Systematic Review

Strongyloidiasis screening in migrants living in Spain: systematic review and meta-analysis

Fernando Salvador1, Begona Treviño2, Pau Bosch-Nicolau1, Nuria Serre-Delcor2, Adrián Sánchez-Montalvá1, Inés Oliveira2, Elena Sulleiro3, Mª Luisa Aznar2, Diana Pou2, Augusto Sao-Avilés1 and Israel Molina1

1 Department of Infectious Diseases, Vall d’Hebron University Hospital, PROSICS Barcelona, Barcelona, Spain
2 Tropical Medicine Unit Vall d’Hebron-Drassanes, Vall d’Hebron University Hospital, PROSICS Barcelona, Barcelona, Spain
3 Department of Microbiology, Vall d’Hebron University Hospital, PROSICS Barcelona, Barcelona, Spain

Abstract

OBJECTIVES To provide information regarding the prevalence of strongyloidiasis among migrants coming from Strongyloides stercoralis-endemic areas who reside in Spain.

METHODS Systematic review of the literature and meta-analysis of studies showing prevalence of S. stercoralis infection among migrants from Latin America, Africa, Eastern Europe, Asia and Oceania who reside in Spain. We included articles published until 30 April 2019 without language restriction. The keywords used for the search included ‘Strongyloides stercoralis’, ‘strongyloidiasis’, ‘Spain’, ‘screening’ and ‘migrants’.

RESULTS Twenty-four studies were included in the review and meta-analysis, comprising 12 386 screened people. Eleven studies (7020 patients) evaluated the presence of S. stercoralis infection only through investigation of larvae in faeces, showing an overall prevalence of 1% (95%CI 1–1%). Thirteen studies (5366 patients) used a serological test, showing an overall prevalence of 14% (95%CI 11–17%). Strongyloidiasis seroprevalence was 20% (95%CI 15–24%) among migrants from sub-Saharan Africa, 14% (95%CI 10–18%) among those from Latin America and 8% (95%CI 5–11%) among migrants from North Africa.

CONCLUSIONS Migrants coming from strongyloidiasis-endemic areas living in Spain had a high S. stercoralis infection prevalence, particularly those from sub-Saharan Africa and Latin America. This population should be screened using serology as the most sensitive test for S. stercoralis infection. This could be easily implemented at primary care level.

keywords Strongyloides stercoralis, strongyloidiasis, migrants, screening, serology

Introduction

Strongyloidiasis is an infection caused by the nematode Strongyloides stercoralis. Although it is globally distributed, the infection mainly affects rural population of tropical and subtropical regions; overall, an estimated 300 million people are infected worldwide [1,2]. Due to the increase in migrant flows and international travels, S. stercoralis infection is being increasingly diagnosed in areas where it is not endemic or where autochthonous cases are sporadically diagnosed. This is the case in Spain, where strongyloidiasis is mostly diagnosed in migrants coming from Latin America and sub-Saharan Africa [3].

Although most S. stercoralis infection cases are asymptomatic, this nematode has some characteristics that make it unique among soil-transmitted helminths. First, S. stercoralis has the ability to persist in the human host for decades due to its autoinfection cycle. Second, some immunosuppressant conditions (such as corticosteroid therapy, organ transplantation and human T-lymphotropic virus 1 (HTLV-1) infection) may lead to severe presentations such as S. stercoralis hyperinfection syndrome and disseminated strongyloidiasis [4]. A recent meta-analysis showed that abdominal pain, diarrhoea and urticaria are symptoms more associated with the chronic infection [5].

Strongyloidiasis diagnosis is very challenging. Confirmed diagnosis is based upon the detection of S. stercoralis larvae in faeces through different microbiological techniques; however, these procedures are not sensitive enough due to the irregular and low output of larvae [6].
Despite of specificity issues, serological techniques (especially those based on enzyme-linked immunosorbent assays [ELISA]) are increasingly being used both in the diagnosis and in the follow-up after treatment, showing good sensitivity and ease of performance [7,8]. The current strategy for strongyloidiasis diagnosis is based on a combination of techniques that usually includes classical parasitological methods and serological techniques.

*Strongyloides stercoralis* infection screening is recommended for migrants from areas with high prevalence, especially those at risk of immunosuppression [9]. The aim of the present study was to provide information regarding the prevalence of strongyloidiasis among migrants coming from endemic areas who reside in Spain through a systematic review of the literature and a meta-analysis.

**Methods**

The systematic review of the literature was performed according to the Preferred Reporting Items for Systematic Review and Meta-Analyses (PRISMA) guidelines. Articles published until 30 April 2019 without language restriction were retrieved from PubMed, EMBASE, Scielo, ISI Web of Knowledge and Cochrane Library databases. Moreover, grey literature in the form of communications presented at congresses was searched through OpenGray and Google Scholar. Additional studies were identified by examining the references of included studies and review articles. The keywords used for the search included a combination of ‘*Strongyloides stercoralis*’, ‘strongyloidiasis’, ‘Spain’, ‘screening’ and ‘migrants’.

We included studies that showed data on the prevalence of *S. stercoralis* infection among migrants from endemic areas (Latin America, Africa, Eastern Europe, Asia and Oceania) who reside in Spain. Studies were included independently of the diagnostic test used: detection of larvae in faeces, serological techniques and molecular biology-based tests (such as polymerase chain reaction [PCR] or loop-mediated isothermal amplification [LAMP]). We excluded case series (where the prevalence could not be evaluated), studies including autochthonous population, review articles, and studies performed exclusively in populations with increased risk of having a *S. stercoralis* infection (patients with symptoms, eosinophilia or HTLV-1 infection).

After the search, results were combined and duplicates removed before screening for relevance. All potentially eligible articles were independently analysed by two researchers in two stages to evaluate compliance with the selection criteria. If the two researchers did not reach a consensus, a third researcher made the final decision. At the first stage, articles were selected by titles and abstracts; at the second stage, the full text of the articles was analysed. When the studies had missed information, the authors of the article were contacted in order to gather all required information.

Those articles that met the inclusion criteria and none of the exclusion criteria were finally included in the study. From each included study, the following data were extracted: year of publication, study period, geographical area and setting, number of included patients, area of provenance of patients, age, microbiological tests performed, global prevalence of strongyloidiasis and prevalence of strongyloidiasis by area of provenance.

The metaprop package of the Stata 13.1 software was used for the meta-analysis. This routine provides procedures for pooling proportions in a meta-analysis of multiple studies and displays the results in a forest plot. Confidence intervals (CI) are based on score (Wilson) or exact binomial (Clopper-Pearson) procedures. A test of whether the summary effect measure is equal to the zero is given, as well as a test for heterogeneity, that is, whether the true effect in all studies is the same. Heterogeneity is also quantified using the I-squared measure [10]. Moreover, publication bias was estimated through the Egger regression asymmetry test using the metabias package of the Stata 13.1 software. The ethical review board of the Vall d’Hebron University Hospital (Barcelona, Spain) was consulted and agreed that ethic committee approval was not necessary. Procedures were performed in accordance with the ethical standards laid down in the Declaration of Helsinki as revised in 2013.

**Results**

The electronic search retrieved 572 citations, and another 10 citations were identified through manual review of the reference lists of each study. After duplicate articles were removed, 495 articles were screened for potential eligibility by title and abstract, and 48 articles were selected for full-text review (see flow diagram in Figure 1). Finally, 24 studies were included in the review and meta-analysis, comprising 12 386 screened people [11–34]. Main characteristics of the included studies are summarised in Tables 1 and 2.

Ten studies were performed in the province of Barcelona and six in the province of Madrid. Eighteen studies were performed among adult populations (age over 18 years), two among paediatric populations, three included both adult and paediatric populations, and one study lacked information regarding the age of the study population. The majority focused on migrants from Latin America, sub-Saharan Africa and North Africa; six studies included migrants from Asia and two included migrants from Eastern Europe.
Eleven studies evaluated the presence of *S. stercoralis* infection only through the investigation of larvae in faeces (Table 1) [11–21]. The most frequently used microbiological techniques were microscopic examination of faeces by concentration techniques (the Ritchie method) and/or specific larvae culture (the Koga agar plate). These studies included 7020 patients altogether, and the prevalence of strongyloidiasis ranged from 0.18% to 3.25%. The overall strongyloidiasis prevalence in studies using only investigation of larvae in faeces was 1% (95% CI 1–1%) (Figure 2). The Egger coefficient was 2.2 ($P = 0.016$), showing significant risk of publication bias.

Thirteen studies including altogether 5366 patients employed an ELISA-based serological test (Table 2).
Table 1 Characteristics of included studies where assessment of *Strongyloides stercoralis* infection was exclusively performed through larvae detection in faeces

<table>
<thead>
<tr>
<th>Reference</th>
<th>Province</th>
<th>Setting</th>
<th>Study period</th>
<th>Number of patients</th>
<th>Geographical area of provenance</th>
<th>Age (years)</th>
<th>Microbiological test</th>
<th>Strongyloidiasis prevalence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roca, 2002 [12]</td>
<td>Barcelona</td>
<td>Tropical Medicine Unit</td>
<td>1984–1994</td>
<td>1321</td>
<td>Af (SSA, NA)</td>
<td>Mean 34.4</td>
<td>Kato-Katz + Flotation (1 sample)</td>
<td>8/1321 (0.37%)</td>
</tr>
<tr>
<td>López-Vélez, 2003 [14]</td>
<td>Madrid</td>
<td>Tropical Medicine Unit</td>
<td>1989–1999</td>
<td>671</td>
<td>LA, Af (SSA, NA), Asia</td>
<td>Median 28</td>
<td>Ritchie + Koga agar plate (3 samples)</td>
<td>6/671 (0.89%)</td>
</tr>
<tr>
<td>Martín-Sánchez, 2004 [15]</td>
<td>Las Palmas</td>
<td>Tropical Medicine Unit</td>
<td>2000</td>
<td>121</td>
<td>Af (SSA)</td>
<td>Mean 24</td>
<td>Lugol + Kato-Katz (3 samples)</td>
<td>1/121 (0.8%)</td>
</tr>
<tr>
<td>Yokocera, 2014 [17]</td>
<td>Barcelona</td>
<td>Tropical Medicine Unit</td>
<td>2007–2010</td>
<td>400</td>
<td>LA, Af (SSA, NA), Asia</td>
<td>Median 34.5</td>
<td>Ritchie (3 samples)</td>
<td>13/400 (3.25%)</td>
</tr>
<tr>
<td>Monge-Maillo, 2015 [18]</td>
<td>Madrid</td>
<td>Tropical Medicine Unit</td>
<td>2000–2009</td>
<td>548</td>
<td>Af (SSA)</td>
<td>Median 29</td>
<td>Formalin-ether (3 samples)</td>
<td>1/548 (0.18%)</td>
</tr>
<tr>
<td>Serre-Delcor, 2016 [19]</td>
<td>Barcelona</td>
<td>Tropical Medicine Unit</td>
<td>2009–2012</td>
<td>171</td>
<td>Af (SSA)</td>
<td>Median 17</td>
<td>Ritchie (1 sample)</td>
<td>3/171 (1.75%)</td>
</tr>
<tr>
<td>Henríquez-Hernández, 2016 [20]</td>
<td>Las Palmas</td>
<td>Tropical Medicine Unit</td>
<td>2000–2010</td>
<td>570</td>
<td>Af (SSA, NA)</td>
<td>Mean 26.8</td>
<td>Ritchie + Koga agar plate (3 samples)</td>
<td>6/570 (1.05%)</td>
</tr>
<tr>
<td>Serre-Delcor, 2018 [21]</td>
<td>Barcelona</td>
<td>Tropical Medicine Unit</td>
<td>2013–2016</td>
<td>248</td>
<td>LA, Af (SSA, NA), Asia, EE</td>
<td>Median 28</td>
<td>Ritchie (1 sample)</td>
<td>2/248 (0.8%)</td>
</tr>
</tbody>
</table>

Af, Africa; EE, Eastern Europe; IQR, interquartile range; LA, Latin America; NA, North Africa; SD, standard deviation; SSA, sub-Saharan Africa.
Table 2 Characteristics of included studies where the assessment of *Strongyloides stercoralis* infection included a serological test

<table>
<thead>
<tr>
<th>Reference</th>
<th>Province</th>
<th>Setting</th>
<th>Study period</th>
<th>No. of patients</th>
<th>Region of provenance</th>
<th>Characteristics of the study population</th>
<th>Age (years)</th>
<th>Microbiological test</th>
<th>Global strongyloidiasis prevalence</th>
<th>Study period</th>
<th>Prevalence in LA patients</th>
<th>Prevalence in SSA patients</th>
<th>Prevalence in NA patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rodríguez-Guardado, 2012 [22]</td>
<td>Asturias</td>
<td>Tropical Medicine Unit</td>
<td>2006–2011</td>
<td>57 LA, Af (SSA)</td>
<td>HIV-infected patients</td>
<td>-</td>
<td>-</td>
<td>ELISA (commercial test, IgG detection of the <em>S. stercoralis</em> L3 filariform larval antigen)/Koga agar plate (3 samples)</td>
<td>6/57 (10.5%)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Salvador, 2013 [23]</td>
<td>Barcelona</td>
<td>Tropical Medicine Unit</td>
<td>2010–2011</td>
<td>190 LA, Af (SSA, NA)</td>
<td>HIV-infected patients</td>
<td>Median 37 (IQR 32–43)</td>
<td>-</td>
<td>ELISA (commercial test, IgG detection of the <em>S. stercoralis</em> L3 filariform larval antigen)/ Ritchie (2 samples)</td>
<td>Overall: 35/190 (18.4%)</td>
<td>By serology: 35/190 (18.4%)</td>
<td>By microscopy: 2/139 (1.4%)</td>
<td>22/141 (15.6%)</td>
<td>11/41 (26.8%)</td>
</tr>
<tr>
<td>Llenas-García, 2013 [24]</td>
<td>Madrid</td>
<td>Tropical Medicine Unit</td>
<td>2008–2009</td>
<td>237 LA, Af (SSA, NA), Asia</td>
<td>HIV-infected patients</td>
<td>Mean 37.5 (SD 9.5)</td>
<td>-</td>
<td>ELISA (commercial test, IgG detection of the <em>S. stercoralis</em> L3 filariform larval antigen)/ Ritchie + Koga agar plate (3 samples)</td>
<td>Overall: 13/237 (5.5%)</td>
<td>By serology: 13/237 (5.5%)</td>
<td>By microscopy: 2/187 (1.1%)</td>
<td>8/175 (4.5%)</td>
<td>5/39 (12.8%)</td>
</tr>
<tr>
<td>Ramos, 2015 [25]</td>
<td>Alicante</td>
<td>Tropical Medicine Unit</td>
<td>2012–2014</td>
<td>157 LA</td>
<td>-</td>
<td>Median 38 (IQR 30.5–55%)</td>
<td>-</td>
<td>ELISA (commercial test, IgG detection of the <em>S. stercoralis</em> L3 filariform larval antigen)</td>
<td>Overall: 38/157 (26.8%)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Salvador, 2016 [26]</td>
<td>Barcelona</td>
<td>Tropical Medicine Unit</td>
<td>2014–2015</td>
<td>66 LA</td>
<td>Chagas disease patients</td>
<td>Median 38 (range 18–67)</td>
<td>-</td>
<td>ELISA (commercial test, IgG detection of the <em>S. stercoralis</em> L3 filariform larval antigen)</td>
<td>Overall: 11/66 (16.6%)</td>
<td>By serology: 11/66 (16.6%)</td>
<td>By microscopy: 1/66 (1.5%)</td>
<td>11/66 (16.6%)</td>
<td>-</td>
</tr>
<tr>
<td>Cobo, 2016 [27]</td>
<td>Almería</td>
<td>Tropical Medicine Unit</td>
<td>2004–2013</td>
<td>2381 LA, Af (SSA, NA)</td>
<td>-</td>
<td>Mean 31.1 (SD 9.1)</td>
<td>-</td>
<td>ELISA (commercial test, IgG detection of the <em>S. stercoralis</em> L3 filariform larval antigen)/Ritchie (3 samples)</td>
<td>38/32381 (1.16%)</td>
<td>3/3196 (16.83%)</td>
<td>3/31930 (9.15%)</td>
<td>1/9255 (7.45%)</td>
<td></td>
</tr>
<tr>
<td>Sánchez-Montalvá, 2016 [28]</td>
<td>Barcelona</td>
<td>Tropical Medicine Unit</td>
<td>2011–2015</td>
<td>34 LA, Af (SSA, NA), Asia</td>
<td>Patients with oncohematological malignancies</td>
<td>Median 39 (IQR 31–51)</td>
<td>-</td>
<td>ELISA (commercial test, IgG detection of the <em>S. stercoralis</em> L3 filariform larval antigen)/Ritchie (3 samples)</td>
<td>Overall: 3/34 (8.8%)</td>
<td>By serology: 3/34 (8.8%)</td>
<td>By microscopy: 1/33 (3%)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Salvador, 2017 [29]</td>
<td>Barcelona</td>
<td>Blood Bank</td>
<td>2005–2015</td>
<td>202 LA</td>
<td>Chagas disease patients</td>
<td>Median 38 (range 18–62)</td>
<td>-</td>
<td>ELISA (commercial test, IgG detection of the <em>S. stercoralis</em> L3 filariform larval antigen)</td>
<td>22/202 (10.9%)</td>
<td>22/202 (10.9%)</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Reference</td>
<td>Province</td>
<td>Setting</td>
<td>Study period</td>
<td>No. of patients</td>
<td>Region of provenance</td>
<td>Characteristics of the study population</td>
<td>Age (years)</td>
<td>Microbiological test</td>
<td>Global strongyloidiasis prevalence</td>
<td>Prevalence in LA patients</td>
<td>Prevalence in SSA patients</td>
<td>Prevalence in NA patients</td>
<td></td>
</tr>
<tr>
<td>-----------</td>
<td>----------</td>
<td>---------</td>
<td>--------------</td>
<td>----------------</td>
<td>----------------------</td>
<td>------------------------------------------</td>
<td>------------</td>
<td>----------------------</td>
<td>-----------------------------------</td>
<td>----------------------------</td>
<td>-----------------------------</td>
<td>-----------------------------</td>
<td></td>
</tr>
<tr>
<td>Belhassen-García, 2017 [30]</td>
<td>Salamanca Tropical Medicine Unit</td>
<td>2007–2011</td>
<td>341 LA, Af (SSA, NA)</td>
<td>Mean 12.4 (SD 4)</td>
<td>ELISA (In-house test)/ Ritchie (3 samples)</td>
<td>Overall: 77/341 (22.5%) By serology: 77/341 (22.5%) By microscopy: 3/274 (1.1%)</td>
<td>7/45 (15.6%) 64/229 (27.9%) 6/67 (9%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gómez-Junyent, 2018 [31]</td>
<td>Barcelona Organ donor serum bank</td>
<td>2004–2014</td>
<td>65 LA, Af (SSA/NA), Asia</td>
<td>Median 41 (IQR 33–51)</td>
<td>ELISA (commercial test, IgG detection of the S. stercoralis L3 filariform larval antigen)</td>
<td>6/65 (9.23%)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Monge-Maillo, 2018 [32]</td>
<td>Madrid, Alicante Community screening</td>
<td>2016</td>
<td>752 LA</td>
<td>Mean 40 (IQR 35–48)</td>
<td>ELISA (commercial test, IgG detection of the S. stercoralis L3 filariform larval antigen)</td>
<td>76/752 (10.1%) 76/752 (10.1%)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Puerta-Alcalde, 2018 [33]</td>
<td>Barcelona Tropical Medicine Unit</td>
<td>2013–2015</td>
<td>361 LA</td>
<td>Median 36 (IQR 29–43)</td>
<td>ELISA (commercial test, IgG detection of the S. stercoralis L3 filariform larval antigen)</td>
<td>52/361 (14.4%) 52/361 (14.4%)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Salas-Coronas, 2018 [34]</td>
<td>Almería Tropical Medicine Unit</td>
<td>2004–2017</td>
<td>523 Af (SSA, NA)</td>
<td>Mean 28 (range 14–74)</td>
<td>ELISA (commercial test, IgG detection of the S. stercoralis L3 filariform larval antigen)/Ritchie (3 samples)</td>
<td>87/523 (16.6%)</td>
<td>-</td>
<td>84/488 (17.2%) 3/35 (8.6%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Af, Africa; EE, Eastern Europe; ELISA, enzyme-linked immunosorbent assays; HIV, human immunodeficiency virus; IQR, interquartile range; LA, Latin America; NA, North Africa; SD, standard deviation; SSA, sub-Saharan Africa.
[22–34] to detect *S. stercoralis* IgG antibodies. These studies found a prevalence of strongyloidiasis ranging from 5.5% to 26.8%, and of 14% (95% CI 11–17%) overall. The Egger coefficient was 0.2 (*P* = 0.893), showing low probability of publication bias. In some studies, seroprevalence by geographical area of origin could be extracted: prevalence in patients from sub-Saharan Africa was 20% (95% CI 15–24%); in patients from Latin America, 14% (95% CI 10–18%) and in patients from North Africa, 8% (95% CI 5–11%) (Figure 3).

**Discussion**

In this systematic review, we describe a high *S. stercoralis* infection prevalence in migrants from endemic areas who live in Spain, especially among migrants from sub-Saharan Africa and Latin America. Studies using serological tests for strongyloidiasis diagnosis showed higher prevalence than those using only larvae detection techniques.

The global prevalence of strongyloidiasis in endemic countries ranges from 10% to 40% depending on the areas studied (*S. stercoralis* transmission is very focal) and the microbiological techniques used. Although *S. stercoralis* infection is highly endemic in South-East Asia, most of the included studies in our literature review focused on sub-Saharan African and Latin American migrants, since they represent the most frequent migration profile in Spain. Hence, the results could be different in other non-endemic countries depending on the migration pattern [2]. The auto-infective cycle of the parasite enables persistence of the infection after years living in a non-endemic country, which could explain the similar prevalence found in endemic countries and in migrants living in Spain. This special characteristic of *S. stercoralis* could also explain why the prevalence in children and adults is very similar.

As expected, studies in which only *S. stercoralis* larvae investigation in faeces was performed for the diagnosis showed lower strongyloidiasis prevalence than studies that included serological tests. Moreover, most of the faeces-testing studies used very low-sensitivity techniques for strongyloidiasis diagnosis, such as the Ritchie technique or the Kato-Katz method. Only 4 studies used the Koga agar plate technique, which could moderately increase the

<table>
<thead>
<tr>
<th>Study</th>
<th>ES (95% CI)</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diaz, 2002</td>
<td>0.03 (0.02, 0.05)</td>
<td>6.67</td>
</tr>
<tr>
<td>Roca, 2002</td>
<td>0.00 (0.00, 0.01)</td>
<td>15.57</td>
</tr>
<tr>
<td>Huerga, 2002</td>
<td>0.01 (0.00, 0.06)</td>
<td>3.72</td>
</tr>
<tr>
<td>López-Vélez, 2003</td>
<td>0.01 (0.00, 0.02)</td>
<td>11.71</td>
</tr>
<tr>
<td>Martin-Sánchez, 2004</td>
<td>0.01 (0.00, 0.05)</td>
<td>5.08</td>
</tr>
<tr>
<td>Monge-Maillo, 2009</td>
<td>0.01 (0.01, 0.01)</td>
<td>15.07</td>
</tr>
<tr>
<td>Bocanegra, 2014</td>
<td>0.03 (0.02, 0.05)</td>
<td>4.56</td>
</tr>
<tr>
<td>Monge-Maillo, 2015</td>
<td>0.00 (0.00, 0.01)</td>
<td>15.34</td>
</tr>
<tr>
<td>Serre-Delcor, 2016</td>
<td>0.02 (0.01, 0.05)</td>
<td>3.78</td>
</tr>
<tr>
<td>Hendriquez-Hernández, 2016</td>
<td>0.01 (0.01, 0.02)</td>
<td>10.45</td>
</tr>
<tr>
<td>Serre-Delcor, 2018</td>
<td>0.01 (0.00, 0.03)</td>
<td>8.04</td>
</tr>
<tr>
<td>Overall (*I^2 = 71.62%, <em>P</em> = 0.00)</td>
<td>0.01 (0.01, 0.01)</td>
<td>100.00</td>
</tr>
</tbody>
</table>

Figure 2 Forest plots of prevalence of strongyloidiasis assessed by larvae detection in faeces.

© 2019 John Wiley & Sons Ltd
However, studies have shown contradictory results. A context of improving the sensitivity and preserve high specificity. In last decades, molecular methods, such as the polymerase chain reaction (PCR), have been developed in the context of *S. stercoralis* infection diagnosis with the aim of improving the sensitivity and preserve high specificity. However, studies have shown contradictory results. A recent meta-analysis by Buonfrate et al showed sensitivity from 56% to 71% depending on the PCR technique used vs. any other methods (including serological tests), although specificity reached high levels (93–95%). These techniques are thus not useful for screening, but could be used as confirmatory tests.

Four studies focused on patients with immunosuppression: three on HIV-infected patients and one on patients with oncohematological malignancies [22–24,28]. Surprisingly, we found no more studies on populations at risk of developing a severe strongyloidiasis, such as patients receiving corticosteroid therapy or organ transplantation [4]. It is important to note that, in the case of HIV infection, the risk factor for dissemination is more associated with the recovery of the CD4 cell count in patients under antiretroviral therapy than to the immunosuppression itself [37]. This lack of information stresses the importance of prevalence studies among more at-risk populations. Several factors make *S. stercoralis* infection very suitable for screening at primary care level among migrant

![Figure 3](https://example.com) Forest plots of seroprevalence of *Strongyloides stercoralis* infection. (a) global prevalence; (b) Prevalence in patients coming from sub-Saharan Africa; (c) Prevalence in patients coming from Latin America; and (d) Prevalence in patients coming from North Africa.

sensitivity compared with the other techniques. Another test that could show higher strongyloidiasis prevalence would be the Baermann technique, but it was not used in any of the included studies [35]. Fortunately, serological techniques developed in the last decades have high sensitivity, especially the ELISA-based techniques that were used in the included studies [6]. However, strongyloidiasis prevalence when measured by serological methods could be overestimated. Cross-reactivity problems and specificity issues may be solved by increasing the cut-off value to consider a positive result, and these techniques have been proved to be very useful in the follow-up control after treatment [3,7,8]. Taking into account all this information, to include a serological test in the *S. stercoralis* infection diagnosis should be mandatory.

In last decades, molecular methods, such as the polymerase chain reaction (PCR), have been developed in the context of *S. stercoralis* infection diagnosis with the aim of improving the sensitivity and preserve high specificity. However, studies have shown contradictory results. A
populations: it is a prevalent, it is asymptomatic in most cases, a very sensitive diagnostic test is available (serology), treatment (ivermectin) is effective and safe, and proper management can avoid severe clinical presentations. Although ivermectin is a safe drug, it is important to rule out loiasis in patients coming endemic areas for this filarial nematode prior to the treatment, given the risk of encephalopathy in patients with high microfilaremia.

Other strategies may include community screening campaigns, as described by Monge-Maillo et al, where two infectious diseases (strongyloidiasis and Chagas diseases) were screened among a Latin American population [32]. In fact, co-infection of these two parasites has been frequently observed in some studies, probably because they share geographical and socio-economical risk factors [26,29,33]. Moreover, strongyloidiasis increases the likelihood of detecting Trypanosoma cruzi DNA in peripheral blood in chronic Chagas disease patients, probably due to immunomodulatory effects of the nematode [29].

As every systematic review, ours has a publication bias: studies not published nor presented at congresses were not included in the present study. Other limitations include the various low-sensitivity microbiological techniques used to detect S. stercoralis larvae and the fact that certain geographical origins of migrants were under-represented (North Africa, Asia and Eastern Europe). Almost all studies were performed in specialised tropical medicine units, which may have led to selection bias. However, all studies in which serological techniques were performed used similar commercial ELISA-based tests, and migrants from Latin America and sub-Saharan Africa were extensively represented. Moreover, these results may be applicable to other non-endemic countries with similar migrant populations.

Conclusion
Migrants from strongyloidiasis-endemic areas who live in Spain have a high S. stercoralis infection prevalence, particularly people from sub-Saharan Africa and Latin America. Special attention must be paid to patients with any kind of present or impending immunosuppression. Given the prevalence, the risk of severe outcomes, and the effective and safe treatment available (ivermectin), migrants from endemic areas should be screened for strongyloidiasis. Serology is the most sensitive tool for S. stercoralis infection screening, and it could be easily implemented at primary care level. These recommendations are in accordance with the recent guidelines published by the European Centre for Disease Prevention and Control regarding the screening for infectious diseases in newly arrived migrants to the European Union, where strongyloidiasis screening through serological methods is recommended for all migrants from countries of high endemcity in Asia, Africa, the Middle East, Oceania and Latin America [38].

References


