# Report on the Programme for the Prevention and Control of Congenital Chagas Disease in Catalonia

## Period 2010-2022

**September 2024**

Generalitat de Catalunya

**Coordinated by:** Pilar Ciruela, María José Vidal

**Authors:** Pilar Ciruela, Jacobo Mendioroz, Marta Palazón and María José Vidal

**Acknowledgments:** to the working group on congenital Chagas disease in Catalonia and to all the healthcare professionals in the public and private healthcare network in Catalonia.



**Promoting unit:**

Subdirectorate-General for Public Health Surveillance and Emergency Response. ASPCAT.

**1st edition:**

Barcelona, September 2024

**Editorial advice:**

Cabinet of the Advisor. Publishing services.

**Language advice:**

Language Planning Service of the Ministry of Health.

**Editorial Plan 2025:**

Record no.: 13555

Design of accessible template 1.08.
Communication Office. Corporate Identity.

# Contents

# 1 Foreword

Chagas disease is a global problem included in the Sustainable Development Goals of the United Nations (UN) 2030 Agenda. Against this backdrop, the World Health Organisation (WHO) urges countries to combat and eradicate congenital transmission of Chagas disease. To this end, it calls for rolling out, ramping up and pooling efforts to eliminate vertical transmission of *Trypanosoma cruzi*.

In 2010, the Secretariat of Public Health kicked off the Programme for the Prevention and Control of Congenital Chagas Disease in Catalonia. This Programme targets pregnant women infected with *T. cruzi* and their children. It is especially aimed at women from countries endemic for this disease living in Catalonia, yet not exclusively, as it also covers any pregnant woman or woman of childbearing age who has spent more than one month in an endemic area where the vector is present. The Programme's priorities include diagnosing, monitoring, follow-up, treatment and epidemiological surveillance of the disease based on demographic trends and the social determinants of health.

The Programme's work dynamics call for a multidisciplinary approach to deliver an effective response. This involves partnership and cooperation between healthcare professionals in the specialities of obstetrics and gynaecology in primary and hospital sexual and reproductive healthcare, microbiology, primary and hospital paediatrics, family medicine and community health, midwifery, infectious diseases, epidemiology, and public and community health.

## 2 Introduction

Chagas disease is a parasitic infection caused by *T. cruzi*. It afflicts millions of people in endemic areas of 21 countries in Latin America. It is found mainly in rural areas of Central and South American countries except for the Caribbean islands, and overlaps with the distribution of the vector insect in the triatomine family, which is responsible for vector transmission of the parasite to humans.[1,2]

The WHO estimates that about 25% of the population in these countries is exposed to the disease. Since 2015, Chagas disease has been classified as a neglected tropical disease by the WHO.[3]

Owing to worldwide globalisation, which gained momentum towards the end of the 20th century, the disease has become a global epidemic, as it has spread to other non-endemic geographical areas. The mean prevalence of infection by *T. cruzi* in populations from endemic areas in Europe is 4.2%.[1,4]

It is estimated that there are around 8 million *T. cruzi*-infected people in the world, with between 68,000 and 122,000 of them thought to be living in Europe. The European country with the highest number of infected people is Spain, accounting for an estimated 48,000 to 87,000 people.[1,5]

In endemic areas, the main mechanisms of transmission are vector-borne, followed by congenital transmission and digestive transmission through contaminated food and drink. Transmission through blood transfusions and organ and tissue transplants from infected donors is less frequent, as legislation is in place to ensure the quality and safety of donations and, in particular, to prevent the transmission of infectious diseases. In non-endemic countries, the main mechanism of *T. cruzi* transmission is congenital transmission. [1,4,5]

Following the WHO recommendation to non-endemic countries to take appropriate measures to prevent and control vertical transmission,[6-8] in Spain some regions (Region of Valencia in 2009, Catalonia in 2010 and Galicia in 2013) have rolled out programmes to screen for, treat and cure cases of congenital *T. cruzi* infection.[9-11] These programmes play a crucial role in curing newborns with congenital infection. The literature reports a cure rate of almost 100% for infants treated before the age of one year.[12,13] Women who have been treated before becoming pregnant are also less likely to transmit the disease to their children.[14-16]

In Catalonia, the Programme for the Prevention and Control of Congenital Chagas Disease in Catalonia was set up in 2010, coordinated by the Subdirectorate-General for Public Health Surveillance and Emergency Response (SGVRESP) at the Secretariat of Public Health.[9] In 2018, the protocol for screening, diagnosing and treating Chagas disease in Latin American pregnant women and their children was updated as part of the Programme.[1]

This report presents the results of the Programme's epidemiological surveillance during the 2010-2022 period.

# 3 Methodology

Under Decree 203/2015,[17] setting up the Epidemiological Surveillance Network of Catalonia and regulating the Notification System for notifiable diseases and epidemic outbreaks, *T. cruzi* is now a notifiable microorganism using the Microbiological Notification System of Catalonia (SNMC). Public and private laboratories are responsible for reporting confirmed cases of *T. cruzi* to the SNMC.

## 3.1 Case definition

Screening and diagnostic circuits for pregnant women, newborns and other children are described in the *Protocol for screening, diagnosis and treatment of Chagas disease in Latin American pregnant women and their children*.[1]

Clinical criteria

The disease progresses in two phases: acute and chronic. The acute phase presents few and usually non-specific symptoms,[1, 2] meaning that in most cases it goes unnoticed or is mistaken for other conditions. In the chronic symptomatic phase, complications can be severe and lead to death, especially if cardiac abnormalities are present.[18]

Epidemiological criteria and target population

Pregnant women:

- Who are from any of the 21 countries endemic for Chagas disease.
- Whose mother was originally from endemic countries even if the patient was born in Catalonia.
- Who have been in endemic areas with vector presence for more than one month.

Classification of cases
Suspicious case:

- Pregnant woman who meets the clinical criteria and presents epidemiological criteria.
- Babies of women with *T. cruzi* infection.
- Other children of women infected with *T. cruzi*.

Confirmed case:

- Pregnant woman resident in Catalonia diagnosed with *T. cruzi* infection before or during the pregnancy period, at the time of delivery or after delivery.
- Babies born in Catalonia with a positive diagnostic test for *T. cruzi*.
- Other children from women with Chagas disease who have a positive diagnostic test for *T. cruzi*.

Confirmed cases are entered in the Registry of Congenital Chagas Disease in Catalonia (RMCC). This registry compiles demographic, clinical and epidemiological information on women diagnosed with *T. cruzi* infection who have had a pregnancy in Catalonia since 2010, their children born in Catalonia from these pregnancies, and the rest of their children living in Catalonia. The professional who diagnoses and follows up the case is the person in charge of providing the demographic and clinical-epidemiological data gathered in the epidemiological survey: one for the mother and another for the baby or other infection-positive children. This information is entered in the RMCC, and from then on, the cases are followed up in conjunction with the key professionals until the case is closed.

### 3.2 Follow-up of pregnant women with *T. cruzi* infection

Under the Pregnancy Follow-up Protocol in Catalonia, any pregnant woman with a positive serological result for *T. cruzi* is considered to have a high-risk pregnancy.[19]

Screening is run using a serological test. If the test has a positive result, a serological diagnostic confirmation test is carried out with an antigen other than the one used in the screening test. If there is a discrepancy between the screening and diagnostic confirmation tests, a third tie-breaker test different from the previous tests is performed.

Women can be treated after pregnancy and breastfeeding.

### 3.3 Diagnosis of congenital infection by *T. cruzi* and follow-up of a newborn with a positive diagnostic test

After birth, if congenital transmission of the baby is confirmed by parasitological tests (positive microhaematocrit at birth), molecular methods (positive PCR one month after birth) or serological methods at 9 months after birth, the baby should start treatment with benznidazole or nifurtimox according to the guidelines in the *Protocol for screening, diagnosis and treatment of Chagas disease in pregnant Latin American women and their children*.[1]

Conversely, if the 9-month serology is negative, the case is closed.

### 3.4 Follow-up of other children with congenital *T. cruzi* infection

Other children of *T. cruzi* seropositive mothers living in Catalonia must be screened for Chagas disease.[1] This screening consists of a serological test to spot antibodies to *T. cruzi*. In case of a positive serological result, the serological test is repeated with a different antigen to confirm diagnosis. In case of discrepancy between the two tests, a third serological tie-breaker test is performed with a different antigen than in the previous tests. If Chagas disease is diagnosed, treatment should be started as soon as possible.

### 3.5 Programme evaluation indicators

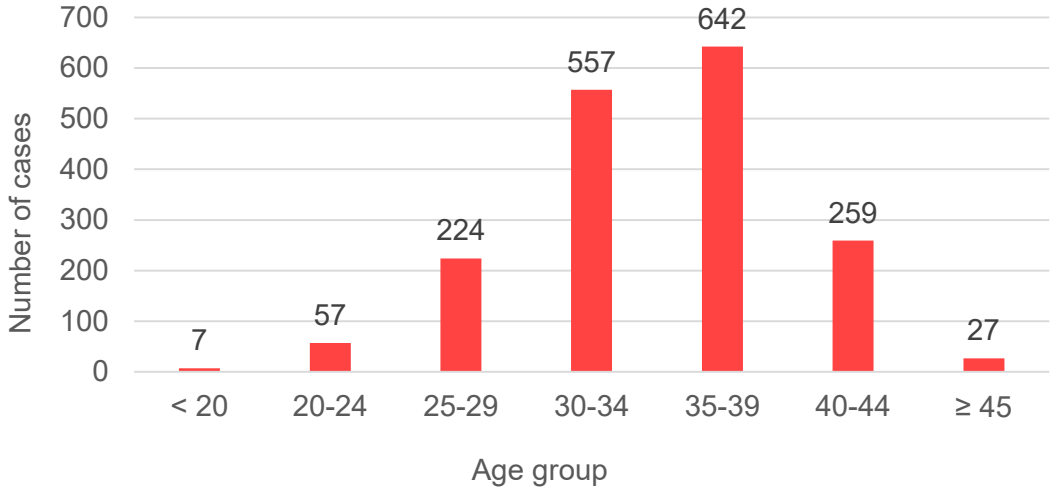
The following indicators have been drawn up to evaluate the Programme and estimate the burden of the disease: Programme coverage rate, prevalence rate of Chagas disease in pregnant women and rate of congenital transmission of Chagas disease.

## 4 Results

### 4.1 Pregnant women

During the 2010-2022 period, *T. cruzi* infection was detected in 1,773 pregnant women in Catalonia. A total of 52.2% (n = 925) were pregnant more than once. Most cases were identified in women aged 35-39 years (36.2%; 642 cases) (figure 1). The mean age of the women was 34.5 years (range 18-50), slightly higher than the mean age of pregnant women in Catalonia (33 years; range 13-56 years).[20]

Figure 1. Distribution of pregnant women diagnosed with Chagas disease according to age group. Catalonia 2010-2022




Source: Register of Congenital Chagas Disease in Catalonia. Subdirectorate-General for Public Health Surveillance and Emergency Response. Secretariat of Public Health.

The country of origin is indicated for almost all (99%) of the 1,773 pregnant women diagnosed in the study period (table 1). 90.6% of the women were from Bolivia, followed by Paraguay (2.9%) and Argentina (1.5%). These findings are consistent with other studies[21,22] which report a higher number of cases acquired by vertical transmission in these countries.

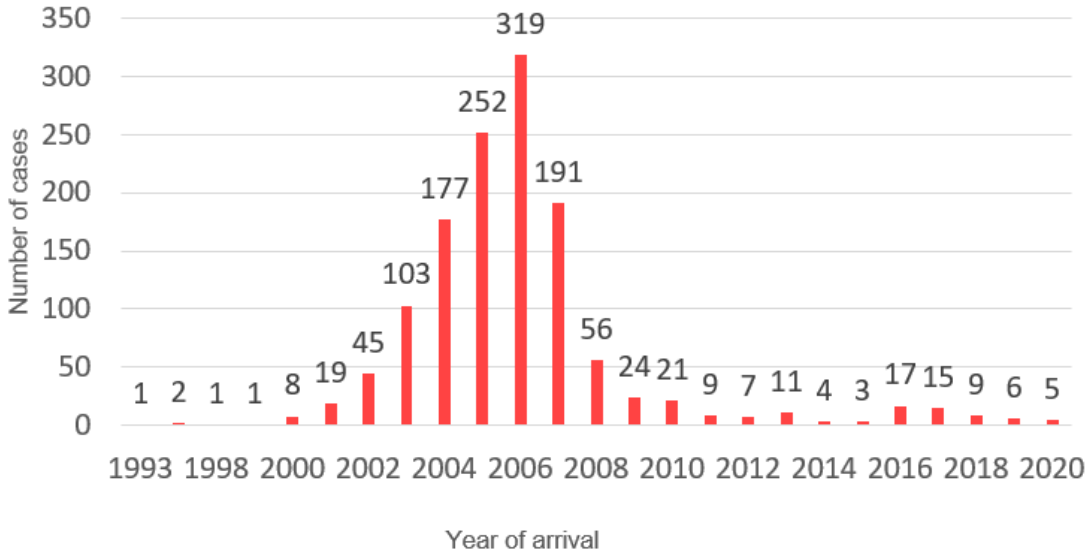
Table 1. Distribution of pregnant women diagnosed with Chagas disease according to country of origin. Catalonia 2010-2022

| Country of origin | Year | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | Total |
| | *n* | *n* | *n* | *n* | *n* | *n* | *n* | *n* | *n* | *n* | *n* | *n* | *n* | *n* |
| Argentina | 2 | 4 | 2 | 0 | 1 | 5 | 2 | 2 | 2 | 4 | 1 | 1 | 0 | 26 |
| Bolivia | 121 | 163 | 161 | 161 | 148 | 146 | 137 | 137 | 115 | 121 | 90 | 64 | 42 | 1,606 |
| Colombia | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 2 | 6 |
| Ecuador | 1 | 2 | 2 | 3 | 0 | 1 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 11 |
| El Salvador | 0 | 0 | 2 | 0 | 2 | 0 | 3 | 2 | 3 | 1 | 1 | 2 | 1 | 17 |
| Spain | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 2 |
| Honduras | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 4 | 0 | 4 | 4 | 0 | 2 | 20 |
| Nicaragua | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 2 |
| Paraguay | 2 | 9 | 2 | 5 | 3 | 2 | 6 | 3 | 8 | 6 | 4 | 1 | 0 | 51 |
| Peru | 2 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 6 |
| Venezuela | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| Chile | 1 | 1 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 6 |
| Not reported | 0 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 4 | 10 | 18 |
| **Total** | **129** | **183** | **176** | **172** | **155** | **156** | **149** | **151** | **130** | **138** | **104** | **73** | **57** | **1,773** |

Source: Registry of Congenital Chagas Disease in Catalonia. Subdirectorate General for Public Health Surveillance and Emergency Response. Secretariat of Public Health.

As to the distribution of cases by year of arrival in Europe, information was gathered for 73.7% of cases (n = 1,306). 79.8% of cases (n = 1,042) arrived between 2003 and 2007 (figure 2). This is in line with the increase in migratory flows in early 21st century, which then declined from 2008 onwards against the background of the recession, as part of the migrant population returned to their countries of origin.[23]

Figure 2. Distribution of pregnant women diagnosed with Chagas disease according to year of arrival in Europe. Catalonia 2010-2022[1]



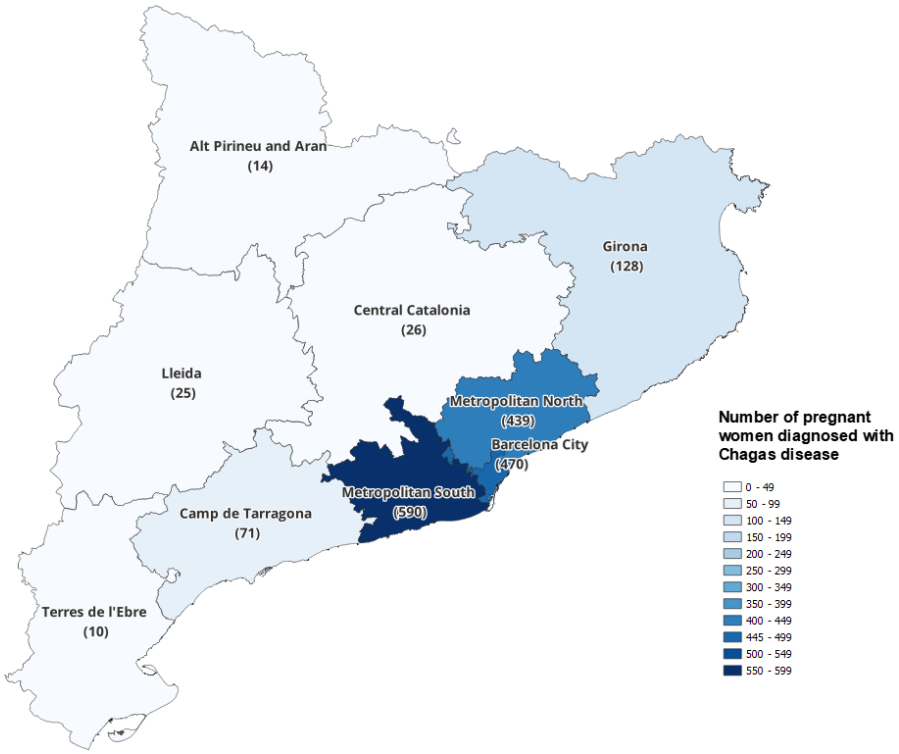

Source: Register of Congenital Chagas Disease in Catalonia. Subdirectorate-General for Public Health Surveillance and Emergency Response. Secretariat of Public Health.

By health region of residence of pregnant women diagnosed with Chagas disease, 84.6% of the cases were in the health regions of Barcelona Metropolitan South (n = 590), Barcelona (city) (n = 470) and Barcelona Metropolitan North (n = 439) (figure 3). These health regions are home to the largest proportion of people from North and Central America and South America.[24,25]

As for the rest of health regions, 7.2% (n = 128) of women live in the Girona Health Region, 4.0% (n = 71) in the Camp de Tarragona Health Region, 1.4% (n = 25) in the Lleida Health Region, 1.4% (n = 26) in the Central Catalonia Health Region, 0.8% (n = 14) in the Alt Pirineu and Aran Health Region, and 0.6% (n = 10) in the Terres de l'Ebre Health Region (table 2).

[1] No pregnant women from endemic areas were reported in 2021 and 2022.

Figure 3. Distribution of pregnant women diagnosed with Chagas disease according to health region. Catalonia 2010-2022




Source: Register of Congenital Chagas Disease in Catalonia. Subdirectorate-General for Public Health Surveillance and Emergency Response. Secretariat of Public Health.

Table 2. Distribution of pregnant women diagnosed with Chagas disease by health region. Catalonia 2010-2022.

| Health regions | Year | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | Total | |
| | *n* | *n* | *n* | *n* | *n* | *n* | *n* | *n* | *n* | *n* | *n* | *n* | *n* | *n* | *%* |
| Alt Pirineu and Aran | 2 | 0 | 1 | 1 | 3 | 0 | 1 | 1 | 0 | 1 | 1 | 2 | 1 | 14 | 0.8 |
| Barcelona City | 26 | 56 | 63 | 45 | 40 | 43 | 38 | 39 | 33 | 29 | 29 | 14 | 15 | 470 | 26.5 |
| Barcelona Metropolitan North | 47 | 43 | 44 | 46 | 34 | 37 | 37 | 36 | 32 | 34 | 23 | 12 | 14 | 439 | 24.8 |
| Barcelona Metropolitan South | 36 | 65 | 48 | 61 | 61 | 49 | 51 | 52 | 42 | 43 | 38 | 30 | 14 | 590 | 33.3 |
| Camp de Tarragona | 1 | 2 | 7 | 7 | 7 | 7 | 12 | 8 | 5 | 4 | 3 | 3 | 5 | 71 | 4.0 |
| Central Catalonia | 4 | 0 | 2 | 0 | 0 | 0 | 4 | 0 | 5 | 4 | 3 | 2 | 2 | 26 | 1.4 |
| Girona | 10 | 16 | 9 | 8 | 8 | 13 | 3 | 13 | 12 | 17 | 4 | 9 | 6 | 128 | 7.2 |
| Lleida | 3 | 1 | 2 | 2 | 1 | 4 | 3 | 1 | 0 | 5 | 2 | 1 | 0 | 25 | 1.4 |
| Terres de l'Ebre | 0 | 0 | 0 | 2 | 1 | 3 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 10 | 0.6 |
| **Total** | **129** | **183** | **176** | **172** | **155** | **156** | **149** | **151** | **130** | **138** | **104** | **73** | **57** | **1,773** | **100** |

Source: Register of Congenital Chagas Disease in Catalonia. Subdirectorate-General for Public Health Surveillance and Emergency Response. Secretariat of Public Health.

The form of the disease is known in 80.7% (n = 1,428) of pregnant women diagnosed with Chagas disease. 95.1% (n = 1,358) of these women have the chronic indeterminate form; 3.2% (n = 47), the chronic cardiac form; 1.3% (n = 18), the digestive form, and 0.4% (n = 5), the mixed form. Several investigators report that the chronic indeterminate form of the disease may persist throughout a person's life with no signs or symptoms of the disease, and those anatomical and histopathological inflammatory *T. cruzi* lesions are focal and microscopic.[26] Other researchers note that these lesions may progress to myocardial, digestive or mixed involvement, or they may be a balance between host and parasite with no potential for progression.[15,21,26] Furthermore, a large proportion of pregnant women with Chagas disease may be at increased risk of preterm delivery, low birth weight and stillbirth.[21]

Table 3. Distribution of pregnant women diagnosed with Chagas disease by form of the disease. Catalonia 2010-2022

| Form of the disease | Year | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | Total | |
| | *n* | *n* | *n* | *n* | *n* | *n* | *n* | *n* | *n* | *n* | *n* | *n* | *n* | *n* | *%* |
| Indeterminate chronic | 108 | 129 | 129 | 118 | 101 | 121 | 127 | 126 | 110 | 111 | 78 | 65 | 35 | 1,358 | 76.6 |
| Cardiac chronic | 3 | 9 | 3 | 1 | 7 | 3 | 5 | 1 | 4 | 3 | 4 | 0 | 4 | 47 | 2.6 |
| Digestive chronic | 0 | 1 | 1 | 5 | 3 | 0 | 1 | 2 | 3 | 0 | 2 | 0 | 0 | 18 | 1.0 |
| Mixed chronic | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 5 | 0.3 |
| Not reported | 17 | 43 | 42 | 47 | 44 | 32 | 16 | 21 | 13 | 24 | 20 | 8 | 18 | 345 | 19.5 |
| **Total** | **129** | **183** | **176** | **172** | **155** | **156** | **149** | **151** | **130** | **138** | **104** | **73** | **57** | **1,773** | **100** |

Source: Register of Congenital Chagas Disease in Catalonia. Subdirectorate-General for Public Health Surveillance and Emergency Response. Secretariat of Public Health.

56.4% (n = 1,000) of cases were diagnosed during pregnancy; 25.5% (n = 453) had been diagnosed in a previous pregnancy; 13.8% (n = 244) were already diagnosed before pregnancy; 2.3% (n = 40), at the time of delivery; and 2.0% (n = 36), after delivery (table 4). The number of cases diagnosed before pregnancy increased over the years (5.4% in 2010 and 42.1% in 2022). Likewise, the number of cases diagnosed at delivery and after delivery fell (15.5% in 2010 and 1.7% in 2022). These aspects reflect on the fact that the Programme has been consolidated over time as its implementation has steadily improved.

Table 4. Distribution of pregnant women diagnosed with Chagas disease by time of diagnosis. Catalonia 2010-2022

| Time of diagnosis | Year | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | Total | |
| | *n* | *n* | *n* | *n* | *n* | *n* | *n* | *n* | *n* | *n* | *n* | *n* | *n* | *n* | *%* |
| During pregnancy | 102 | 152 | 137 | 120 | 101 | 99 | 87 | 71 | 44 | 34 | 27 | 11 | 15 | 1,000 | 56.4 |
| In previous pregnancies | 0 | 6 | 16 | 27 | 35 | 36 | 48 | 55 | 63 | 66 | 45 | 39 | 17 | 453 | 25.5 |
| Before pregnancy | 7 | 10 | 12 | 24 | 15 | 17 | 10 | 21 | 14 | 37 | 31 | 22 | 24 | 244 | 13.8 |
| During delivery | 14 | 11 | 6 | 0 | 2 | 2 | 2 | 0 | 2 | 1 | 0 | 0 | 0 | 40 | 2.3 |
| After delivery | 6 | 4 | 5 | 1 | 2 | 2 | 2 | 4 | 7 | 0 | 1 | 1 | 1 | 36 | 2.0 |
| **Total** | **129** | **183** | **176** | **172** | **155** | **156** | **149** | **151** | **130** | **138** | **104** | **73** | **57** | **1,773** | **100** |

Source: Register of Congenital Chagas Disease in Catalonia. Subdirectorate-General for Public Health Surveillance and Emergency Response. Secretariat of Public Health

82.5% of cases (n = 1,463) completed the pregnancy at term; 14.6% (n = 259) were unsuccessful pregnancies; and in 2.9% of cases this information is unknown (n = 51) (table 5). As to unsuccessful pregnancies, 50.6% (n = 131) were miscarriages; 35.5% (n = 92) were voluntary terminations of pregnancy; 5.4% (n = 14) were stillbirths; in 5% (n = 13) had an abortion of unspecified type; and 3.5% (n = 9) had a therapeutic abortion (table 6). A Canadian report shows a prevalence of miscarriages between 15-25% during period 2005-2014[27] while in Spain a cohort study describes 12% of multifactorial miscarriages during period 2002-2015.[28] Likewise, the literature also reports an increase in miscarriages and stillbirths in pregnant women with *T. cruzi* infection and associates this with the presence of trophoblastic and chorionic villus alterations attributable to the infection.[29-31]

Furthermore, some researchers suggest potential under-reporting of miscarriages and stillbirths due to *T. cruzi*.[32]

Table 5. Distribution of pregnant women diagnosed with Chagas disease by the way the pregnancy ended. Catalonia 2010-2022

| Way the pregnancy ended | Year | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | Total | |
| | *n* | *n* | *n* | *n* | *n* | *n* | *n* | *n* | *n* | *n* | *n* | *n* | *n* | *n* | *%* |
| Delivery | 114 | 158 | 143 | 147 | 134 | 134 | 129 | 121 | 103 | 112 | 68 | 57 | 43 | 1,463 | 82.5 |
| Abortion | 7 | 17 | 21 | 22 | 18 | 17 | 18 | 28 | 23 | 24 | 36 | 16 | 12 | 259 | 14.6 |
| Lost to follow-up | 8 | 8 | 12 | 3 | 3 | 5 | 2 | 2 | 4 | 2 | 0 | 0 | 2 | 51 | 2.9 |
| **Total** | **129** | **183** | **176** | **172** | **155** | **156** | **149** | **151** | **130** | **138** | **104** | **73** | **57** | **1,773** | **100** |

Source: Register of Congenital Chagas Disease in Catalonia. Subdirectorate General for Public Health Surveillance and Emergency Response. Secretariat of Public Health.

Table 6. Distribution of pregnant women diagnosed with Chagas disease by type of abortion. Catalonia 2010-2022

| Type of abortion | Year | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | Total | |
| | *n* | *n* | *n* | *n* | *n* | *n* | *n* | *n* | *n* | *n* | *n* | *n* | *n* | *n* | *%* |
| Miscarriage | 1 | 9 | 13 | 13 | 9 | 12 | 8 | 15 | 14 | 13 | 15 | 6 | 3 | 131 | 50.6 |
| Voluntary | 0 | 3 | 2 | 7 | 6 | 2 | 9 | 11 | 6 | 10 | 19 | 10 | 7 | 92 | 35.5 |
| Stillbirth | 0 | 1 | 3 | 2 | 0 | 2 | 1 | 0 | 2 | 0 | 1 | 0 | 2 | 14 | 5.4 |
| Not specified | 4 | 4 | 1 | 0 | 1 | 0 | 0 | 2 | 0 | 0 | 1 | 0 | 0 | 13 | 5.0 |
| Therapeutic | 2 | 0 | 2 | 0 | 2 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 9 | 3.5 |
| **Total** | **7** | **17** | **21** | **22** | **18** | **17** | **18** | **28** | **23** | **24** | **36** | **16** | **12** | **259** | **100** |

Source: Register of Congenital Chagas Disease in Catalonia. Subdirectorate-General for Public Health Surveillance and Emergency Response. Secretariat of Public Health.

Over the course of the Programme, 2.9% of cases have been lost (51/1,773), with a downward trend, falling to 0 cases in the last three years. Of these, in 84.3% of cases (n = 43) the woman left Catalonia and the remaining 15.7% (n = 8) were lost to follow-up.

These losses are mainly because the woman did not show up for the scheduled consultation or because it was impossible to trace her for a reschedule, which made it difficult to ensure appropriate follow-up.

Table 7. Distribution of pregnant women diagnosed with Chagas disease by reason for loss of case. Catalonia 2010-202

| | Year | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Reasons for losing the case** | **2010** | **2011** | **2012** | **2013** | **2014** | **2015** | **2016** | **2017** | **2018** | **2019** | **2020** | **2021** | **2022** | **Total** | |
| | ***n*** | ***n*** | ***n*** | ***n*** | ***n*** | ***n*** | ***n*** | ***n*** | ***n*** | ***n*** | ***n*** | ***n*** | ***n*** | ***n*** | ***%*** |
| Left Catalonia | 4 | 5 | 12 | 3 | 3 | 5 | 2 | 2 | 4 | 1 | 0 | 0 | 2 | 43 | 84.3 |
| Lost to follow-up | 4 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 8 | 15.7 |
| **Total** | **8** | **8** | **12** | **3** | **3** | **5** | **2** | **2** | **4** | **2** | **0** | **0** | **2** | **51** | **100** |

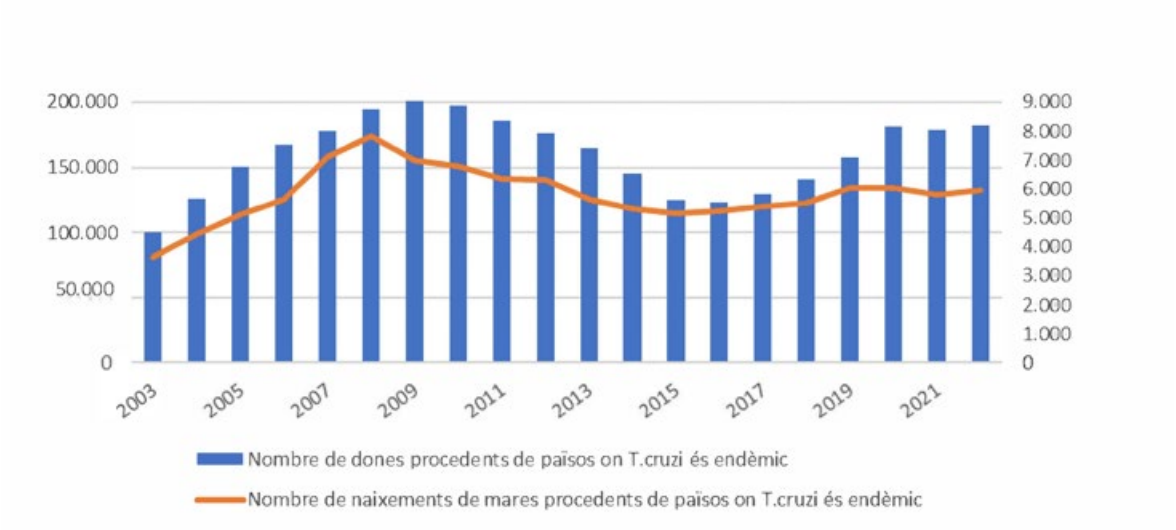
Source: Register of Congenital Chagas Disease in Catalonia. Subdirectorate-General for Public Health Surveillance and Emergency Response. Secretariat of Public Health.

## 4.2 Live births

Table 8 shows the number of live births in Catalonia to mothers from countries endemic for Chagas disease between 2010 and 2022 (n = 75,349). This number of births represents 8.5% of total births in Catalonia (n = 889,847).[20]

Figure 4 shows an increase in both women from endemic countries and their children. From 2008 onwards, there is a drop in both variables, most likely due to recession. From 2018 onwards, the number of women from these countries tends to increase while the number of babies born to mothers from countries in endemic regions presents a more sustained trend.

Figure 4. Distribution of the number of women from *T. cruz*i endemic countries and babies born to women from these countries. Catalonia 2010-2022




Source: Idescat, based on the Annual Population Census.//Newborns Registry. Subdirectorate-General for Public Health Surveillance and Emergency Response. Secretariat of Public Health

Table 8. Babies born to mothers from endemic countries according to the health region of residence at the time of birth. Catalonia 2010-2022

**Year**

| Health region | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Barcelona City | 1,925 | 1,734 | 1,812 | 1,726 | 1,506 | 1,532 | 1,507 | 1,488 | 1,596 | 1,765 | 1,732 | 1,665 | 1,652 | 21,640 |
| Metropolitan North | 1,661 | 1,612 | 1,600 | 1,394 | 1,358 | 1,224 | 1,281 | 1,266 | 1,336 | 1,405 | 1,461 | 1,358 | 1,473 | 18,429 |
| Metropolitan South | 1,608 | 1,497 | 1,418 | 1,261 | 1,288 | 1,258 | 1,289 | 1,212 | 1,326 | 1,404 | 1,345 | 1,365 | 1,375 | 17,646 |
| Girona | 686 | 631 | 626 | 549 | 546 | 558 | 538 | 549 | 584 | 693 | 644 | 620 | 636 | 7,860 |
| Camp de Tarragona | 408 | 388 | 340 | 300 | 269 | 239 | 256 | 274 | 294 | 339 | 356 | 332 | 331 | 4,126 |
| Central Catalonia | 198 | 190 | 222 | 160 | 132 | 153 | 180 | 157 | 188 | 175 | 223 | 199 | 211 | 2,388 |
| Lleida | 152 | 155 | 158 | 125 | 119 | 107 | 110 | 131 | 96 | 158 | 158 | 145 | 157 | 1,771 |
| Alt Pirineu and Aran | 81 | 75 | 56 | 59 | 66 | 58 | 50 | 35 | 45 | 65 | 64 | 44 | 67 | 765 |
| Terres de l'Ebre | 76 | 60 | 69 | 60 | 46 | 46 | 42 | 42 | 57 | 37 | 64 | 61 | 64 | 724 |
| **Total** | **6,795** | **6,342** | **6,301** | **5,634** | **5,330** | **5,175** | **5,253** | **5,154** | **5,522** | **6,041** | **6,047** | **5,789** | **5,966** | **75,349** |

Source: Newborns Registry. Subdirectorate-General for Public Health Surveillance and Emergency Response. Secretariat of Public Health

### 4.2.1 Follow-up with microhaematocrit at birth and/or PCR one month after birth

Of the total of 1,463 babies born to mothers diagnosed with Chagas disease, 3.4% of cases (n = 49) were not reported directly to the Programme for a microhaematocrit (MH) test at birth. By means of active search and without finding evidence of the test being performed, these cases are included as cases with no test performed.

In 34.3% of cases (n = 502), the test was performed at birth (table 9). This low percentage is consistent with the recommendation to test only in centres which are experienced in this procedure. Use of MH to detect *T. cruzi* declined significantly since the start of the Programme (64% in 2010 and 7% in 2022).

Five (1% of cases) out of the total number of MH tests performed in the entire period of analysis were positive for *T. cruzi* between 2010 and 2013 (table 10).

Of the total of 1,463 babies born to mothers diagnosed with Chagas disease, 2.9% of cases (n = 43) were not reported directly to the Programme for PCR testing. By means of active search and without finding evidence of the test being performed, these cases are included as cases with no test performed.

Of the reported cases, 79.3% (n = 1,160) had a PCR test performed one month after birth (tables 9 and 10). Use of PCR steadily increased until 2018 (86.4%) and then declined significantly in 2022 (46.5%). 1.6% of the total number of PCRs performed between 2010 and 2022 (n = 1,160) were positive (n = 18) (table 10). Six of these had been previously microhaematocrit-tested. Three cases were positive for both microhaematocrit and PCR. The remaining 15 cases were diagnosed exclusively by PCR.

Table 9. Distribution of microhaematocrit, PCR and serology tests performed or not on babies born to mothers diagnosed with Chagas disease. Catalonia 2010-2022

| Test performed | | Year | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | Total |
| | | n = 114 | n = 158 | n = 143 | n = 147 | n = 134 | n = 134 | n = 129 | n = 121 | n = 103 | n = 112 | n = 68 | n = 57 | n = 43 | n = 1,463 |
| MH | Yes | 73 | 61 | 70 | 77 | 74 | 72 | 32 | 18 | 8 | 12 | 1 | 1 | 3 | 502 |
| | No | 41 | 97 | 73 | 70 | 60 | 62 | 97 | 103 | 95 | 100 | 67 | 56 | 40 | 961 |
| | % performed | 64 | 38.6 | 49 | 52.4 | 55.2 | 53.7 | 24.8 | 14.9 | 7.8 | 10.7 | 1.5 | 1.8 | 7 | 34.3 |
| PCR | Yes | 84 | 100 | 112 | 123 | 113 | 108 | 116 | 105 | 89 | 96 | 54 | 40 | 20 | 1,160 |
| | No | 30 | 58 | 31 | 24 | 21 | 26 | 13 | 16 | 14 | 16 | 14 | 17 | 23 | 303 |
| | % performed | 73.7 | 63.3 | 78.3 | 83.7 | 84.3 | 80.6 | 89.9 | 86.8 | 86.4 | 85.7 | 79.4 | 70.2 | 46.5 | 79.3 |
| Serology | Yes | 93 | 124 | 113 | 119 | 121 | 118 | 116 | 113 | 93 | 107 | 57 | 47 | 29 | 1,250 |
| | No | 21 | 34 | 30 | 28 | 13 | 16 | 13 | 8 | 10 | 5 | 11 | 10 | 14 | 213 |
| | % performed | 81.6 | 78.5 | 79 | 81 | 90.3 | 88.1 | 89.9 | 93.4 | 90.3 | 95.5 | 83.8 | 82.5 | 67.4 | 85.4 |

Source: Register of Congenital Chagas Disease in Catalonia. Subdirectorate-General for Public Health Surveillance and Emergency Response. Secretariat of Public Health

Table 10. Distribution of microhaematocrit, PCR and serology tests performed and positive results. Catalonia 2010-2022

| Test performed | | Year 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | Total | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | n | n | n | n | n | n | n | n | n | n | n | n | n | n | % |
| MH | Yes | 73 | 61 | 70 | 77 | 74 | 72 | 32 | 18 | 8 | 12 | 1 | 1 | 3 | 502 | 34.3 |
| | Positive | 2 | 2 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 | |
| PCR | Yes | 84 | 100 | 112 | 123 | 113 | 108 | 116 | 105 | 89 | 96 | 54 | 40 | 20 | 1,160 | 79.3 |
| | Positive | 2 | 1 | 1 | 5 | 3 | 0 | 0 | 2 | 2 | 1 | 1 | 0 | 0 | 18 | |
| Serology | Yes | 93 | 124 | 113 | 119 | 121 | 118 | 116 | 113 | 93 | 107 | 57 | 47 | 29 | 1,250 | 85.4 |
| | Positive | 5 | 2 | 1 | 5 | 4 | 3 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 24 | |

Source: Register of Congenital Chagas Disease in Catalonia. Subdirectorate-General for Public Health Surveillance and Emergency Response. Secretariat of Public Health

### 4.2.2 Follow-up 9 months after birth

Of the total of 1,463 babies born to mothers diagnosed with Chagas disease, 2.3% of cases (n = 33) were not reported directly to the Programme for serology testing. By means of active search and without finding evidence of the test being performed, these cases are included as cases with no test performed. Table 9 shows that 85.4% of the babies were followed up at 9 months or more after birth (n = 1,250). Of these, 1.9% tested positive (n = 24) (table 10). Of these, 58.3% (n = 14) of the babies had not been detected by previous tests (microhaematocrit and CRP).

87.8% of babies completed follow-up for diagnosis of *T. cruzi* infection (table 11) while the remaining 12.2% of babies could not be successfully traced and were therefore included in the "lost to follow-up" group. The main causes of these losses are failure to attend the follow-up consultation (7.6%) or leaving Catalonia (4.6%), causes that have become less significant in recent years (2021: 1.7% and 1.7%, respectively; 2022: 2.3% and 0%, respectively). The data for recent years are under constant review as a result of the recovery of cases by public health in partnership with primary care and hospital paediatrics services.

### 4.2.3 Positive newborns

The risk of congenital transmission may be due to the complex interaction between the level of parasitaemia, maternal immune response, placental factors, and the characteristics of the infecting strain.[30,31,33]

In the 12 years of the duration of Programme, 34 babies were diagnosed with *T. cruzi* infection through congenital transmission, which is 2.6% (table 11). Diagnostic confirmation was by the microhaematocrit method at birth (14.7%), by PCR one month after birth (44.1%) and by serology 9 months after birth (41.2%). Since 2013, all cases have been diagnosed by PCR or serology.

Table 11. Distribution of newborns with a mother diagnosed with Chagas disease according to follow-up outcome. Catalonia 2010-2022

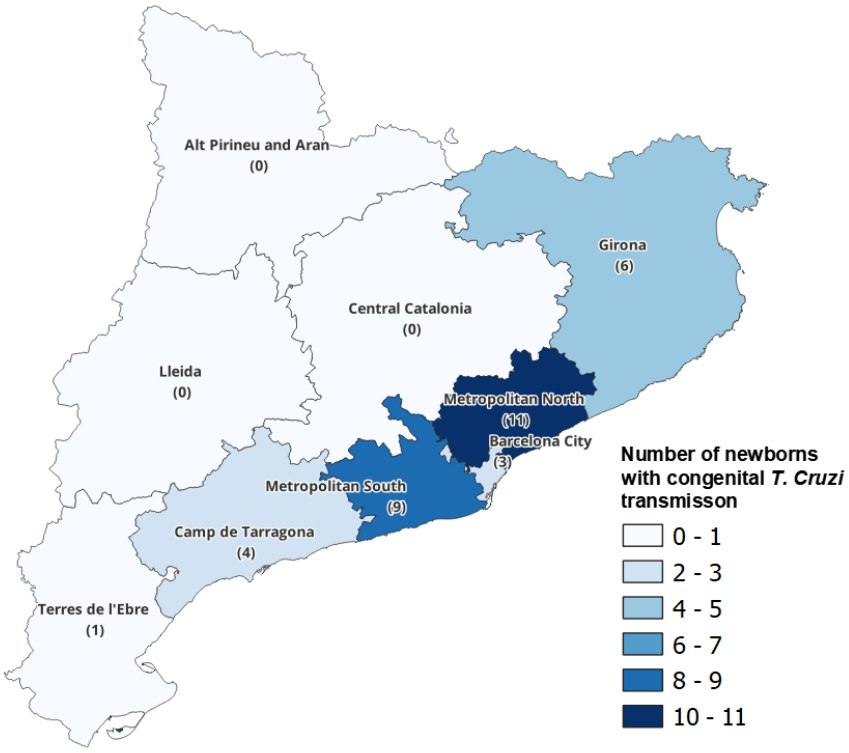
| | | Year | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Follow-up outcome** | | **2010** | **2011** | **2012** | **2013** | **2014** | **2015** | **2016** | **2017** | **2018** | **2019** | **2020** | **2021** | **2022** | **Total** | |
| | | **n** | **n** | **n** | **n** | **n** | **n** | **n** | **n** | **n** | **n** | **n** | **n** | **n** | **n** | **%** |
| Complete follow-up | | 93 | 125 | 113 | 120 | 122 | 118 | 116 | 113 | 94 | 108 | 65 | 55 | 42 | 1,284 | 87.7 |
| Follow-up lost | Left Catalonia | 2 | 13 | 12 | 18 | 9 | 2 | 4 | 1 | 3 | 1 | 1 | 1 | 0 | 67 | 4.6 |
| | Lost to follow-up | 19 | 20 | 18 | 9 | 3 | 14 | 9 | 7 | 6 | 3 | 2 | 1 | 1 | 112 | 7.6 |
| Positive newborns | | 7 | 4 | 2 | 8 | 5 | 3 | 0 | 1 | 2 | 1 | 1 | 0 | 0 | 34 | |
| Total | | 114 | 158 | 143 | 147 | 134 | 134 | 129 | 121 | 103 | 112 | 68 | 57 | 43 | 1,463 | |
| CTR[2] | | 7.5% | 3.2% | 1.8% | 6.7% | 4.1% | 2.5% | 0 | 0.9% | 2.1% | 0.9% | 1.5% | 0 | 0 | 2.6% | |

Source: Register of Congenital Chagas Disease in Catalonia. Subdirectorate-General for Public Health Surveillance and Emergency Response. Secretariat of Public Health

[2] Congenital transmission rate per 100 newborns.

Figure 5 shows the geographical distribution of confirmed cases of congenital *T. cruzi* transmission. 67.7% of the cases are in the health regions of Barcelona Metropolitan North, Barcelona Metropolitan South and Barcelona city. This would be accounted for by the same points made in figure 3.

Figure 5. Geographical distribution of newborns with congenital *T. cruzi* transmission in Catalonia and in the Barcelona Health Region. Catalonia 2010-2022




Source: Register of Congenital Chagas Disease in Catalonia. Subdirectorate-General for Public Health Surveillance and Emergency Response. Secretariat of Public Health.

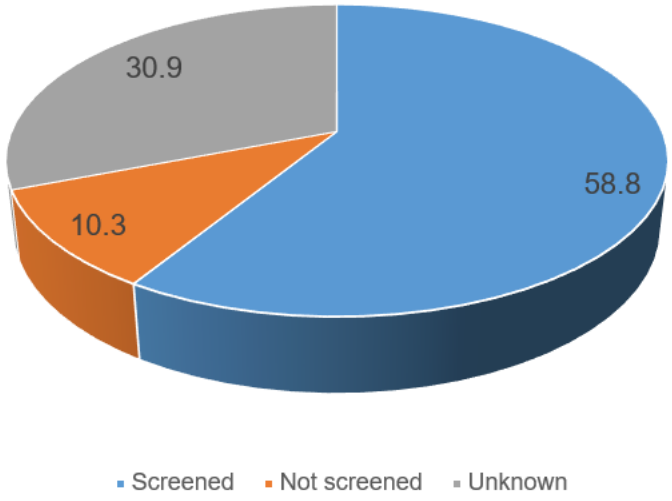
53% of the 34 newborns diagnosed with Chagas disease were girls (n=18) while 94.1% (n=32) successfully completed paediatric treatment with benznidazole. One child had to discontinue treatment due to adverse effects in 2010 and another child did due to an infectious disease at the end of treatment in 2018.

79.4% (n = 27) of the 34 babies diagnosed have been cured, presenting serological negativity, while 11.8% (n = 4) are awaiting post-treatment serological evolution, with progressive reductions in *T. cruzi* antibody levels observed in annual follow-up serologies. The evolution of the remaining 8.8% of cases (n = 3) is unknown due to failure to attend follow-up consultations, despite efforts to retrieve them, or because they had left Catalonia.

### 4.3 Other children

Out of the 1,773 pregnant women diagnosed with Chagas disease between 2010 and 2022, 1,578 (89%) provided the number of their other children living in Catalonia. Of these, 824 (52.2%) have at least one other child. The rest of the women either have no other children or do have them but they live outside Catalonia. In total, 835 other children in need of serological screening were notified (figure 6), of which 491 (58.8%) were reported to have completed a serological screening test. Twenty-six (5.3%) of these screened children tested positive for *T. cruzi*. The rest have not been screened or there is no relevant information.

Figure 6. Distribution of the other children of *T. cruzi* positive pregnant women according to whether they were screened or not. Catalonia 2010-2022




Source: Register of Congenital Chagas Disease in Catalonia. Subdirectorate-General for Public Health Surveillance and Emergency Response. Public Health Agency.

The mean age of the children at diagnosis was 10.7 years (range 3-22 years). Of these children, 69.2% (n = 18) were born in the endemic country and subsequently arrived in Catalonia. The remaining 30.8% (n = 8) were born outside the endemic country before 2010 and were not screened. Out of the total number of children, 80.8% (n = 21) have been successfully treated with benznidazole and/or nifurtimox but so far none has shown seronegativity.

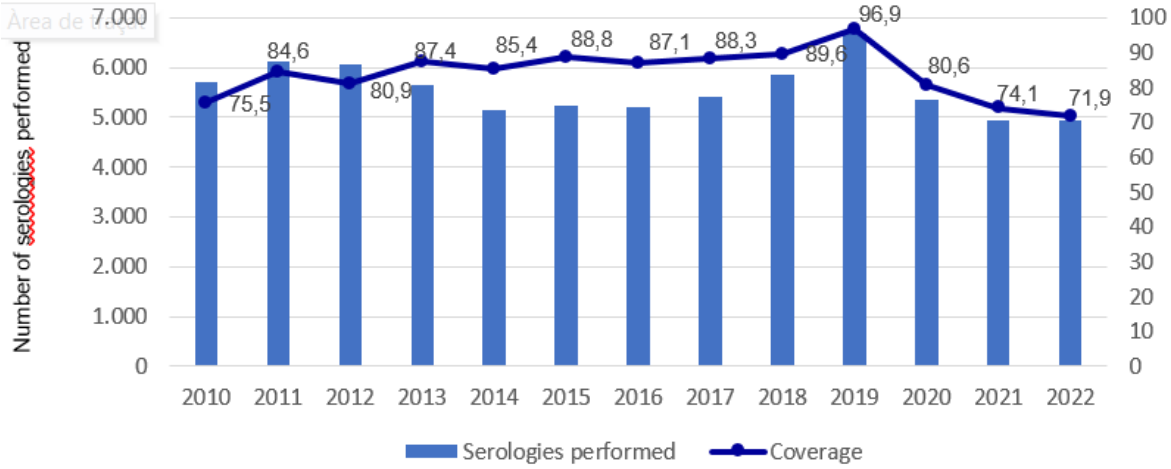
### 4.4 Programme indicators

The **estimated coverage rate** has been calculated as the number of *T. cruzi* serologies performed in pregnant women originating from endemic areas in a year (numerator) over the total number of women originating from these endemic areas

who have become pregnant in the same period (denominator). The numerator information has been provided by some of the laboratories participating in the Programme, while the denominator information has been retrieved from the SGVRESP Newborns Registry.

Delays in notifications coupled with the active search for cases mean that up-to-date coverage data for the Programme in recent years are not available. The estimated coverage rate for period 2010-2020 is 83.6%. After 2010, there was a steady increase over the years to 96.9% until 2019, when a decline began (figure 7). The cause for this decline might be multifactorial, most likely due to the COVID-19 pandemic and a change in epidemiological and demographic patterns of the population. However, reporting tools and surveillance systems are being reviewed to further elucidate the reduction in coverage.

Figure 7. Estimated coverage rate of the Programme. Catalonia 2010-2022

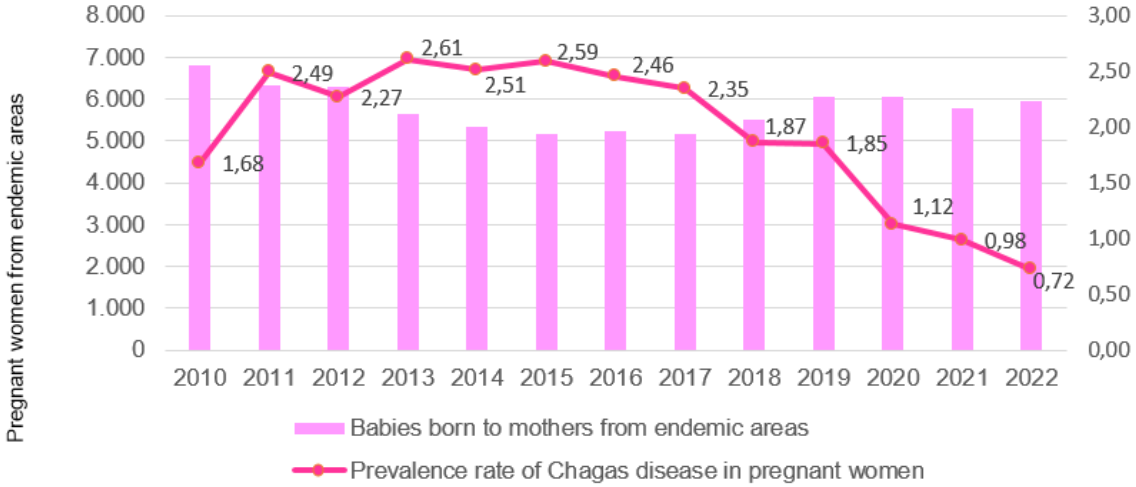



Source: Register of Congenital Chagas Disease in Catalonia. Subdirectorate-General for Public Health Surveillance and Emergency Response. Secretariat of Public Health.

The **prevalence rate of Chagas disease** has been calculated as the number of pregnant women diagnosed with Chagas disease and reported to the Programme (numerator) over the total number of pregnant women from endemic areas who gave birth reported in the SGVRESP Newborns Registry (denominator).

The prevalence rate for the period 2010-2022 was 1.94%. This rate had steadily decreased since 2015 (2.59%) and stood at 0.72% in 2022.

Figure 8. Prevalence rate of *T. cruzi* infection in pregnant women from endemic countries. Catalonia 2010-2022

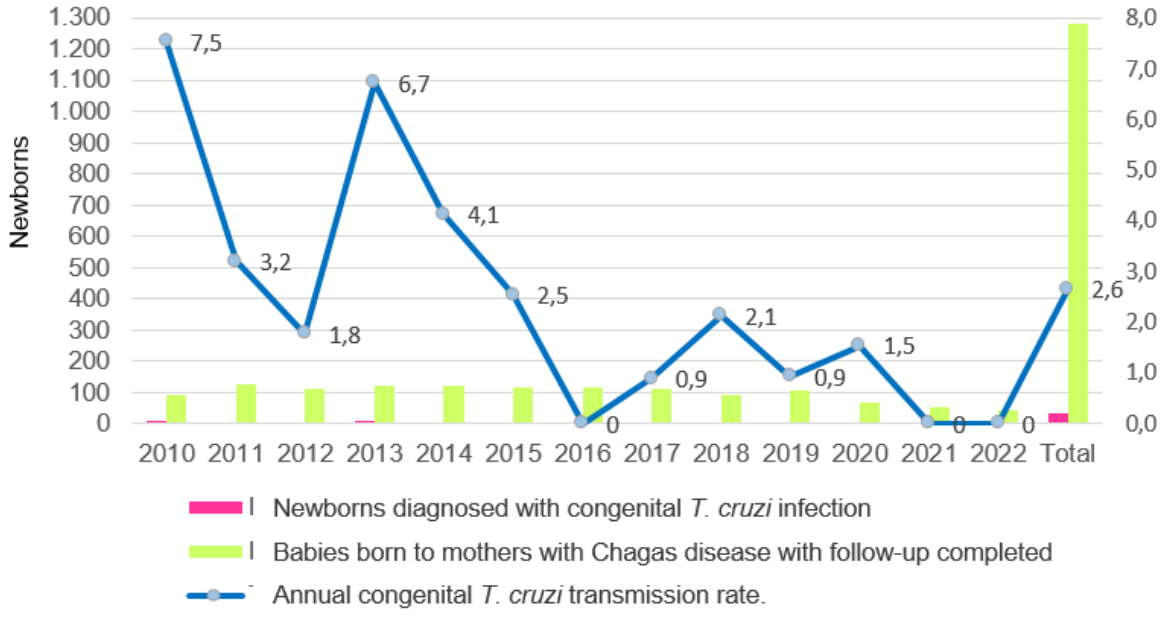



Source: Registry of Congenital Chagas Disease in Catalonia; Newborns Registry. Subdirectorate-General for Public Health Surveillance and Emergency Response. Secretariat of Public Health.

The **transmission rate** is defined as the number of babies with congenital *T. cruzi* infection reported to the Programme (numerator) over the total number of babies born to mothers diagnosed with Chagas disease in the same year (denominator).

Congenital *T. cruzi* transmission rate for period 2010-2022 is 2.6% (range: 6.7% in 2013 and 0% in 2022).

Figure 9. Annual congenital *T. cruzi* transmission rate. Catalonia 2010-2022




Source: Register of Congenital Chagas Disease in Catalonia. Subdirectorate-General for Public Health Surveillance and Emergency Response. Secretariat of Public Health.

# 5 Conclusions

Between 2010 and 2022, 1,773 cases of pregnant women diagnosed with Chagas disease were reported. Concerning these women:

- 90.6% came from endemic areas of Bolivia.
- 79.8% arrived in Europe between 2003 and 2007.
- 84.6% live in the health regions of Barcelona Metropolitan North, Barcelona City and Barcelona Metropolitan South.
- 76.6% have an undetermined chronic form of the disease.
- As the Programme progressed over time, the proportion of women diagnosed with Chagas disease before pregnancy increased (5.4% in 2010 and 42.1% in 2022). Likewise, the proportion of women diagnosed at delivery and after delivery fell (15.5% in 2010 and 1.7% in 2022). These aspects reflect well that the Programme was consolidated over the years.
- 14.6% of pregnant women had an abortion. Of these, 50.6% were miscarriages and 5.4% were stillbirths.

Among live births, 34.3% were tested for haematocrit at birth, 79.3% were tested for PCR one month after birth, and 85.4% were tested for serology 9 months or more after birth.

Thirty-four babies were born with vertical transmission of Chagas disease during the study period. Some foundings were:

- 53% of the children were girls.
- 94.1% of the children completed the treatment properly.
- 79.4% of the children have been cured and 11.8% are awaiting post-treatment serological evolution, although a progressive reduction in antibody titres is observed in the annual follow-up serologies.

Concerning the other children:

- In 41.2% of cases, no follow-up serological screening has been reported.
- Of the children screened (58.8%), 26 cases were diagnosed with Chagas disease with a mean age of 10.7 years.
- 80.8% of screened cases were treated successfully.

In terms of the Programme's indicators for the study period:

- The estimated coverage rate was 83.6%.
- The prevalence rate observed in pregnant women infected with *T. cruzi* was 1.94%.
- The congenital *T. cruzi* transmission rate was 2.6%.

# 6 Recommendations

- It is essential to improve awareness of Chagas disease screening:

  - For all pregnant women at risk of presenting the disease based on place of birth and not exclusively on nationality, given the increase in dual nationalities and the fact that the second generations have been born in Spain.
  - For all babies born to women with Chagas disease.
  - For all children who are at risk of presenting the disease.

- Reporting procedures need to be improved: both mandatory microbiological reporting (through the SNMC) and reporting the epidemiological records of the woman, newborn and other children which are to be sent to the SGVRESP (emailed to: chagas@gencat.cat).

- Emphasis must be put on treatment starting as soon as possible:

  - For all pregnant women at the end of pregnancy and breastfeeding.
  - For all newborns with a positive parasitological result at birth, a positive PCR result at one month of age or a positive serological result after age 9 months.
  - For all other children with a positive serological result.

- The multidisciplinary approach to controlling the disease should be stepped up among all professionals engaged in the pre-pregnancy and pregnancy stages plus the newborn and infant stages to halt congenital transmission, in line with the WHO's strategic approach.

## References


1. Ciruela P, Basile L, Jané M, Requena A, Valls ME, Gallego M et. al. Protocol de cribratge, diagnòstic i tractament de la malaltia de Chagas en dones embarassades llatinoamericanes i en els seus fills [Internet]. Barcelona: Public Health Agency of Catalonia; 2018. Available at: https://hdl.handle.net/11351/1173.2

2. Abras A, Ballart C, Fernández-Arévalo A, Pinazo MJ, Gascón J, Muñoz C et al. Worldwide Control and Management of Chagas Disease in a New Era of Globalization: a Close Look at Congenital Trypanosoma cruzi Infection. Clin Microbiol Rev [Internet]. 2022 Apr 20;35(2):e0015221. Available at: https://doi.org/10.1128/cmr.00152-21

3. World Health Organization. Integrating neglected tropical diseases into global health and development: fourth WHO report on neglected tropical diseases. [Internet]. World Health Organization [Internet]. 2017. 270 p. Available at: https://www.who.int/publications/i/item/9789241565448

4. Requena-Méndez A, Aldasoro E, de Lazzari E, Sicuri E, Brown M, Moore DA, Gascon J, Muñoz J. Prevalence of Chagas disease in Latin-American migrants living in Europe: a systematic review and meta-analysis. PLoS Negl Trop Dis [Internet]. 2015 Feb 13;9(2):e0003540. Available at: https://doi.org/10.1371/journal.pntd.0003540

5. Basile L, Ciruela P, Requena-Méndez A, José Vidal MA, Dopico E, Martín-Nalda A et al. Epidemiology of congenital Chagas disease 6 years after implementation of a public health surveillance system, Catalonia, 2010 to 2015. Eurosurveillance [Internet]. 2019;24(26):1-16. Available at: https://doi.org/10.2807/1560-7917.es.2019.24.26.19-00011

6. World Health Organization (WHO). Chagas disease: control and elimination. Sixty-Third World Heal Assem [Internet]. 2010 (April):4. Available at: http://apps.who.int/gb/ebwha/pdf_files/WHA63/A63_17-en.pdf

7. World Health Organization (WHO). A compendium of indicators for monitoring and evaluating progress of the roadmap for neglected tropical diseases 2021-2030 [Internet]. 2022. Available at: https://www.who.int/teams/control-of-neglected-tropical-diseases/ending-ntds-together-towards-2030

8. World Health Organization (WHO). Report of the seventeenth meeting of the Strategic and Technical Advisory Group for Neglected Tropical Diseases [Internet]. 2024. Available at: https://www.who.int/groups/strategic-and-technical-advisory-group-for-neglected-tropical-diseases

9. Basile L, Ciruela P. Vigilància epidemiològica del Protocol de cribratge i diagnòstic de la malaltia de Chagas en dones embarassades llatinoamericanes i en els seus nadons. [Internet]. Barcelona: Public Health Agency of Catalonia. Generalitat de Catalunya, Government of Catalonia; 2010. Available at: https://hdl.handle.net/11351/9335

10. Generalitat Valenciana, Government of Valencia. Ministry of Health. Enfermedad de Chagas importada. Protocolo de actuación [Internet]. Available at: https://pesquisa.bvsalud.org/portal/resource/pt/lis-42597

11. Xunta de Galicia, Government of Galicia: Directorate for Healthcare, Subdirectorate-General of Planning and Healthcare Regulation. Protocolo de cribado da enfermidade de chagas en mulleres embarazadas [Internet]. 2012. Available at: https://www.sergas.es/Asistencia-sanitaria/Documents/650/Protocolo%20de%20cribado%20da%20enfermidade%20de%20Chagas%20en%20mulleres%20embarazadas.pdf

12. Monge-Maillo B, López-Vélez R. Challenges in the management of Chagas disease in Latin-American migrants in Europe. Clin Microbiol Infect [Internet]. 2017;23(5):290-5. Available at:: https://doi.org/10.1016/j.cmi.2017.04.013

13. Howard EJ, Xiong X, Carlier Y, Sosa-Estani S, Buekens P. Frequency of the congenital transmission of Trypanosoma cruzi: A systematic review and meta-analysis. BJOG An Int J Obstet Gynaecol [Internet]. 2014;121(1):22-33. Available at: https://doi.org/10.1111/1471-0528.12396

14. Picado A, Cruz I, Redard-Jacot M, Schijman AG, Torrico F, Sosa-Estani S et al. The burden of congenital Chagas disease and implementation of molecular diagnostic tools in Latin America. BMJ Glob Heal [Internet]. 2018;3(5):e001069. Available at: https://doi.org/10.1136/bmjgh-2018-001069

15. Llenas-García J, Wikman-Jorgensen P, Gil-Anguita C, Ramos-Sesma V, Torrús-Tendero D, Martínez-Goñi R et al. Chagas disease screening in pregnant Latin American women: Adherence to a systematic screening protocol in a non-endemic country. PLoS Negl Trop Dis [Internet]. 2021;15(3):1-14. Available at: https://doi.org/10.1371/journal.pntd.0009281

16. Danesi E, Fabbro DL, Segura EL, Sosa-Estani S. Higher congenital transmission rate of Trypanosoma cruzi associated with family history of congenital transmission. Rev Soc Bras Med Trop [Internet]. 2020;53(January):1-7. Available at: https://doi.org/10.1590%2F0037-8682-0560-2019

17. Decree 203/2015, of 15 of September, creating the Epidemiological Surveillance Net and the notification system of diseases submitted to mandatory reporting and of epidemic outbreaks, of the Official Gazette of the Government of Catalonia [Internet]. 2013;1-16. Available at:: https://portaljuridic.gencat.cat/ca/document-del-pjur/?documentId=702922#

18. Keegan R, Yeung C, Baranchuk A. Sudden Cardiac Death Risk Stratification and Prevention in Chagas Disease: A Non-systematic Review of the Literature. Arrhythm Electrophysiol Rev [Internet]. 2020, Dec.9 (4):175-181. Available at: :https://doi.org/10.15420%2Faer.2020.27

19. Generalitat de Catalunya, Government of Catalonia. Protocol de seguiment de l'embaràs a Catalunya [Internet]. 3a ed. Barcelona: Departament de Salut; 2018. Available at: https://hdl.handle.net/11351/1204

20. Ciruela P, Mendioroz J, Prats B, Vidal MJ. Indicadors de salut perinatal a Catalunya, 2022. Barcelona: Subdirectorate-General for Public Health Surveillance and Emergency Response [Internet]. 2023. Available at: https://hdl.handle.net/11351/10216

21. Molina I, Salvador F, Sánchez-Montalvá A. Actualización en enfermedad de Chagas. Enferm Infecc Microbiol Clin [Internet]. 2016;34(2):132-8. Available at: https://doi.org/10.1016/j.eimc.2015.12.008

22. Colombo V, Giacomelli A, Casazza G et al. Trypanosoma cruzi infection in Latin American pregnant women living outside endemic countries and frequency of congenital transmission: a systematic review and metaanalysis. J Travel Med [Internet]. 2021;28(1), taa170, 1-9. Available at: https://doi.org/10.1093/jtm/taaa170

23. Valero-Matas JA, Coca JR, Valero-Oteo I. Análisis de la inmigración en España y la crisis económica. Pap.poblac [Internet]. 2014;20(80) Available at: https://www.scielo.org.mx/scielo.php?script=sci_arttext&pid=S1405-74252014000200002

24. Ruiz-Almar E, Aparicio Moreno R, Serrano i Martí M, Velasco i Relats A, Marco i Garcia C. Dades demogràfiques del territori metropolità de Barcelona, 2020. Estudis territorials. Area for the Development of Urban Policies [Internet]. 2021. Available at: https://www.researchgate.net/publication/355424736_Dades_demografiques_del_territori_metropolita_de_Barcelona_2020

25. Idescat. Cens de població estrangera a 1 de gener. Per comarques [Internet]. Barcelona: Institut d'Estadística de Catalunya. 2023. Available at: https://www.idescat.cat/poblacioestrangera/?nac=c12&b=4&t=2022

26. Hasslocher-Moreno AM, Xavier SS, Saraiva RM, de Sousa AS. Indeterminate form of chagas disease: Historical, conceptual, clinical, and prognostic aspects. Rev Soc Bras Med Trop [Internet]. 2021;54(June):1-5. Available at: https://doi.org/10.1590/0037-8682-0254-2021

27. Public Health Agency of Canada. Loss and grief. Canadian Public Health Service: Chapter 7 [Internet]. Ottawa, 2020. Available at: https://www.canada.ca/en/public-health/services/publications/healthy-living/maternity-newborn-care-guidelines-chapter-7.html

28. Sanchez Ortiz S, Huerta C, Llorente-García A, Ortega P, Astasio P, Cea-Soriano L. A Validation Study on the Frequency and Natural History of Miscarriages Using the Spanish Primary Care Database BIFAP. Healthcare (Basel). 2021 May 18;9(5):596. Available at: https://doi.org/10.3390%2Fhealthcare9050596

29. Mezzano L, Morán JP, Moreira-Espinoza MJ, Triquell MF, Mezzano J, Díaz-Luján CM et al. Chagas disease affects the human placental barrier's turnover dynamics during pregnancy. Mem Inst Oswaldo Cruz [Internet]. 2022;117(22):1-7. Available at: https://doi.org/10.1590/0074-02760210304

30. Carlier Y, Truyens C. Congenital Chagas disease as an ecological model of interactions between Trypanosoma cruzi parasites, pregnant women, placenta and

fetuses. Acta Trop [Internet]. 2015;151(1):103-15. Available at: https://doi.org/10.1016/j.actatropica.2015.07.016

31. Duaso J, Rojo G, Cabrera G, Galanti N, Bosco C, Maya JD, et al. Trypanosoma cruzi induces tissue disorganization and destruction of chorionic villi in an ex vivo infection model of human placenta. Placenta [Internet]. 2010;31(8):705-11. Available at: https://doi.org/10.1016/j.placenta.2010.05.007

32. Matthews S, Tannis A, Puchner KP, Bottazzi ME, Cafferata ML, Comandé D et al. Estimation of the morbidity and mortality of congenital Chagas disease: A systematic review and meta-analysis. PLoS Negl Trop Dis [Internet]. 2022;16(11):1-21. Available at: https://doi.org/10.1371/journal.pntd.0010376

33. Bustos PL, Milduberger N, Volta BJ, Perrone AE, Laucella SA, Bua J. Trypanosoma cruzi infection at the maternal-fetal interface: Implications of parasite load in the congenital transmission and challenges in the diagnosis of infected newborns. Front Microbiol [Internet]. 2019;10. Available at: https://doi.org/10.3389/fmicb.2019.01250