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DE GRUYTER

Changes in the incidence of intestinal giardiosis in Mexican population during five years (2011-2015)

Gabriela Ibáñez–Cervantes[1#], Gloria León–Ávila[2*], Juan Manuel Bello–López[3#], Armando Pérez–Rangel[1], Gregorio León–García[4], Benjamín Nogueda–Torres[5] and José Manuel Hernández[1*]

[1]Departamento de Biología Celular, Centro de Investigación y Estudios Avanzados del Instituto Politécnico Nacional, Av. IPN 2508, Col. San Pedro Zacatenco, 07360. México City, México; [2]Departamento de Zoología, Escuela Nacional de Ciencias Biológicas, Instituto Politécnico Nacional, Carpio y Plan de Ayala, Col. Casco de Santo Tomás, 11340. México City, México; [3]Unidad de Investigación en Microbiología y Toxicología Hospital, Juárez de México, Av. Instituto Politécnico Nacional 5160, Zacatenco, Gustavo A. Madero, 07360, México City, México. [4]Servicio de Medicina Interna, Hospital Español, Ejército Nacional 617, Col. Granada, C.P. 11520 México, México City, México; [5]Departamento de Parasitología, Escuela Nacional de Ciencias Biológicas, Instituto Politécnico Nacional, Carpio y Plan de Ayala, Col. Casco de Santo Tomás, 11340 México City, México

Abstract

Giardiosis is a parasitic disease caused by the protozoan *Giardia intestinalis*, which is distributed worldwide. Most of the data on the prevalence of giardiosis in Mexico comes from research, but it is also necessary to study the data provided by the Mexican Health Ministry and issued by the General Directorate of Epidemiology. The aim of this work was analyse the national surveillance data for human giardiosis in order to update the epidemiological data of this disease in Mexico. A retrospective observational analysis of giardiosis (from January 2011 to December 2015) was performed in the annual reports emitted by the GDE in Mexico. The cases were classified by year, state, age group, gender and seasons of the year. During the period of 2011–2015, a reduction of 38.51% was observed in the total number of new cases of giardiosis reported in the whole country. The states of Sinaloa, Yucatan, and Chiapas presented the highest number of new cases reported during the analysed period. Giardiosis rates were always higher among women in all age groups, but the maximum incidence was observed in both sexes in the age group of 1–4 years old (the most susceptible group). On the other hand, the number of cases increased dramatically in southern states during warmer months. Giardiosis is influenced by ambient temperature changes along the year, although this study suggests that tends to decrease in all the analysed states and could be related to the overall improvement of hygienic practices within the Mexican population,

Keywords

Epidemiology, *Giardia intestinalis*, giardiosis, Mexico, incidence

Introduction

Giardiosis is a non–invasive parasitic disease caused by the protozoan *Giardia intestinalis*. This parasite is distributed worldwide and about 280 million cases are reported annually (WHO 2007). Cysts of this parasite are relatively resistant to chlorination and ozonolysis and remain viable for several weeks (Ali and Hill 2003). The acquisition of *Giardia* sp. occurs more frequently through ingestion of water or food contaminated with cysts from faeces of infected individuals (Efstratiou *et al*. 2017; Rosado-García *et al*. 2017; Ryu *et al*. 2008; Karains *et al*. 2007; Dawson 2005).

In developing countries, *Giardia* spp. person–to–person transmission is highly frequent. This happens especially in unhygienic environments where faecal–oral exposure is common. Therefore, recurrent infections are present and are associated with asymptomatic excretion of cysts. An infected person can shed up to 5×10^8 cysts over the course of an infection

*Corresponding authors: leonavila60@yahoo.com.mx and manolo@cell.cinvestav.mx
#Gabriela Ibáñez–Cervantes and #Juan Manuel Bello–López have contributed equally to this work

(Graczyk *et al.* 2008; Vazquez *et al.* 2009). The infectious dose is low: humans can be infected with as few as 10 cysts (Ortega and Adam, 1997; Steiner *et al.* 1997). The microscopic identification of *Giardia* cysts or trophozoites in three stool specimens collected in consecutive days is the method of choice for diagnosis in Mexico (NOM–017–SSA2–2012). Most infections are asymptomatic but individuals with symptomatic giardiosis may develop diarrhoea, abdominal pain, bloating, and stomach cramps. These symptoms normally appear after 1 to 3 weeks of becoming infected (Gautret *et al.* 2012). In developing countries, repeated exposure and endemic infections are common (Mukherjee *et al*. 2014). While in developed countries, it occurs as zoonotic transmission by ingestion of water contaminated by faeces from infected wild animals, this must be considered potential sources of contamination (Wallis *et al.* 1984; Monzingo *et al*. 1987; Thompson, 2000; Rickard *et al*. 1999).

The frequency of giardiosis in Mexico is extremely variable, with rates ranging from 2% to 39% (Cifuentes *et al.* 2004; Sánchez-Vega *et al.* 2006; Quihui *et al*. 2006; Quihui-Cota *et al*. 2012), but a sero–epidemiology study showed a prevalence of 55.3% that increases with age, reaching the highest value in people older than 40 years old (Cedillo-Rivera *et al*. 2009). However, as far as we know, there are no scientific reports on the current state of this parasitic disease and its national distribution. According to the Mexican Epidemiological Surveillance System, giardiosis is classified as an infectious, transmissible, parasitic disease of the digestive system and its classification is based on the standards established by the Pan American Health Organisation (www.paho.org), which defines suspicious cases as those that present acute diarrhoea with hypocolic and foul-smelling stools. A suspected case is confirmed by a coproparasitological study of the faeces (search for trophozoites in stool samples) or a parasitological study of fluid obtained by duodenal sounding. All confirmed cases must be notified weekly, the notification is regulated by the Mexican Official Norm (NOM-017-SSA2-2012). On the other hand, Mexico possesses a peculiar landscape formed by two mountain cordilleras and the Trans-Mexican Volcanic Belt and there are communities established all along the country, which are located far away from health services. As a consequence, the incidence of giardiosis could be underestimated, since many people that could be infected cannot' travel to a Health Care Unit. Additionally, in those communities, the level of poverty is very high: houses with dirt floor, without clean water supply and waste water disposal systems. All the conditions described above might affect the incidence rates of giardiosis detected by the Mexican Surveillance System. In order to know the epidemiology of this disease in México, the present work analyses the national surveillance data for giardiosis issued by the General Directorate of Epidemiology (GDE). This information will be also helpful to promote prevention and contribute to display the disease distribution in the last five years.

Materials and Methods

Study design and data collection

The GDE receives the reported cases of giardiosis across the country on a monthly basis. An observational retrospective analysis of the annual reports dating from January 2011 to December 2015 emitted by the GDE was performed. The epidemiological data for the period 2011–2015 were taken from morbidity yearbooks found in www.epidemiologia.salud.gob.mx/anuario/html/anuarios.html. The data reported in this website were generated and analysed previously by the Health Department through its platform *SUAVEweb* (www.sinave.gob.mx). All data of giardiosis cases were statistically analysed using Microsoft Excel 2013 (Microsoft Corporation, Redmond, WA, USA) by year, states, and demographic variables (age group and gender). Additionally, an incidence analysis of giardiosis by season was performed. An analysis of variance (ANOVA) was also calculated in order to evaluate significant differences over time ($p = 0.05$), for data/year and month.

Results

Behaviour of new cases and incidence of giardiosis

The regulatory policies in Mexico established the notification of probable cases of giardiosis. The analysis showed that 18,831 new cases of giardiosis were reported in 2011; contrastingly, in 2015 11,578 new cases were reported reflecting a reduction of 38.51% of new cases in all the country. A direct relationship between the number of new cases per year and the incidence was observed (Fig. 1). There is a significant decrease in the incidence rates during the period analysed from 17.24 to 9.57. Throughout this period a media incidence of 12.98 ± 2.74 was identified.

Geographical distribution of giardiosis

The distribution of the new reported cases of giardiosis all over the country is mostly headed by the states on the Pacific coast, followed by the southeast region. The lowest incidence rate was detected in some northern states. The analysis of the geographic distribution of giardiosis cases showed that southern states such as: the State of Mexico, Mexico City, Guerrero, Oaxaca, Chiapas and Yucatán presented higher variations of the mean of giardiosis cases during this period. Northern states like Sinaloa and San Luis Potosi had the highest number of cases in the country compared to other northern states. The states particularly located in the north of the country, such as Coahuila, Durango and Nayarit, presented the lowest number of new cases during the period analysed. Although Tlaxcala is located in the southern part of the country, the number of cases of giardiosis was lower compared to that of most of the states in this geographical zone (Fig. 2).

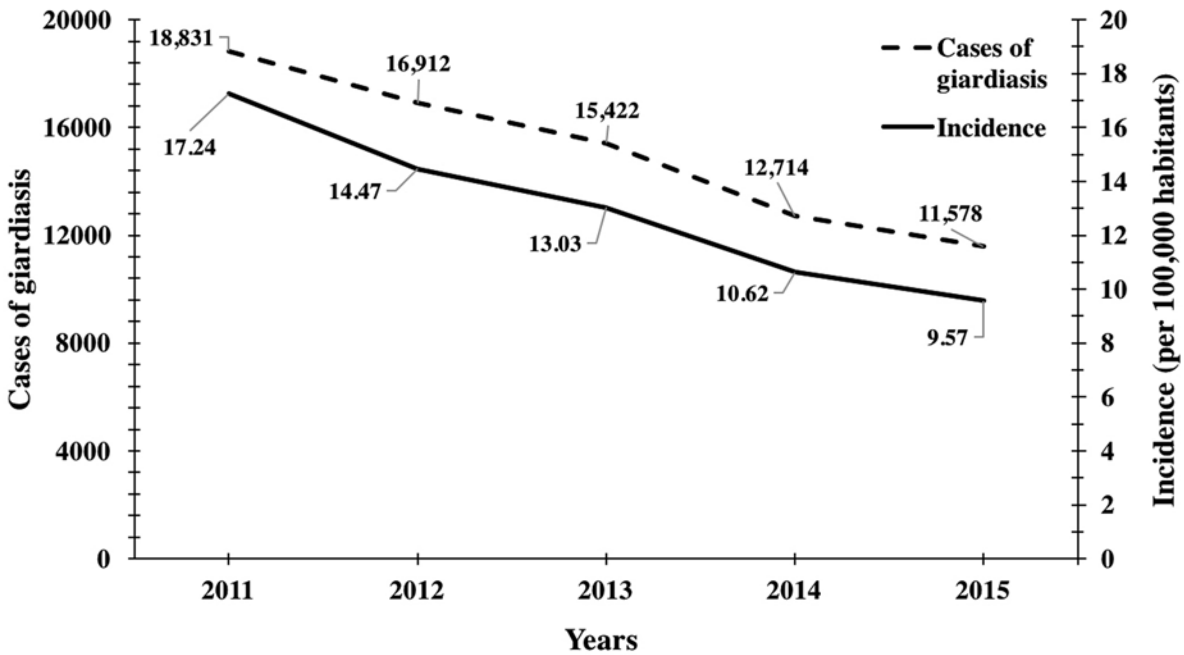

Fig. 1. Behaviour of new giardiasis cases per year in Mexico and incidence (cases per 100 000 inhabitants) during the period of 2011-2015

Incidence of giardiosis per age groups and gender

The analysis of new cases of giardiosis by age group showed that the most susceptible groups to infection were <1, 1–4 and 5–9 years old. The incidence values (per 100,000 inhabitants) identified in the same age groups for male were 22.8 ± 7.7, 39.6 ± 8.8, and 26.8 ± 4.8, respectively, and for female were 9.1 ± 6.4, 35.6 ± 13, and 25.4 ± 3.9 respectively. The statistical analysis ($p = 0.05$) per age groups and gender revealed that giardiosis cases were higher in female patients in all age groups (Fig. 3). Additionally, the maximum incidence peak was observed in both genders in the interval between 1–4 years, followed by children aged 5–9 years. However, a slight rate increase was observed in both genders in the groups aged 25–44 and 50–59 years.

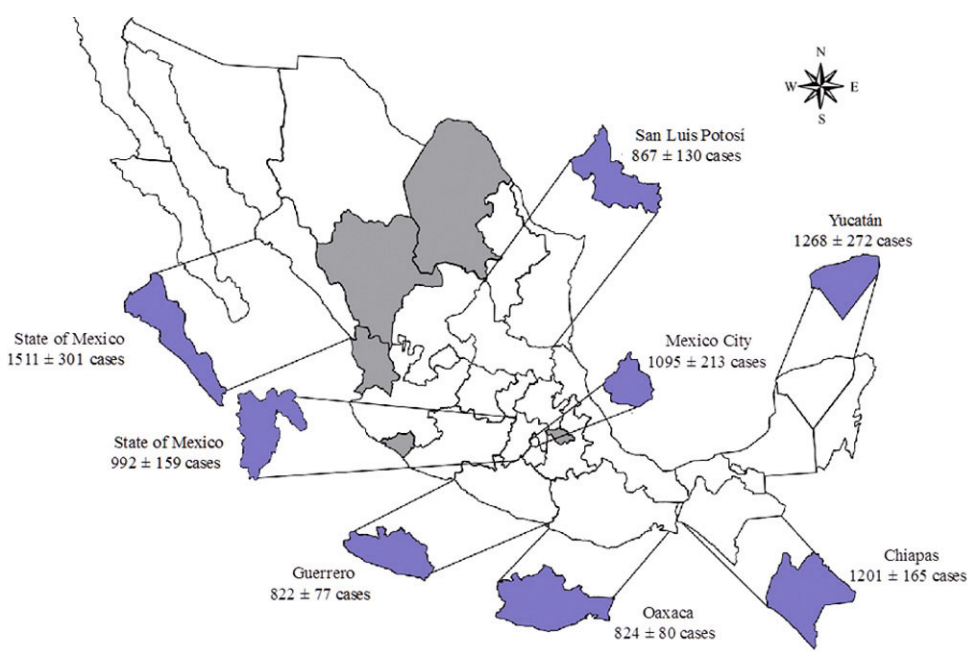

Fig. 2. Average of new giardiasis cases per year in Mexico in the period of 2011-2015. States with the highest number of accumulated cases: Mexico City, Guerrero, State of Mexico, San Luis Potosí, Yucatán, Sinaloa, Chiapas and Oaxaca (purple colour) and states with the fewest cumulative cases: Coahuila, Durango, Nayarit, Colima and Tlaxcala (grey colour)

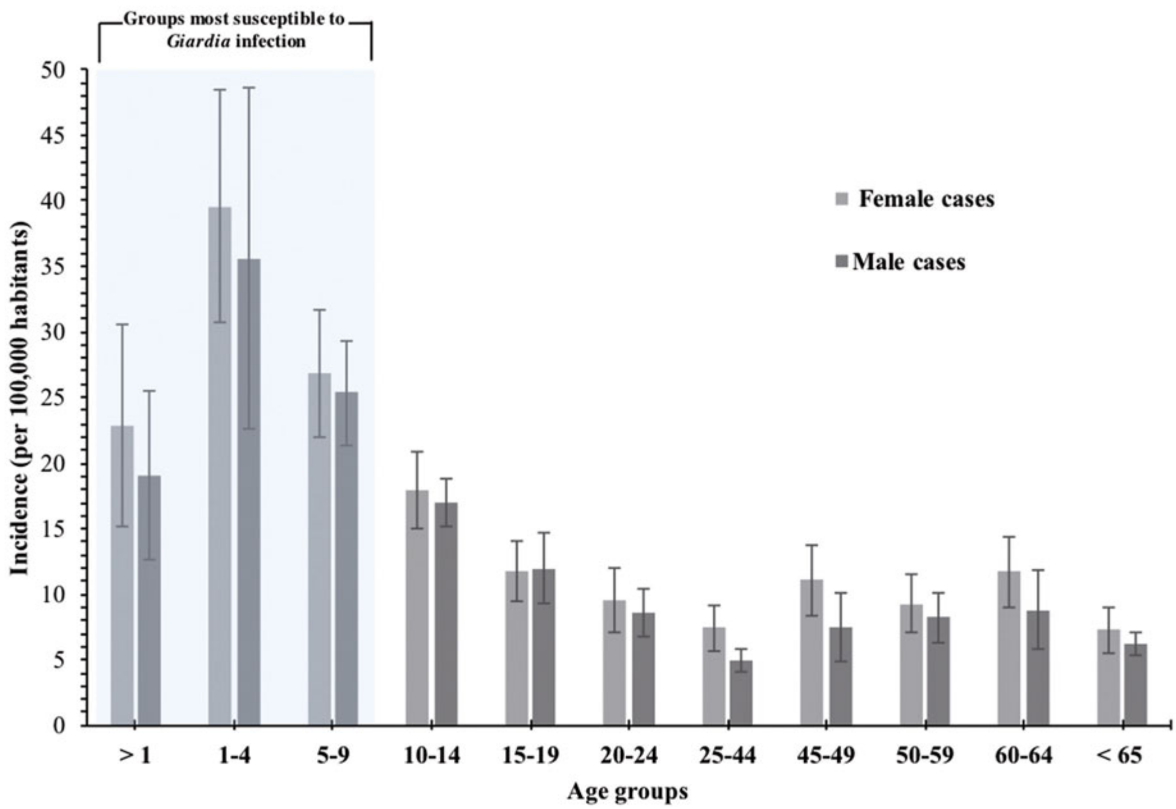

Fig. 3. Incidence of giardiasis (Number of cases per 100,000 inhabitants) in Mexico in the period of 2011-2015

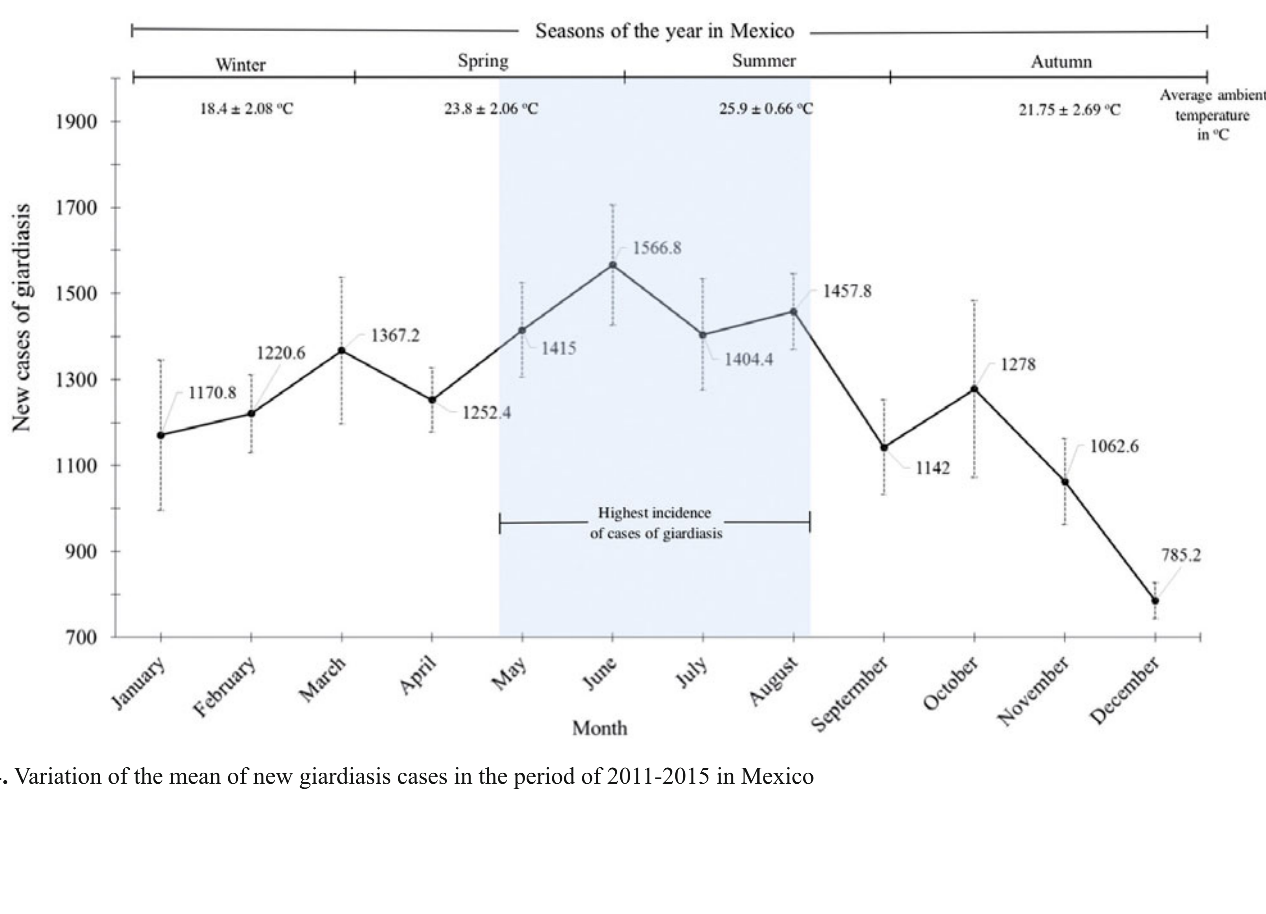

Fig. 4. Variation of the mean of new giardiasis cases in the period of 2011-2015 in Mexico

Seasonal distribution of giardiosis cases

The information of new cases categorised by month/year was analysed by distribution within the yearly seasons (winter, spring, summer and autumn). The highest number of new giardiosis cases was identified in the months of the warm season (May, June, July and August). The values of the new cases (monthly average of giardiosis) were 1415 ± 110, 1566 ± 140, 1404 ± 130 and 1457 ± 88 for the months of May, June, July, and August, respectively (spring–summer). A gradual decline in the number of new cases spanning the cold autumn months was identified. The values of 1,142 ± 110, 1,276 ± 204, 1,062 ± 101 and 785 ± 41 new cases corresponded to the months for September, October, November, and December, respectively. Finally, at the end of winter and early spring, a gradual increase of giardiosis cases was observed (Fig. 4). The above results reflect a direct relationship between the environmental temperature increase by season and the number of new cases of giardiosis.

Discussion

Enteric parasitic infections are diseases with a high prevalence in low income environments. In this retrospective study, the prevalence in reports emitted by the GDE for *G. intestinalis* in Mexico from 2011–2015 was analysed. The behaviour of giardiosis tends to decrease, the number of new cases of giardiosis continues declining by about 10,562 cases with an incidence of 8.64. This reduction has been observed in others countries such as Colombia and USA (Rodriguez-Morales *et al.* 2016; Painter *et al.* 2015).

It is essential to highlight the high rate of giardiosis found in children less than one year old, which can be infected by family members or other potentially infected children in day–care centres (SSA 2005). This is possibly related to poor hygiene, low education, and inadequate basic sanitation. Giardiosis may cause malabsorption, malnutrition, wasting, stunting and a reduction of cognitive functions in children (Guerrant *et al*. 1999; Berkman *et al*. 2002; Ignatius *et al.* 2012). However, the actions taken to assure the improvement in the quality of water have impacted on the drop of the national rate of giardiosis in children under five year's old (SSA 2005). The number of cases decreased from 204 per 100000 inhabitants in 1998 to 150 in 2002, but dropped to 32.97 in 2014. These data represent a significant decrease in the incidence rates. The high incidence of *G. intestinalis* in children (>1–12 years) is consistent with the data published in several studies in Mexico (Quihui-Cota *et al*. 2012; Paniagua *et al.* 2007; Tay *et al*. 1994) and other countries (Heimer *et al.* 2015; Fletcher *et al.* 2014, Neghina *et al*. 2013; Lim *et al.* 2008). In all cases, the reported giardiosis rate was higher for females than males (an average of two points above the rate), opposite to the data reported by Cedillo-Rivera (Cedillo-Rivera *et al.* 2009). It is known that taking care of the children is among the occupational activities of the female population, this might explain the higher incidence of giardiosis in females. Another study revealed that the risk of *Giardia* infection was significantly higher for housewives and nursing mothers compared to that for the male population. Physical contact with children wearing diapers showed a significant association with giardiosis, even with a fourfold increased risk (Hoque *et al*. 2001). Additionally, it was reported that the transmission between children was higher, when babies who were not toilet trained wearing nappies were sitting together in padding pools (Linnane *et al*. 2001). Moreover in Mexico, people with low income do not buy disposable nappies, the nappies are made of cotton and are washed by hand, which can favour the transmission of the infection. The highest number of cases was found in Sinaloa state, but this state hosts only 10.19% of the total number of cases. Sinaloa is located in the west coast of the country. It has eleven rivers that supply water to their dams, which form the same basic irrigation infrastructure, and all commercial activities depend on these sources. It is common that rural communities in Mexico directly discharge raw human sewage and animal waste to the rivers without treatment, thereby having a negative impact on the water quality (Castro-Espinoza *et al*. 2009; Balderrama-Carmona *et al*. 2015). Thus, contamination of rivers by human pathogens likely contributes to the high prevalence of giardiosis among the population. However, it is necessary to consider that the Epidemiological Surveillance in Sinaloa is better, thus facilitating cases to be reported. The lack of this system could mean that the incidence in other states could be underestimated. Furthermore, the southern region of the country, including Yucatan, Chiapas, Veracruz, Oaxaca and Guerrero states, also presented a high rate of giardiosis. These states share the same topology with Sinaloa; they have a rich hydrography with a high probability of contamination. All these states have the highest percentage of giardiosis. In the case of big cities such as Mexico City, San Luis Potosi, and Guadalajara, the major causes of giardiosis spreading are: overpopulation, the lack of education to avoid the pathogen's transmission, and low hygiene. The global analysis of the states by period showed that giardiosis incidence has a tendency to decrease in all the analysed states. The decrease in the incidence of cases of giardiasis is due to the government's specific health services actions, as well as basic activities such as sanitation measures to improve water quality and others (SSA 2012). The water disinfection monitoring is carried out periodically and so is the ongoing monitoring for free residual chlorine in the distribution network (NOM–127–SSA1–1994, NOM–014–SSA1–1993).

Although the availability of chlorinated water has increased, the efforts to administer water resources to the whole country have been insufficient (National Development Plan 2013–2018). In Mexico, there are few studies detecting Giardia in water for irrigation of vegetables for human consumption. The presence of *Giardia* cysts in water for irrigation, washing and disinfection applications was previously investigated by Chaidez *et al*. (2005). This study revealed the presence of *Cryptosporidium* oocysts in 48% of the tested samples and 50% were positive for *Giardia* cysts. The presence of the parasite cysts is a potential risk of contamination of fresh products. Additionally, Balderrama-Carmona and coworkers (2015) detected *Giardia* cysts in well water samples and suggested establishing a programme in Mexico for water treatment to reduce the incidence of parasites from intestinal infections contaminating the potable water. Monitoring of water disinfection is carried out periodically and so is the ongoing monitoring for free residual chlorine in the distribution network (NOM-127-SSA1-1994).

In USA, a seasonal peak of Giardiosis that might be correlated with outdoor water activities such as swimming in pools was found (Yoder *et al*. 2010). Another study found that 40% (4/10) of the pools were positive for *Giardia* (Bonadonna *et al*. 2004). The presence of *Giardia* in the pool filters during the outbreak associated with this parasite has also been demonstrated (Shields *et al*. 2008). These type of studies have not been performed in Mexico, however, this way of transmission is also plausible.

In Mexico are communities located far away from health services and in those communities the level of poverty is very high (Morales-Espinoza *et al*. 2003). All the conditions described above might affect the incidence rates detected by the Mexican Surveillance System. On the other hand, it is critical to notice that the chemists that perform the coproparasitoscopic analysis must be well trained and the laboratories need to be periodically by the Program Quality Assurance (PACAL).

This study reports a significant decrease in the number of cases of giardiosis in Mexico for five years. This could be the result of national campaigns to promote awareness of good personal hygiene practices, food handling, and water purification. However, it is essential to continue making prospective epidemiological studies, in order to keep track of the rates of incidence by region and correlate them to potential sources of contamination. This information can help improve health programs to reduce giardiosis in Mexico.

Conclusions

The present analysis showed that the rate of giardiosis is apparently decreasing in Mexico. These results summarise and recall how important it is to implement the monitoring of giardiosis cases as well as to confirm these cases in order to determine the current real state of this disease.

Authors' contributions: GIC, APR, JMBL, GLA, GLG, BNT and JMHH designed the study; GIC, APR, JMBL, GLA, GLG, BNT and JMHH analysed and interpreted the data and results; GIC, GLA, JMBL and JMHH gave a major contribution to the writing. All authors read and approved the final manuscript. GIC, GLA, JMBL, and JMHH are guarantors of the paper.

Competing interests: the authors reported no potential conflict of interest.

Ethical approval: Not required.

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