed rural areas, children in poor and unstructured families, illegal immigrants, refugees and asylum seekers, single immigrant women, gypsy population, and families with children whose adults are unemployed or work in precarious conditions.

Conditions of social exclusion and poverty are considered determining and critical factors that impact the health of individuals and populations (Morales-Espinoza et al., 2003; Harhay et al., 2010; Abbaszadeh Afshar et al., 2020; Sitotaw and Shiferaw, 2020) for not having access to quality health care or good housing, or safe food, thus increasing their vulnerability to diseases. To our knowledge, there is hitherto no study available on the distribution of intestinal parasitic infections in a deprived Spanish population.

The purpose of this research was to determine the level of enteroparasites present in a Valencian population that met these deprivation conditions as a valuable contribution for health authorities and policymakers to implement action plans against poverty, framed in the first of the Sustainable Development Goals, "No poverty," set by the United Nations (A/RES/71/313, 2017).

MATERIALS AND METHODS

Study area and population analyzed

The Valencian Association of Charity (known as Casa Caridad) is a private and independent, non-profit institution without political or religious connotation, declared of public utility by the Spanish Council of Ministers, which has been providing assistance for more than 100 yr. Casa Caridad operates 3 Early Childhood Education centers (Paseo Pechina-Valencia, Obra Social La Caixa-Benicalap, Santa Lucia-Torrente) that serve more than 150 children 1–3 yr-of-age daily. Parallel to the

Table I. Demographic characteristics of participants.

	Volunteers	Children	Adults
Total	460	288	172
Female	254	137	117
Male	206	150	56
Median age value	7 yr	3 yr	35 yr
Age range	1–68 yr	1–17 yr	19–68 yr

educational and pedagogical work with the attendees in those schools, thanks to the "Family School" program an intervention is carried out with the whole families so that the needs, deficiencies, and problems are addressed as well as work habits and routines. The aim is to improve the quality of life of families, promote their social integration, and facilitate their access to work.

During the 5 yr (2015–2019) that the coproparasitological study was offered among the users (children and adult relatives) of the 3 Casa Caridad schools, a population of 719 individuals was reached, of whom a total of 460 volunteers signed informed consent for participation (participation rate 63.9%). Table I characterizes the participants. The volunteers constituted a total of 130 family groups; 41 groups from South European countries, 22 from South American countries, and 67 from African countries.

Parasitological analysis

One stool sample was collected from each of the 460 participants in an empty plastic container with a lid. Samples received were fixed in 10% formalin solution (1:3) for 24 hr and transported to the Laboratory of Parasitology of the University of Valencia (Valencia, Spain) for analysis. These samples were processed by wet mount and by a sedimentation/concentration Ritchie technique. One aliquot of sediment obtained with the concentration technique was stained using a modified Ziehl-Neelsen technique for the detection of coccidian protozoa. In addition, 1 Graham tape test was also collected from each of the 460 participants for the detection of *Enterobius vermicularis* eggs. The Ritchie technique and the Graham tape test results were used to obtain prevalence data. In positive cases of pathogens, a medical appointment for the administration of the corresponding treatment was made.

Epidemiological analysis

An open descriptive questionnaire of basic demographic data (age, sex, nationality) and a closed dichotomous descriptive questionnaire of clinical data (intestinal symptoms, presence of disease, drug treatment) and socioeconomic data (work/occupation, type of accommodation, single parents, living with pets) were collected from all participants together with the fecal material. We considered that a comprehensive examination of a single stool specimen is adequate to rule out parasitic infection (Branda et al., 2006).

Statistical analysis

The epidemiological study design was observational, descriptive, analytical, and cross-sectional. Statistical analysis was performed with the STATA 12 software (StataCorp, College Station, Texas). Proportions were compared by using a chi-square test. Associations of variables with the total parasitized were obtained. Observed differences in data were considered significant if the *P*-value was below 0.05.

Table II. Prevalence of total, pathogen/potentially pathogenic and non-pathogenic species observed among population studied (IS = with intestinal symptoms; N = total volunteers; NIS = asymptomatic; n = number of parasitized; % = prevalence; CI = confidence interval).

	N = 460				
	IS	NIS	n	%	CI 95%
Total parasitized	50	96	146	31.7	27.6–36.1
Pathogen/potentially pathogenic species					
Entamoeba complex	0	3	3	0.6	0.2–1.8
Giardia intestinalis	6	7	13	2.8	1.6–4.7
Blastocystis sp.	10	68	78	17	13.7–20.6
Dientamoeba fragilis	0	10	10	2.2	1.1–3.8
Enterobius vermicularis	0	15	15	3.3	1.9–5.2
Trichuris trichiura	0	1	1	0.2	0.01–1.1
Non-pathogenic species					
Endolimax nana	40	9	49	10.7	8.0–13.7
Entamoeba coli	12	6	18	3.9	2.4–6.0
Entamoeba hartmani	6	9	15	3.3	1.9–5.2
Iodamoeba bütchlii	2	0	2	0.4	0.1–1.4

Ethics statements

Only those who submitted a consent form signed by themselves or by their parents or guardians participated in the study. The study involving human participants was reviewed and approved by the Experimental Research Commission on Ethics from the University of Valencia (ref. H20190402150539).

RESULTS

A total parasite prevalence of 31.7% (146/460) was obtained. It is noteworthy that the prevalence of parasites corresponding to the adult population (36%; 62/172) was higher than in children (29.2%; 84/288), but without statistically significant differences, and the female population prevalence (31.9%; 81/254) was similar to that in males (31.6%; 65/206) (Fig. 1).

Pathogens/potentially pathogenic species appeared more frequently than non-pathogens in the total population, children, and female population, with statistically significant differences (*P*-value = 0.024, 0.002, and 0.009), respectively (Fig. 2). Likewise, non-pathogens appeared more frequently in adults than in children with statistically significant differences (*P*-value = 0.033). However, pathogens/potentially pathogenic species were not significantly different by age or sex (Fig. 2).

Prevalence of infection by pathogens/potentially pathogenic species and non-pathogens and the distribution of parasitization according to the presence (34.2%; 50/146) or absence of intestinal symptoms (65.8%; 96/146) is shown in Table II. Among pathogens/potentially pathogenic species, *Blastocystis* sp. reached the highest prevalence (17%; 78/460) in the total population studied, i.e., in adult (20.3%; 35/172), children (13.5%; 39/288),

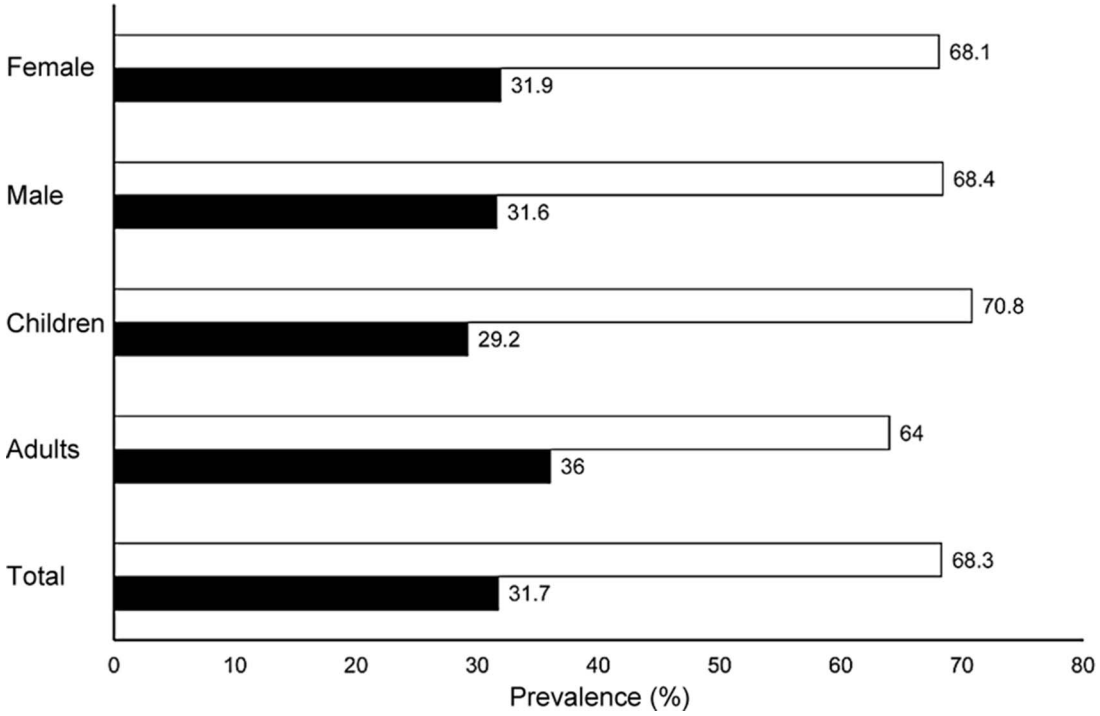

Figure 1. Prevalence distribution of parasitized (black) and non-parasitized (white) individuals in the total population studied and categorized by age and sex.

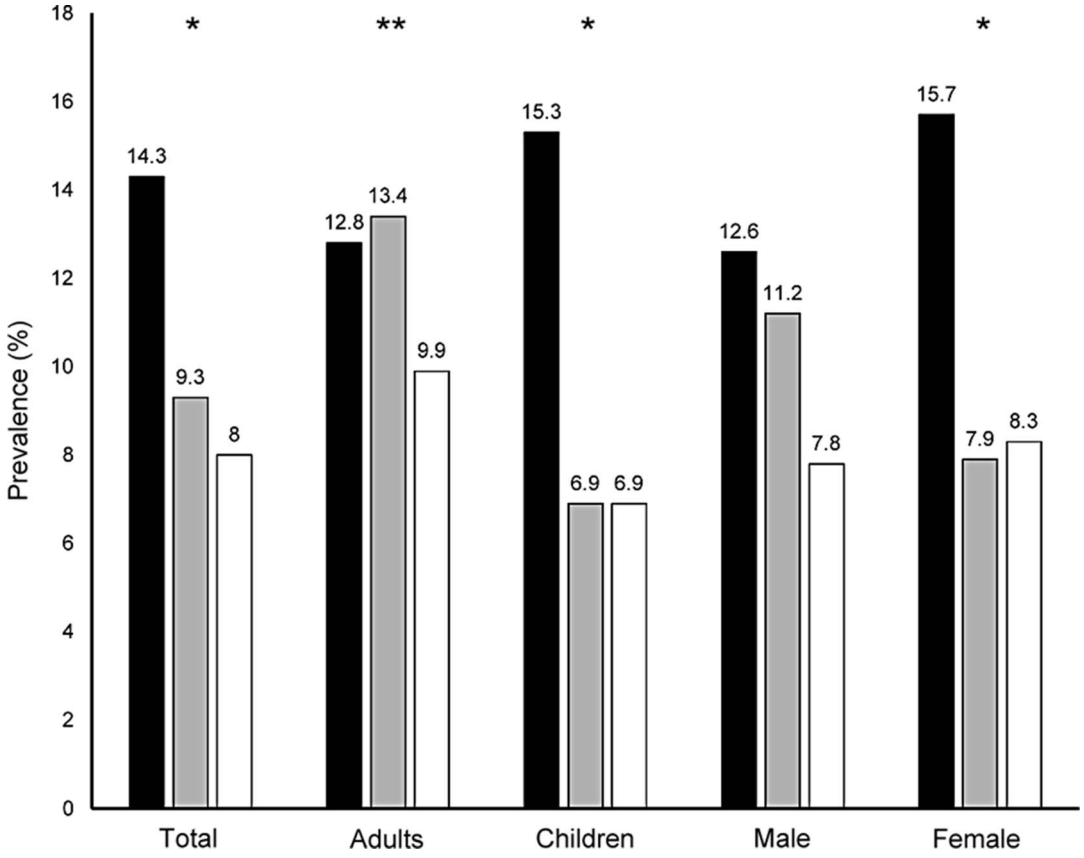

Figure 2. Prevalence distribution of only pathogen/potentially pathogenic species (black), only non-pathogenic species (grey), and both pathogenic/potentially pathogenic species and non-pathogenic species (white) in the total population studied and categorized by age and sex (*$P < 0.05$ only pathogen/potentially pathogenic vs. only non-pathogenic species; ** $P < 0.05$ by age in only non-pathogens).

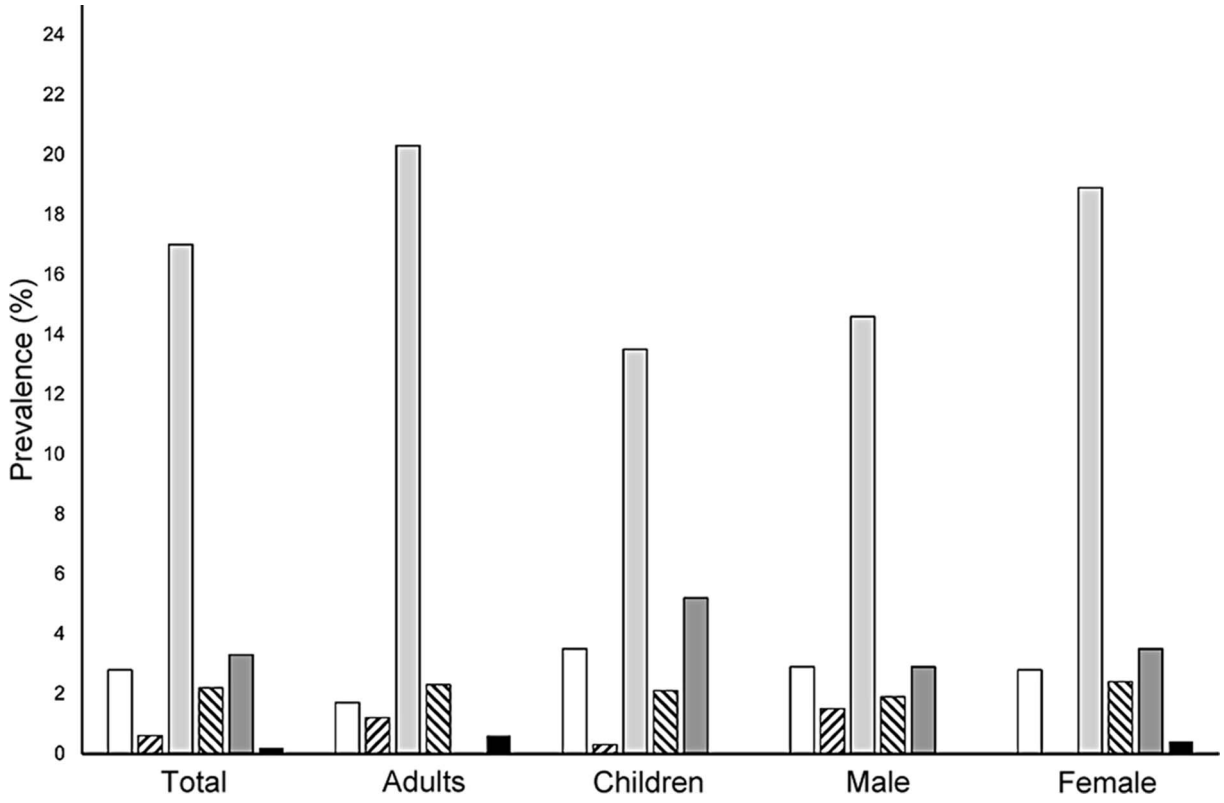

Figure 3. Prevalence distribution of different pathogen/potentially pathogenic species (protozoa and helminths) detected in the total population studied and categorized by age and sex. (*Giardia intestinalis*, white; *Entamoeba* complex, right slash; *Blastocystis* sp., light gray; *Dientamoeba fragilis*, left slash; *Enterobius vermicularis*, dark gray; *Trichuris trichuria*, black.)

female (18.9%; 48/254), and male (14.6%; 30/206) populations (Fig. 3).

Intestinal symptoms (26.3%; 121/460) and unemployment/precarious employment (43.5%; 200/460) were both related to parasitization in a statistically significant manner (P-value = 0.011 and <0.0000001, respectively). Moreover, intestinal symptoms (pain and/or diarrhea) nearly doubled in those parasitized (1.78; 1.52–2.74) (P-value = 0.011).

Among those parasitized, the frequency of infection by at least 1 pathogen/potentially pathogenic species (66.4%; 97/146) was higher than that by non-pathogens only (33.5%; 49/146), with statistically significant differences (P-value <0.0000001). Table III shows intestinal symptoms to be more frequent in those parasitized by non-pathogenic species (81.6%; 40/49) than in those parasitized by pathogens (10.3%; 10/97), with statistically significant differences (P- value <0.0000001). No significant variables associated with parasitization have been found (Table III), although 20.6% (20/97) of those living in conditions of overcrowding and 17.5% (17/97) of those who live with pets appeared parasitized by pathogen/potentially pathogenic species.

Parasitized individuals in the survey came from Africa (54.8%; 80/146), southern Europe (22.6%; 33/146), and South America (22.6%; 33/146). The highest frequency of infection by pathogens/potentially pathogenic species (47.4%; 46/97) and non-pathogens (69.4%; 34/49) occurred among Africans, while among southern Europeans infection by pathogens/potentially pathogenic species (28.9%; 28/97) was predominant. Presenting pathogens/potentially pathogenic species infection increased in those of southern European origin (P-value = 0.019). In South Americans, infection by pathogens/potentially pathogenic species (23.7%; 23/97) and by non-pathogens (20.4%; 10/49) was similar (Fig. 4).

Concerning the family groups analyzed, the prevalence reached 60.0% (78/130), with a higher frequency of pathogens/potentially pathogenic species (78.2%; 61/78) than non-pathogens (21.8%; 17/78) (P-value <0.0000001).

Up to 18 different geographical origins were analyzed. The highest number of parasitized family groups (51.3%; 40/78) came from Africa, followed by southern Europe (26.9%; 21/78) and South America (21.7%; 17/78). After those from Nigeria (28.2%; 22/78), parasitized family groups from Spain exceeded those from other countries considered endemic in parasites (17.9%; 14/78) (Table IV).

DISCUSSION

In developed countries, there are certain public health infrastructures (safe drinking water, sanitary facilities, health education, etc.) that prevent a generally high prevalence of enteroparasites (Morales-Espinoza et al., 2003; Abbaszadeh Afshar et al., 2020). However, there are still populations in developed countries that are susceptible to presenting high prevalences of intestinal parasites (Hotez and Gurwith, 2011; Masucci et al., 2011; Ali et al., 2014; Ojha et al., 2014; Azcona-Gutiérrez et al., 2017). It is assumed that culture and poverty influence knowledge, behavior, and preventive measures con-

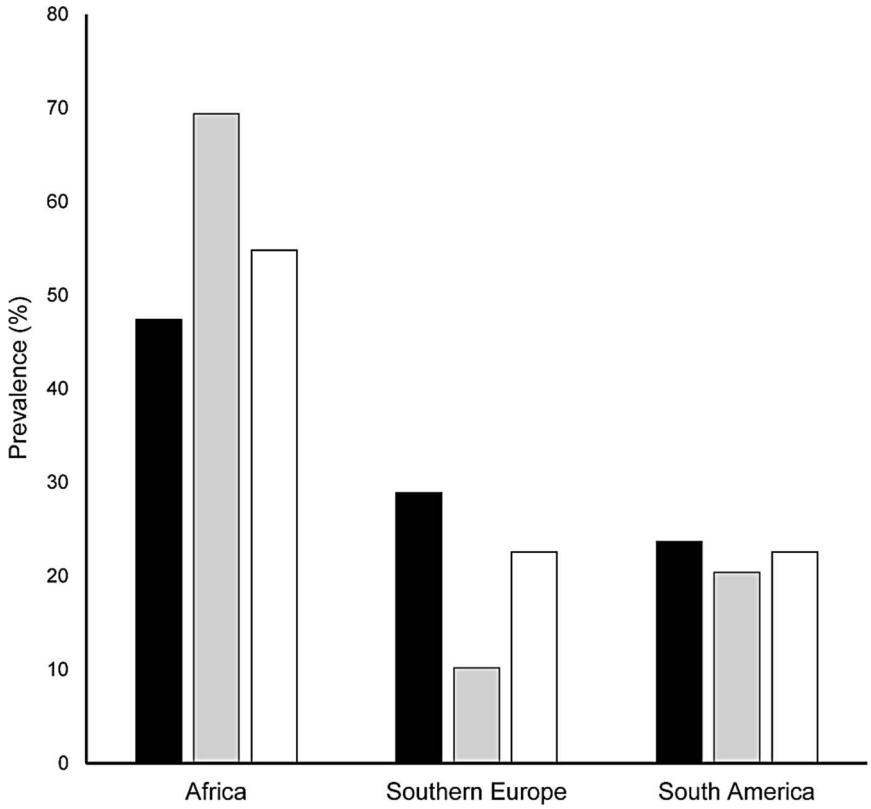

Figure 4. Prevalence of parasitized individuals (grey) and frequency of pathogen/ potentially pathogenic species (black) and non-pathogenic species (white) detected, according to geographical origin.

Table III. Distribution of variables among total parasitized, those with pathogen/potentially pathogenic species and those with non-pathogenic species (n = number of parasitized; % = frequency; CI = confidence interval; — = not applicable).

	Pathogen/potentially pathogenic (N = 97)			Non-pathogenic species (N = 49)			Parasitized (N = 146)			
Variables	n	%	CI 95%	n	%	CI 95%	n	%	CI 95%	*P*-value
Intestinal symptoms										
Yes	10	10.3	5.4–17.6	40	81.6	68.9–90.7	50	34.2	26.9–42.2	<0.0000001
No	87	89.7	82.4–94.6	9	18.4	9.3–31.0	96	65.8	57.8–73.1	—
Age										
Children	61	62.9	52.9–72.1	23	46.9	33.3–60.9	84	57.5	49.4–65.4	0.096
Adults	36	37.1	27.9–47.0	26	53.1	39.1–67.5	62	42.5	34.6–50.6	—
Sex										
Male	39	40.2	30.8–50.2	25	51	37.2–64.8	64	43.8	35.9–51.9	0.287
Female	58	59.8	49.8–69.2	24	48.9	35.2–62.8	82	56.1	48.0–64.1	—
Crowded										
Yes	20	20.6	13.4–29.5	8	16.3	7.9–28.7	28	19.2	13.4–26.2	0.689
No	77	79.4	70.5–86.6	41	83.7	71.3–92.1	118	80.8	73.8–86.6	—
Pets										
Yes	17	17.5	10.9–26.1	7	14.3	6.5–26.2	24	16.4	11.1–23.1	0.793
No	80	82.5	73.9–89.1	42	85.7	73.8–93.5	122	83.6	76.9–88.9	—
Single parent										
Yes	38	39.2	29.8–49.1	20	40.8	27.8–54.9	58	39.7	32.0–47.8	0.99
No	59	60.8	50.9–70.2	29	59.2	45.1–72.2	88	60.3	52.2–67.9	—
Occupation										
Unemployment/unstable	82	84.5	76.3–90.7	45	91.8	81.5–97.4	127	86.9	80.8–91.7	0.328
Stable/independent	15	15.5	9.3–23.7	4	8.2	2.6–18.5	19	13	8.3–19.2	—

Table IV. Distribution of 78 parasitized family groups according to the geographical origin (n = number of parasitized/N = total family groups studied; % per country = parasitized families from each country; frequency = % parasitized among the total parasitized families; CI 95% = confidence interval 95%; — = not applicable).

		78 Parasitized family groups			
Continent/Country	n/N	%/Country	Frequency	CI 95%	*P*-value
Europe	21/41	51.2	26.9	17.9–37.6	0.067
Spain	14/33	42.4	17.9	10.6–27.6	—
Romania	5/6	83.3	6.4	2.4–13.6	—
Italy	2/2	100	5.6	0.4–8.2	—
South America	17/22	77.3	21.7	13.7–31.9	0.42
Bolivia	7/9	77.8	8.9	4.0–16.9	—
Ecuador	3/4	75	3.8	1.0–10.1	—
Argentina	2/2	100	5.6	0.4–8.2	—
Venezuela	2/2	100	5.6	0.4–8.2	—
Honduras	2/2	100	5.6	0.4–8.2	—
Colombia	1/2	50	1.3	0.1–6.2	—
Chile	0/1	—	—	—	—
Africa	40/67	59.7	51.3	40.2–62.2	0.725
Nigeria	22/39	56.4	28.2	19.1–38.9	—
Morocco	6/10	60	7.8	3.2–15.3	—
Equatorial Guinea	6/7	85.7	7.8	3.2–15.3	—
Mali	2/5	40	5.6	0.4–8.2	—
Algeria	1/2	50	1.3	0.1–6.2	—
Somalia	1/1	100	1.3	0.1–6.2	—
Senegal	1/2	50	1.3	0.1–6.2	—
Cameroon	1/1	100	1.3	0.1–6.2	—

cerning parasitic transmission (Morales- Espinoza et al., 2003; Abbaszadeh Afshar et al., 2020). Among the Valencian population in deprived conditions, the prevalence of enteroparasites, detected by traditional diagnostic methods, exceeds 30%, similar to that found in a study of Belda et al. (2008) in Valencian schoolchildren (26.7%) and much higher than that reported in a study by González-Moreno et al. (2011) in the Catalan population (13.7%). At the European level, Kosovar schoolchildren present parasitic prevalences (19.1%) higher than Serbs (4.2%) (Korzeniewski et al., 2020). In countries like Italy, using both traditional and molecular diagnostic methods, the prevalence reaches 16.6% both in the native and immigrant populations (Calderaro et al., 2014). Worldwide, the results found among the Valencian population studied are similar to those of Amin (2002) who detected a parasitization rate of 32% among the U.S. American population affected by deprivation or 54.2% in the Peruvian population in precarious conditions (Zuta Arriola et al., 2019).

Blastocystis sp. (17%) is the most prevalent potentially pathogenic species detected, similar to a previous work carried out in Spain (Muadica et al., 2020). However, the prevalence detected for *Giardia intestinalis* (2.8%) is lower than that previously reported in Valencian schoolchildren (4.3%) (Belda et al., 2008) and in schoolchildren from Madrid (17.4%) found by molecular diagnosis (Muadica et al., 2020). *Enterobius vermicularis* prevalence (3.3%) is lower than in a previous study in Valencia (9.6%) (Belda et al., 2008) and in other works undertaken in Spain such as in southern Gran Canaria (11.4%) (Carrillo-Quintero et al., 2016), in Castellón (21.5%) (Catalán et al., 1992), in Seville (20.44%) (Pérez Armengol et al., 1997), and in Gran Canaria (36.7%) (Novo Veleiro et al., 2012), although the age range of the population studied in the present study is much wider because it does not focus exclusively on schoolchildren.

Blastocystis sp. pathogenicity (including diarrhea, abdominal pain, nausea, anorexia, vomiting, weight loss, and flatulence) is still debatable and molecular-based studies reported contradictory results. In vitro studies have been carried out associating *Blastocystis* sp. with colorectal cancer (Ajjampur and Tan, 2016; Kumarasamy et al., 2017). Those parasitized with *G. intestinalis*, though asymptomatic infections appear to be very common, present symptoms such as diarrhea, cramps, nausea, intestinal malabsorption, and reduction in brush-border dissacharidases. Recent work has shown that irritable bowel syndrome (IBS) and chronic fatigue syndrome (CFS) develop years after this parasite has been eliminated (Fink and Singer, 2017; Hanevik et al., 2017). Contrary to what was expected, in our study intestinal symptoms resulted more often in people colonized by non-pathogen parasites, although symptoms of bacterial or viral indole cannot be ruled out. Among those harboring pathogens/potentially pathogenic species, only 10.3% presented intestinal symptoms, which means that general daily activities remain unaltered or unmodified, which causes the correct treatment not to be applied and, consequently, the increase in possible new transmissions is facilitated. Moreover, this increase in transmissions could be enhanced in situations of crowding, as occurs in large families, facilitating interpersonal parasitic transmission. In our study, there is a positive but not significant association between crowded conditions and parasitization, detecting the same parasite species in other parasitized family members. The association between crowded living conditions and polyparasitism (Harhay et al., 2010) showed that the larger the family nucleus, the higher the prevalence of parasitism. In this work, the presence of pathogens/potentially pathogenic species is detected in 20.6% of people who live in crowded conditions. In the previous work by Belda et al. (2008), sleeping in the same room with a sibling is also cited as a risk factor of infection. Moreover, we found a positive, but not significant, association between pathogens/potentially pathogenic species in those who live with pets, although zoonotic transmission seems to be infrequent in developed countries (Lucio et al., 2017).

In other industrialized countries of North America and Europe, parasitic infections are most prevalent within immigrant and refugee communities linked to precarious conditions (Harhay et al., 2010), which can cause problems of social exclusion in host societies. However, in this work, presenting pathogens/potentially pathogenic species infection was more prevalent in autochthonous Spanish families.

The study has some limitations: 1 stool sample per participant, and the lack of the application of molecular diagnostic techniques, might bias the prevalence data reported (no diarrhea-causing pathogens of viral or bacterial origin were investigated); and no control group was included for comparison of results. However, our study can be used to improve epidemiological surveillance, health education, and hygiene/sanitation (i.e., including health personnel in social care centers to apply parasite diagnostic techniques routinely) to eliminate parasitic transmission among those who suffer from deprivation conditions.

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