

# Prevalence of parasitosis in children aged 1 to 7 years in vulnerable condition in the South Central Region of Costa Rica

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## Abstract

**Objective:** to determine the prevalence of parasitosis in children in Costa Rica and its association with socioeconomic factors.

**Methods:** We conducted a cross-sectional study to assess the prevalence of intestinal parasites and commensals in children aged 1-7 years old, from 13 centers with two types of food distribution programs. We administered a structured questionnaire, which included some questions from the 2014 Costa Rican National Home Survey, to most of the parents who consented for their children to participate in the study (n=2435 out of 2514). We collected stool samples from children (n=1368; 54,0%) and then analyzed them using a direct smear and Kato assembly. Odds ratios (OR) and chi-square tests were calculated and a binary logistic regression model was fitted to assess the associations between socioeconomic characteristics of the children's families and the probability of having an intestinal parasitic infection.

**Results:** The prevalence of commensal protozoans, pathogenic protozoans, helminthes, or a combination of them (referred to henceforth as CPH) was 24.1% (95% CI: 21.9-26.4), whereas prevalences of pathogenic parasites and helmithiasis were 8.5% (95% CI: 7.5-10.5) and 0.7% (95% CI: 0.1-1.5), respectively. The most prevalent pathogenic parasite was *Giardia intestinalis* (8.0%), the most frequent commensal protozoan was *Endolimax nana* (7.7%), and the most prevalent helminth was *Ascaris lumbricoides* (0.4%). There were no significant differences in the prevalence of CPH or parasitosis by sex or nutritional program. The highest prevalences of CPH and parasitosis were observed in La Uruca (46.9% and 17.2%, respectively) and the lowest in Paso Ancho (7.7% and 0%, respectively). Being 5 years old or above, living in a house with walls made up of waste material or zinc, having a non-suitable house (i.e., indigenous housing, living in a small room inside a quaterly house, slums, mobile housing, pension, or convent), and having more than 4 family members were identified as risk factors for having a CPH.

**Conclusions:** The CPH prevalence found in this study was lower than the one observed in the Costa Rican National Nutritional Survey 2008-2009 (32.6%). However, this study shows that there are several permissive conditions that allow the transmission of intestinal parasites and that it is necessary to improve the preventive and treatment measures of intestinal parasites.

**Keywords:** Intestinal parasites, children, CEN-CINAI, Costa Rica.

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**Abbreviations:** CCP, Child Care and Protection Program; FFD, Family Food Distribution Program; ENC, Education and Nutrition Centers; CNCCC, Children's Nutrition and Comprehensive Care Centers; CPH, commensals, pathogens, helminths. It refers to stool samples in which commensal protozoa, pathogenic protozoa, helminths or a combination of the above are observed; NNS, National Nutrition Survey of Costa Rica; CI, confidence interval; OR, Odds Ratio.

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**Table 1A. Socio-economic characteristics, deworming and medical attention of parents and children participating in the study who completed the survey and collected fecal samples, beneficiaries of CCP, FFD or both programs of the Central South Region of Costa Rica, 2014-2016.**

| <b>Variables</b>   | <b>Category</b>                        | <b>Categories it contains</b>   | <b>Total<br/>n = 1301<br/>n (%)</b> | <b>CCP<br/>n = 820<br/>n (%)</b> | <b>CCP + FFD<br/>n = 80<br/>n (%)</b> | <b>FFD<br/>n = 401<br/>n (%)</b> |
|--|--|---|-------------------------------------|----------------------------------|---------------------------------------|----------------------------------|
| <b>Age of the child<br/>(n = 1368)</b>   | ≤5 years                               | 0 to 1 years  | 0 (0,0)                             | 0 (0,0)                          | 0 (0,0)                               | 0 (0,0)                          |
|  |  | > 1 to 2 years  | 21 (1.5)                            | 2 (0,2)                          | 0 (0,0)                               | 18 (4,4) 45                      |
|  |  | > 2 to 3 years  | 77 (5,6) 257                        | 26 (3,0)                         | 7 (8,1)                               | (11,0) 71                        |
|  |  | > 3 to 4 years  | (18,8) 414                          | 176 (20,1)                       | 10 (11,6)                             | (17,4) 108                       |
|  | >5 years                               | > 4 to 5 years  | (30,3) 380                          | 287 (32,8)                       | 19 (22,1)                             | (26,5)                           |
|  |  | > 5 to 6 years  | (27,8) 205                          | 248 (28,4)                       | 35 (40,7)                             | 96 (23,5)                        |
|  |  | > 6 to 7 years  | (15,0) 14                           | 132 (15,1)                       | 15 (17,5)                             | 58 (14,3)                        |
|  |  | > 7 to 8 years  | (1,0)                               | 3 (0,4)                          | 0 (0,0)                               | 12 (2,9)                         |
| <b>Sex of the child<br/>(n = 1368)</b>   | F                                      | Female  | 677 (49,5)                          | 413 (47,3)                       | 43 (50,0)                             | 221 (54,2)                       |
|  | M                                      | Male  | 691 (50,5)                          | 461 (52,7)                       | 43 (50,0)                             | 187 (45,8)                       |
| <b>Child took dewormers<br/>in the last year</b>   | Yes                                    | Yes   | 662 (50,9)                          | 412 (50,2)                       | 48 (60,0)                             | 202 (50,4)                       |
|  | No                                     | No  | 585 (45,0)                          | 375 (45,7)                       | 29 (36,3)                             | 181 (45,1)                       |
|  | DK/NR                                  | DK/NR   | 54 (4,1)                            | 33 (4,0)                         | 3 (3,7)                               | 18 (4,5)                         |
| <b>Child had diarrhea<br/>in the last 6 months</b>   | No                                     | No  | 547 (42,0)                          | 343 (41,8)                       | 36 (45,0)                             | 168 (41,9)                       |
|  | Yes                                    | Yes   | 716 (55,0)                          | 459 (56,0)                       | 43 (53,8)                             | 214 (53,4)                       |
|  | DK / NR                                | DK / NR   | 38 (3,0)                            | 18 (2,2)                         | 1 (1,3)                               | 19 (4,7)                         |
| <b>Year of the last<br/>medical appointment</b>  | ≤ 1 year                               | <1 year   | 1124(86,4)                          | 714 (87,1)                       | 64 (80,0)                             | 346 (86,3)                       |
|  | > 1 year                               | > 1 year  | 177 (13,6)                          | 106 (12,9)                       | 16 (20,0)                             | 55 (13,7)                        |
|  | DK/NR                                  | DK/NR   | 0 (0,0)                             | 0 (0,0)                          | 0 (0,0)                               | 0 (0,0)                          |
| <b>Age of parent<br/>or guardian</b>   | Intermediate                           | 21-50 years   | 1149 (88,3)                         | 723 (88,2)                       | 71 (88,8)                             | 355 (88,5)                       |
|  | Extreme                                | 15-20 and from 51 to 70   | 109 (8,4)                           | 69 (8,4)                         | 7 (8,7)                               | 33 (8,2)                         |
|  | DK/NR                                  | DK/NR   | 43 (3,3)                            | 28 (3,4)                         | 2 (2,5)                               | 13 (3,3)                         |
| <b>Last school year<br/>completed by the<br/>parent or guardian<br/>or lower</b>                                   | High school<br>or higher               | High school, college<br>and university  | 377 (29,0)                          | 290 (35,4)                       | 23 (28,7)                             | 64 (16,0)                        |
|  | Elementary<br>or preschool, elementary | No grade, kindergarten  | 896 (68,8)                          | 510 (62,2)                       | 53 (66,3)                             | 333 (83,0)                       |
|  | DK / NR                                | DK / NR   | 28 (2,2)                            | 20 (2,4)                         | 4 (5,0)                               | 4 (1,0)                          |
| <b>Last week the father<br/>helped in a business<br/>or family farm without<br/>payment, none of<br/>the above</b> | Yes                                    | He worked for an hour<br>or more; he did not work,<br>but he has a job  | 520 (40,0)                          | 389 (47,4)                       | 17 (21,2)                             | 114 (28,4)                       |
|  | No                                     | Helped in a family business or<br>business without payment;<br>none of the above  | 728 (56,0)                          | 390 (47,6)                       | 53 (66,3)                             | 285 (71,1)                       |
|  | DK/NR                                  | DK/NR   | 53 (4,0)                            | 41 (5,0)                         | 10 (12,5)                             | 2 (0,5)                          |
| <b>Activities carried out<br/>last week by the father<br/>or guardian</b>  | Various tasks                          | Farming work, raised or<br>fished, sold products,<br>looked after people, cleaned,<br>ironed for another home,<br>did various jobs. | 459 (35,3)                          | 324 (39,5)                       | 26 (32,5)                             | 109 (27,2)                       |
|  | None                                   | Did not perform<br>any of the above.  | 713 (54,8)                          | 417 (50,9)                       | 44 (55,0)                             | 252 (62,8)                       |
|  | DK / NR                                | DK/NR   | 129 (9,9)                           | 79 (9,6)                         | 10 (12,5)                             | 40 (10,0)                        |

Abbreviations: CCP: Child Care and Protection program; FFD: Family Food Distribution program; CCP + FFD children who belong to the CCP program and the FFD program simultaneously; DK/NR: do not know, no response

**Table 1B. Socioeconomic characteristics of the housing of the families of the children participating in the study who completed the survey and collected fecal samples, beneficiaries of CCP, FFD or both programs of the Central South Region of Costa Rica, 2014-2016.**

| <b>Variables</b>                          | <b>Category</b>         | <b>Categories it contains</b>   | <b>Total<br/>n = 1301<br/>n (%)</b> | <b>CCP<br/>n = 820<br/>n (%)</b> | <b>CCP + FFD<br/>n = 80<br/>n (%)</b> | <b>FFD<br/>n = 401<br/>n (%)</b> |
|---|-------------------------|---|-------------------------------------|----------------------------------|---------------------------------------|----------------------------------|
| <b>Type of housing<br/>(n = 1368)</b>     | Adequate                | Detached house, independent house in condominium, apartment building, apartment building in condominium | 1122 (86.3)                         | 729 (88.9)                       | 75 (93.7)                             | 318 (79.3)                       |
|   | Not adequate >5 years   | Traditional or indigenous housing, quarter in barracks, slum, mobile home or truck, convent or lodge    | 167 (12.9)                          | 83 (10.1)                        | 5 (6.3)                               | 79 (19.7)                        |
|   | DK/NR                   | DK/NR   | 12 (0.8)                            | 8 (1.0)                          | 0 (0.0)                               | 4 (1.0)                          |
| <b>Material of the walls of the house</b> | Adequate                | Block or brick, socket, wood, prefabricated or tiles, Fibrolit or Ricalit                               | 1104 (84.9)                         | 715 (87.2)                       | 72 (90.0)                             | 317 (79.1)                       |
|   | Not adequate Yes        | Natural fibers, waste material or tin   | 183 (14.1)                          | 97 (11.8)                        | 8 (10.0)                              | 78 (19.4)                        |
|   | DK/NR                   | DK/NR   | 14 (1.0)                            | 8 (1.0)                          | 0 (0.0)                               | 6 (1.5)                          |
| <b>Material of the roof of the house</b>  | <b>Adequate</b>         | Tin, Fibrolit, Ricalit or asbestos  | 1259 (96.8)                         | 796 (97.1)                       | 80 (100)                              | 383 (95.5)                       |
|   | Not adequate            | Natural material such as palm, straw, waste or waste material   | 24 (1.8)                            | 12 (1.5)                         | 0 (0.0)                               | 12 (3.0)                         |
|   | DK/NR                   | DK/NR   | 18 (1.4)                            | 12 (1.5)                         | 0 (0.0)                               | 6 (1.5)                          |
| <b>Floor of the house</b>                 | Adequate                | Ceramic, mosaic, terrazzo, cement, wood   | 1234 (94.9)                         | 782 (95.4)                       | 76 (95.0)                             | 376 (93.8)                       |
|   | Not adequate            | Dirt floor  | 51 (3.9)                            | 24 (2.9)                         | 4 (5.0)                               | 23 (5.7)                         |
|   | DK/NR                   | DK/NR   | 16 (1.2)                            | 14 (1.7)                         | 0 (0.0)                               | 2 (0.5)                          |
| <b>Family members under the same roof</b> | ≤ 4                     | ≤ 4 people  | 650 (50.0)                          | 423 (51.6)                       | 35 (43.8)                             | 192 (47.9)                       |
|   | > 4                     | > 4 people  | <b>631 (48.5)</b>                   | <b>385 (47.0)</b>                | <b>45 (56.3)</b>                      | <b>201 (50.1)</b>                |
|   | DK/NR                   | DK/NR   | 20 (1.5)                            | 12 (1.4)                         | 0 (0.0)                               | 8 (2.0)                          |
| <b>Water source of the house</b>          | Aqueduct                | ASADAS, CARR, city hall, AyA, company aqueduct or cooperative   | 1193 (91.7)                         | 765 (93.3)                       | 73 (91.2)                             | 355 (88.5)                       |
|   | No aqueduct             | Well, river, tanker or hydrant  | 28 (2.2)                            | 12 (1.5)                         | 2 (2.5)                               | 14 (3.5)                         |
|   | DK / NR                 | DK/NR   | 80 (6.1)                            | 43 (5.2)                         | 5 (6.3)                               | 32 (8.0)                         |
| <b>Piped water to the home</b>            | Yes                     | Yes   | 1267 (97.4)                         | 795 (97.0)                       | 75 (93.7)                             | 397 (99.0)                       |
|   | No                      | No  | 18 (1.4)                            | 14 (1.7)                         | 2 (2.5)                               | 2 (0.5)                          |
|   | DK / NR                 | DK/NR   | 16 (1.2)                            | 11 (1.3)                         | 3 (3.8)                               | 2 (0.5)                          |
| <b>Toilet connected to:</b>               | Sewerage or septic tank | Sanitary sewer and septic tank  | 1094 (84.1)                         | 685 (83.5)                       | 69 (86.3)                             | 340 (84.8)                       |
|   | Without connection      | Direct exit to irrigation ditch, ditch, river or estuary, is a pit of black well or sewer               | 70 (5.4)                            | 39 (4.8)                         | 2 (2.5)                               | 29 (7.2)                         |
|   | DK / NR                 | DK/NR   | 137 (10.5)                          | 96 (11.7)                        | 9 (11.2)                              | 32 (8.0)                         |

Abbreviations: CCP: Child Care and Protection program; FFD: Family Food Distribution program; CCP + FFD children who belong to the CCP program and the FFD program simultaneously; DK/NR: do not know, no response

Intestinal parasitosis is a major public health problem.<sup>1,2</sup> Currently between 20-30% of the Latin American population suffers from parasitosis.<sup>3</sup> However, given that the parasitosis can go unnoticed, it is possible that these prevalences are underestimates and that this disease is neglected because it is not considered a health problem.<sup>3</sup> For example, for 2007, it was estimated that approximately 3500 million people were affected by parasitic infections worldwide, but only clinical conditions were reported in 450 million people.<sup>4,5</sup>

In Costa Rica, as in other poor countries,<sup>6</sup> it has been identified that the groups most affected by intestinal parasitosis are children of preschool and school age, which is mainly due to their inadequate hygienic habits and the immaturity of their immune system.<sup>4,7,8,9</sup> The last National Nutrition Survey (NNS) conducted in Costa Rica in the years 2008-2009 (n = 227) identified that 8% of children aged 0-6 had pathogenic protozoa, 3% had helminths and 24% had showed commensal protozoa.<sup>1,10</sup> However, the findings of the Survey do not reflect the conditions of populations that could be more vulnerable to infection, such as children belonging to the Education and Nutrition Centers and Children's Nutrition and Comprehensive Care Centers (ENC-CNCCC) of the Ministry of health. The children who benefit from ENC-CNCCC programs come from families that live in poverty, suffer from severe or moderate malnutrition, have signs of some type of aggression, and are children of teenage mothers or poor pregnant or lactating women.<sup>11,12,13</sup> This child population is of great relevance, since parasitic diseases are especially prevalent in socially disadvantaged children,<sup>14</sup> and generate important sequelae in physical and cognitive development, even when children do not have symptoms of this disease.<sup>15</sup>

The ENC or CNCC establishments have different programs aimed at children. Undernourished, thin or infants with delayed growth are beneficiaries of the Family Food Distribution Program (FFD), an extramural program (i.e., the child does not stay in the ENC or CNCC establishments, only attends on specific dates for be heavy and measured, while their parents attend once a month to withdraw food for the family group).<sup>12,13</sup> Another of the programs offered by the ENC-CNCC establishments is the Child Care and Protection (CCP), of intramural modality, which offers education and daily feeding to children during the hours they remain in the Centers (ENC or CNCC).<sup>12,13</sup> Despite the entry criteria of children to be beneficiaries of CCP and FFD, the socioeconomic characteristics of these children can be diverse, depending on the specific center to which they belong and the conditions of each family;<sup>16</sup> it has been described that approximately 32% of children

benefiting from ENC-CNCC have a high socioeconomic status.<sup>17</sup>

The few studies conducted in children attending the ENC-CNCC in Costa Rica, have indicated the high prevalence of parasitosis in this population.<sup>18,19,20</sup> However, up-to-date information is not available, nor is it known how the different socioeconomic factors influence these parasitosis.<sup>18,19,20</sup> That is why the objectives of the study were to determine the prevalence of intestinal parasitosis in children benefiting from the Child Care and Protection (CCP) and Family Food Distribution (FFD) programs of the ENC-CNCC of the South Central Region, and identify the socioeconomic determinants of these parasitosis. It also sought to educate parents and those in charge of the centers in terms of prevention and monitoring of these diseases, and emphasize their appropriate approach to doctors who treat these diseases.

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## Materials and Methods

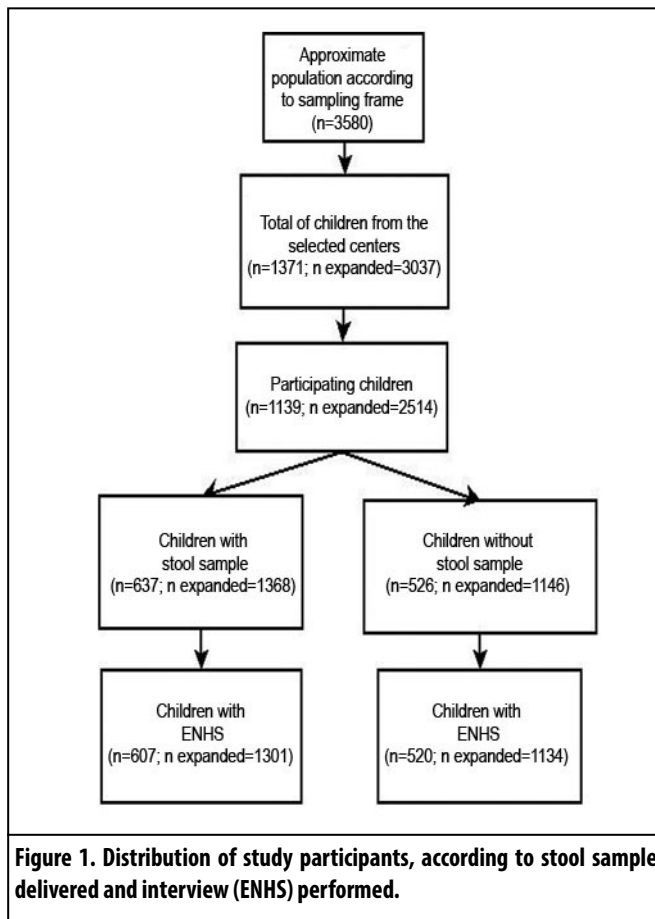
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### *a. Population and study design*

An observational cross-sectional study was carried out that included children beneficiaries of the CCP and FFD programs of the ENC-CNCC of the South Central Region of Costa Rica, between August 2014 and May 2016. Only centers were included in the study (ENC or CNCC) that counted simultaneously with the CCP programs (intramural modality) and FFD (extramural modality), so that in each ENC or CNCC information of children of both programs was collected.

The Central South Region had 36 ENC-CNCC centers with approximately 3580 children from the CCP and FFD programs (Figure 1). Using as a sampling frame the database generated by the National Directorate of ENC-CNCC of the Ministry of Health in June 2014, 13 of the centers were randomly selected to be counted, a total of 1139 children signed informed consent, of which 733 they corresponded to CCP beneficiaries, 338 to FFD beneficiaries and 68 belonged to both programs (Figure 1). The type of sampling and the size of the sample were chosen based on the size of the population, the available budget and the guideline of the National Directorate of ENC-CNCC to sample all the children in each center, for ethical reasons.

All the activities and instruments of the study were approved by the Ethics-Scientific Committee of the University of Costa Rica (VI-2884-2014) and all the parents or caregivers of the participating children signed an informed consent.



### b. Interview

A part of the National Household Survey of Costa Rica (ENAHO) of 2014 was applied to the parents or caregivers of the children,<sup>21</sup> hereinafter referred to as the Extract from the National Household Survey (ENHS). With this survey, sociodemographic information was collected (i.e., child's age, gender), information on the conditions of the family's home (i.e., type of dwelling, material of the walls of the house, material of the roof of the house, members of the family under the same roof), of the sanitary conditions (i.e., source of water in the house, connection of the sanitary service), education and work of the parent or guardian (i.e., age of the parent or guardian, last year of study approved by the parent or guardian, type of work performed by the parent or guardian the previous week) and the child's health (i.e., if the child took dewormers in the last year, if the child had diarrhea in the last 6 months and year of the child's last medical appointment). The variables were operationalized as dichotomous variables, whose classification is observed in Table 1.

### c. Collection of stool samples

Stool was collected from 637 children (expanded

$n = 1368$ ); 593 children ( $n$  expanded = 1279) gave a single stool sample and 44 children ( $n$  expanded = 89) delivered 2 samples (collected on different days). For that it was explained to the parents or guardians of children orally and in writing how to collect stool samples from children and were given a sterile plastic wide-mouth jar. The samples were transported at room temperature to the Laboratory of Medical Helminthology of the Faculty of Microbiology of the University of Costa Rica, where they were analyzed, in a period <4 hours.

### d. Determination of parasitosis

The stool samples were analyzed by means of the direct examination and assembly of Kato.<sup>22</sup> The presence of parasites in the feces was classified as: (a) "prevalence of commensal protozoa", which corresponds to the percentage of children whose sample had 1 or more commensal protozoa (b) "prevalence of helminthiasis", is the percentage of children whose sample showed 1 or more helminths (c) "prevalence of parasitosis" percentage of children whose sample had 1 or more pathogenic protozoa and / or helminths in the stool sample (d) "prevalence of commensals, pathogens and / or helminths (CHP)" "Percentage of children whose sample had any of the following: commensal protozoa, pathogenic protozoa and helminths in the stool, either independently or in combination. The CPH category was created to compare the results of this study with the results of the last National Nutrition Survey of Costa Rica 2008-2009. It is important to clarify that the categories are not mutually exclusive, as a child who presents parasites in their feces (helminths and pathogenic protozoa), can simultaneously present protozoa commensal.

### e. Statistical analysis

Given that each establishment differed in the number of beneficiaries of the CCP and FFD programs and in the percentage of children with stool samples analyzed, an expansion factor was used prior to the analysis of the data.<sup>23</sup> Then, the prevalence of parasitosis and CPH was estimated, for the total population studied, for each of the ENC or CNCC centers and for each aid program. The prevalence of helminthiasis in the total population studied was determined. The differences in the prevalences of parasitosis and CPH were estimated according to sex and program of adscription. In the bivariate analyzes, chi-squared tests were run and odds ratios (OR) were calculated, with their respective 95% confidence intervals (95% CI) to examine the associations between CPH and the different socioeconomic factors (Table 3). Finally, a predictive logistic regression model for CPH was run (Table 4).

| <b>Table 2. Percentage of CPH and parasitosis in the beneficiary children CCP-FFD of the South Central Region, according to center of affiliation, 2014-2016 (n = 1368)</b> |                                       |                                  |  |   |
|---|---------------------------------------|----------------------------------|--|---|
| Centers (ENC-CNCCC)   | Children with samples collected n (%) | Children with stool samples      |  |   |
|   |                                       | Prevalence of children with CPHa | Prevalence of children with commensal protozoa | Prevalence of children with parasitosis |
| CNCCC La Uruca  | 145 (55.8)                            | 46.9                             | 37.2   | 17.2                                    |
| ENC Rio Azul  | 127 (56.7)                            | 32.3                             | 24.4   | 12.6                                    |
| ENC San Rafael  | 62 (58.5)                             | 25.8                             | 22.6   | 7.9                                     |
| ENC Center of Pavas   | 59 (56.7)                             | 25.0                             | 22.0   | 6.7                                     |
| CNCCC Alajuelita  | 101 (48.6)                            | 24.8                             | 18.8   | 7.9                                     |
| CNCCC Santiago of Puriscal  | 126 (43.8)                            | 25.0                             | 22.6   | 6.4                                     |
| ENC San Miguel  | 140 (71.8)                            | 24.3                             | 21.4   | 10.7                                    |
| CNCCC Gravilias   | 165 (50.4)                            | 21.9                             | 16.4   | 7.3                                     |
| CNCCC Asseri  | 140 (67.0)                            | 20.0                             | 17.1   | 5.7                                     |
| ENC Salitrillos   | 59 (60.8)                             | 20.0                             | 16.9   | 5.1                                     |
| CNCCC La Facio  | 131 (52.0)                            | 11.4                             | 4.6  | 6.8                                     |
| ENC San Juan of Tibás   | 48 (30.6)                             | 8.3                              | 0.0  | 8.3                                     |
| CNCCC Paso Ancho  | 65 (74.7)                             | 7.7                              | 7.7  | 0.0                                     |
| <b>TOTAL</b>  | <b>1368 (54.4)</b>                    | <b>24.1</b>                      | <b>19.0</b>                                    | <b>8.5</b>                              |

<sup>a</sup>The CPH category includes children whose samples presented commensals or parasites, which are not mutually exclusive, since a stool sample can simultaneously contain commensals and parasites.

#### f. Educational sessions

Educational sessions were held with 83 teachers and members of the administrative staff of ENC-CNCCC, 1200 parents, 23 medical heads and epidemiologists from the Health Areas of the South Central Region of the Costa Rican Social Security Fund (CCSS). Teachers and parents were explained what intestinal parasites are, their clinical manifestations and methods of prevention. The importance of performing a serial stool test ( $\geq 3$  stool samples collected on non-consecutive days) was emphasized when the child had symptoms, but no parasites were observed in the first stool test. Parents were instructed on the proper collection of stool samples; the medical heads and epidemiologists were stressed the importance of the timely attention of the referred children, the need to use appropriate protocols for the approach of the parasitosis and they were updated on the topic of antiparasitic resistance.

## Results

#### a. Characteristics of the study population

Table 1 summarizes some of the socioeconomic characteristics of the children who participated in the

study and their families. The families of the children studied, despite the low economic level (according to their selection criteria to be beneficiaries of CCP or FFD), mostly had access to basic sanitary conditions (piped water to the home, not having an earth floor) and use of antiparasitics (Table 1).

When comparing the characteristics of the families, according to the program to which the child belonged, it was observed that the families of the CCP children had better socioeconomic conditions (eg, better type of housing, better materials of the walls of the house, type of floor, water quality, parents with a higher educational level and more employment) than FFD beneficiaries (Table 1;  $p < 0.05$  in all cases).

#### b. Prevalence of parasitosis

##### b.1. Prevalence of commensals, pathogens and helminths (CPH)

Stool samples were analyzed in 1368 children. The prevalence of CPH was 24.1% (95% CI: 21.9-26.4). There were no statistically significant differences in the prevalence of CPH among boys and girls (24.8% vs. 22.8%, respectively,  $p = 0.40$ ) or between the different aid programs (23.0% of CPH in children beneficiaries of CCP

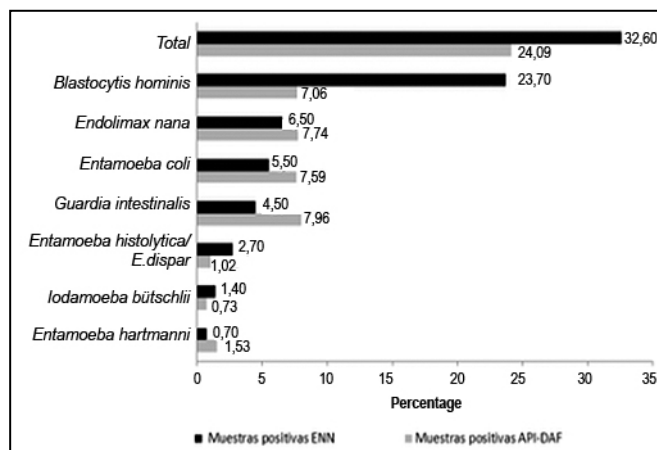
vs. 27.4% in FFD vs. 20.1% in CCP + FFD,  $p = 0.14$ ). In contrast, differences were found in the prevalence of CPH among the different establishments of the ENC-CNCC ( $p < 0.001$ , Table 2), with the CNCC La Uruca having the highest prevalence.

When comparing the socioeconomic characteristics of the families of the children of CNCC La Uruca with those of the rest of the centers, it was observed that a greater proportion of families of that center were grouped into categories that suggested a possible risk for CPH in most of the centers variables (according to classification in Table 1, data not shown).

It is important to note that in the 89 children who delivered 2 stool samples, there was an increase in the prevalence of CPH of 9.0% (95% CI: 3.0-15.1) with the first stool sample. 21.0% (95% CI: 13.0-30.2) when analyzing 2 stool samples.

### b.2. Prevalence of pathogenic parasites

In the study population, a prevalence of parasitosis of 8.5% (95% CI: 7.5-10.5) was identified. As for CPH, there were no statistically significant differences in prevalences, according to sex (7.8% in children vs. 10.2% in girls,  $p = 0.13$ ) or aid program (8.3% in girls) children beneficiaries of CCP vs. 10.3% in FFD vs. 10.5% in CCP + FFD,  $p = 0.47$ , but between different establishments ( $p = 0.006$ , Table 2). The CNCC The Uruca was the center that presented a higher prevalence of parasitosis.



**Figure 2. Distribution of intestinal protozoa detected in children aged 1 to 7 years benefiting from the programs of Child Care and Protection (CCP) and Foods to Families Distribution (FFD) 2014-2016 (n = 1368), and in the children 0-6 years old included in the National Nutrition Survey (NNS) conducted in 2008-2009 (n = 227)**

### b.3. Prevalence of helminths

Helminths were found in 10 stool samples (prevalence = 0.7%, 95% CI: 0.1-1.5). Six of these samples presented *Ascaris lumbricoides*, two showed *Trichocephalus trichiurus* and two *Hymenolepis nana*. Two cases of ascariasis were found in the children of ENC de Salitrillos, two cases of hymenolepiasis in children of ENC of Pavas Centro and the rest of helminths were found in children samples of CNCC of La Uruca. The positive ratio of protozoa (pathogens and commensals) with respect to the helminths was 30,8.

Figure 2 shows the prevalence of the different protozoa detected in the stool samples of children aged 1 to 7 years who participated in the current study compared to the prevalence found in children aged 0-6 years included in the last National Survey of Nutrition (ENN) performed in 2008-2009<sup>10</sup>. A greater total prevalence of intestinal protozoa was observed in the ENN; however, ENC-CNCC children had higher prevalences for most protozoa.

In the current study, 103 (7.5%) samples were found with 2-4 commensal protozoa, 54 (3.8%) samples with protozoan commensals and protozoan pathogens and 6 (0.4%) samples with mixed infections by protozoa and helminths. *Giardia intestinalis* was the protozoan of highest prevalence in infants of 2 years, *Entamoeba coli* was the most frequent in children of 3, 6 and 7 years and *Blastocystis hominis* was the most frequent in children of 4 and 5 years (data not shown).

### c. Socioeconomic determinants of parasitosis

Table 3 shows the results of bivariate analyzes of socioeconomic characteristics with the presence of CPH. It was observed that living in a house with a wall of waste material or tin (OR = 3.0, 95% CI: 2.2-4.2), living in an inadequate dwelling [i.e., indigenous dwelling, room in barracks, slum, mobile home, boarding house or convent (OR = 2.6, 95% CI: 1.9-3.7)], living in a house with a dirt floor (OR = 1.9, 95% CI: 1.1-3.5), have a family with more than 4 members (OR = 1.4, 95% CI: 1.1-1.8) and an age > 5 years (OR = 1.4, 95% CI: 1.1-1.7) were associated with the presence of CPH.

Table 4 shows the results of the multivariate logistic regression model. After adjusting for other characteristics, it was observed that living in a house with walls of waste material or tin (OR = 2.2, 95% CI: 1.5-3.1), living in an inadequate dwelling (OR = 2.0, 95% CI: 1.4-2.9), have a family of > 4 members (OR = 1.4, 95% CI: 1.0-1.8) and have an age > 5 years (OR = 1, 4, 95% CI: 1.1-1.8) were associated with the presence of CPH.

**Table 3. Bivariate associations between socioeconomic characteristics, deworming and medical care and the presence of CPH in children benefiting from CCP-FFD of the Central South Region, 2014-2016**

| Variable   | n   | OR (CI 95%)   | pa    |
|--|-----|---------------|-------|
| Male sex   | 368 | 1.1 (0.8-1.4) | 575   |
| Age > 5 years  | 368 | 1.4 (1.1-1.7) | 0.003 |
| Inadequate housing*  | 289 | 2.6 (1.9-3.7) | 0.001 |
| Inadequate wall material*  | 287 | 3.0 (2.2-4.2) | 0.001 |
| Roof material of the house not adequate  | 282 | 0.3 (0.1-1.2) | 0.001 |
| Dirt floor *b  | 284 | 1.9 (1.1-3.5) | 5,056 |
| More than 4 family members under the same roof*  | 282 | 1.4 (1.1-1.8) | 0.022 |
| House water not coming from an aqueduct  | 221 | 1.1 (0.5-2.0) | 0.082 |
| Family receives piped water to the home  | 285 | 0.4 (0.1-1.7) | 271   |
| Toilet with direct access to ditch, ditch, river or estuary, or is a pit of black well or latrine  | 164 | 1.2 (0.7-2.0) | 569   |
| Age of the parent or guardian is 15-20 or between 51 to 70 years old   | 258 | 1.5 (1.0-2.3) | 0.097 |
| Last school year passed by the parent or guardian was elementary or lower  | 273 | 1.4 (1.0-1.8) | 0.044 |
| Last week the father did not do agricultural work, he raised or fished, he sold products, he took care of people he cleaned, he ironed for another home, he did various jobs | 248 | 0.8 (0.6-1.0) | 0.044 |
| Child was not dewormed in the last year  | 247 | 1,0 (0,8-1,3) | 1     |
| Child had diarrhea in the last 6 months  | 262 | 0,9 (0,7-1,2) | 5,715 |
| The child's last medical appointment was more than 1 year ago  | 301 | 1.1 (0.8-1.6) | 0.610 |

<sup>a</sup>Value of the chi-square test  
<sup>b</sup>Example of interpretation: Children who live in houses with dirt floors are 1.9 times more likely to have parasitic diseases than children who do not have a house with a dirt floor.  
\* Socioeconomic variables that behave as a risk factor for CPH in the bivariate analysis

## Discussion

The present study found a high prevalence of CPH and a relatively low prevalence of parasitosis in children aged 1-7 years, from the ENC-CNCC of the South Central Region. No statistically significant differences were found in the prevalences of parasitosis or CPH according to sex, nor according to the adscription program (CCP, FFD, CCP + FFD), but according to the center, with CNCC La Uruca having the highest prevalence, both of parasitosis as of CPH.

Among the few studies of parasitosis performed on children of ENC-CNCC in the Greater Metropolitan Area of Costa Rica, the study by Reyes (1987), which reported high prevalences of *Giardia intestinalis* (25%), *Entamoeba histolytica* (16%), stands out, *Ascaris lumbricoides* (25%) and *Trichocephalus trichiurus* (37%).<sup>18</sup> The present study showed a prevalence of parasitosis close to that reported for children from 0-6

years old to the last ENN of Costa Rica in 2008-2009 (8.5%), 10 but lower than the prevalences observed in other vulnerable child populations in Latin American countries (30-90%).<sup>24,25</sup> As in other studies conducted in Costa Rica, in this research *Giardia intestinalis* was the most prevalent pathogenic protozoan and the most frequent commensal protozoa were *Endolimax nana* and *Entamoeba coli*.<sup>10,18,26</sup>

The prevalence of helminthiasis found in the study (0.7%) was lower than that reported for Costa Rica (2.6%) in the NNH of 2008-2009.<sup>10</sup> Unlike the ENN, in the stool samples collected in this investigation no hooks were found nor *Taenia* sp. and two cases were detected of *Hymenolepis nana*. *Ascaris lumbricoides* was the most prevalent helminth, a finding that is consistent with what has been observed in some studies carried out in Costa Rica,<sup>20,27</sup> but inconsistent with the findings of the 2008-2009 NNE and other national investigations that report *Trichocephalus trichiurus* as the most prevalent helminth.<sup>10,26</sup>



**Table 4. Model of best fit for the socioeconomic characteristics associated with the presence of CPH in the beneficiary children CCP-FFD of the Central South Region, 2014-2016 (n = 1281)**

| Variable   | OR (CI 95%)   |
|--|---------------|
| Constant   | 0,1           |
| Inadequate walls   | 2,2 (1,5-3,1) |
| Inadequate housing   | 2.0 (1.4-2.9) |
| > 4 family members under the same roof   | 1.4 (1.0-1.8) |
| Age> 5 years   | 1.4 (1.1-1.8) |
| R <sup>2</sup> =0,07   |               |
| <sup>a</sup> Example of interpretation: Children living in houses with inadequate walls (natural fibers or waste material) are 2.2 times more likely to present CPH than children whose houses are built with block or brick, plinth, wood, prefabricated or tiles, Fibrolit or Ricalit. |               |

Despite the low prevalence of parasites found in the study, almost a quarter of the children had CPH; Other studies conducted in Costa Rica have found prevalences of CPH between 20% and 80% in preschool and school populations.<sup>20,26,28,29</sup> However, determining the true prevalence of CPH is difficult when analyzing a single stool sample; As observed in the study, in children who presented 2 stool samples, the prevalence of CPH increased significantly, so it can be expected that in other studies also the actual prevalence of CPH is higher than that reported. This has been explained because the cycles of excretion of the parasites in the feces are not continuous, which implies that the parasites are not excreted in the feces daily and hence the importance of performing serial analyzes of stool samples.<sup>30,31</sup>

The CPH category includes commensal protozoa, which, although not pathogenic, are indicators of ingestion of fecal matter and the risk of being parasitized or of contracting an infection with enteroparasites. In the study, as in other investigations,<sup>26,27</sup> the majority of CPH found in the feces were protozoan commensals and a small percentage, pathogenic protozoans or helminths. The high percentage of commensal protozoa could be due to the massive deworming campaigns that take place in the country.<sup>32</sup> In these campaigns albendazole is used as an antiparasitic, which is effective against some of the helminths, but not against protozoa, except *Giardia intestinalis*, in which its effectiveness is limited, since it requires a greater dosage.<sup>34,35</sup>

The children assigned to CNCC La Uruca had the highest prevalences of CPH and parasitosis, which seems to be related to poor socioeconomic conditions, since the children of CNCC La Uruca, as well as the beneficiaries of the FFD program, showed a greater proportion of

families classified in risk categories for these variables. No statistically significant differences were found in the prevalence according to the program to which the child belonged (CCP, FFD, CCP + FFD), despite the fact that there was a trend towards higher prevalences in the FFD beneficiaries, according to the absolute numbers.

In the study, socioeconomic factors such as having an age > 5 years, having a family with more than 4 members, living in an inadequate dwelling (indigenous dwelling, quarter in barracks, slum, mobile home, boarding house or convent) or in a House with walls built with waste materials or tin, were determining factors to present CPH. The association of these socioeconomic factors with parasitosis has been explained by other authors who mention that older children may be more exposed to risk factors for parasitosis;<sup>34,35</sup> large families are more likely to live in crowded conditions, which facilitates the spread of parasites,<sup>21,33</sup> and that the condition of housing and walls are commonly a risk factor for infant mortality and parasitosis.<sup>34,37</sup>

Other socioeconomic factors such as: that the father of a family has an educational level of primary or lower or living in a house with a dirt floor, were also risk factors for CPH, but only in the bivariate analysis. The literature indicates that a low educational level of parents is related to poor hygienic practices<sup>36,38</sup> and that the earth floor is a risk factor for parasitosis, since it provides an adequate means for the development and transmission of geohelminths and favors, in turn, the transmission of protozoa of zoonotic origin.<sup>39,40</sup> Although other studies point to the low level of sewage or poor disposal of excrement<sup>25,41</sup> and the inadequate quality of the water<sup>25,41</sup> as risk factors to have parasites or commensals, in this investigation the source of water supply of the house, presence of piped water to the home and type of sanitary service, were not associated with CPH, possibly due to the homogeneous distribution of said factors in the studied population.

Although intestinal parasitosis is a preventable and treatable disease, which has been reduced significantly in Costa Rica, there are still major weaknesses in its approach. Some of these weaknesses include: lack of a standardized protocol for the care of parasitosis, few therapeutic options (i.e., albendazole, metronidazole and ivermectin),<sup>42</sup> scarce research on the subject and poor training of health personnel in the care and treatment of these diseases. Another significant weakness is that empirical treatment is commonly provided for intestinal parasitosis, which is rarely supported by a previous demonstration of infection by parasites.<sup>43</sup>

Among the limitations of the study is that the socioeconomic information, information about deworming and about the child's medical care, was referred by their father or guardian, and not through a verification of the houses, for which there may be information bias. It is also not possible to eliminate the conglomeration effect of children (similarity of children belonging to the same center) for the calculation of total prevalence, since a study design by conglomerates was not used. Some strengths of this research include the large number of children analyzed, the support of a team of specialist parasitologists for the analysis of the samples, the collection of socioeconomic data in parallel to the analysis of stool samples, as well as the verification of the care medical of children.

This research, beyond generating updated data on parasitosis in children aged 1-7 years in vulnerable condition, is a wake-up call, since it shows that in many regions of our country there are still permissive conditions for the transmission of enteropathogens (evidenced by the presence of commensal protozoa in almost a quarter of children). In addition, there is a need to encourage the use of serial analysis of feces, strengthen the preventive measures of parasitosis, develop protocols for its approach and design a strategy that includes the preschool population within the programs that evaluate the child's development periodically.

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