Received: 15 March 2018 | Revised: 25 October 2018 | Accepted: 11 November 2018
DOI: 10.1111/zph.12547

REVIEW ARTICLE

WILEY

Epidemiology of taeniosis, cysticercosis and trichinellosis in Iran: A systematic review

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Abstract

Background: The aim of this review was to establish the current epidemiology of taeniosis, cysticercosis and trichinellosis among humans and animals in Iran by carrying out a comprehensive assessment of published articles reporting on these foodborne zoonotic diseases across the country.

Methods: The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guideline was used in the search for relevant published articles reporting on cysticercosis, taeniosis and trichinellosis in Iran using a number of appropriate key words. The search was conducted through PubMed, Web of Science, Google Scholar, SpringerLink, SCOPUS, WHOLIS, FAO and CDC. Published scientific articles including journals, books and book chapters reporting on cysticercosis, taeniosis and trichinellosis in Iran for the period between 1967 and 2018 were selected.

Results: A total of 37 articles met the search criteria and were incorporated in this review. Of these, 10 (27%) reported on human taeniosis, 15 (40.5%) on cysticercosis (10 on *Taenia saginata* and five on *Taenia* spp. cysticercosis) and 12 (32.5%) on trichinellosis. *T. saginata* was implicated in all human taeniosis cases. All *Taenia* spp. cysticercosis cases were reported among domesticated pigs and wild animals. A case of neurocysticercosis was reported in a male patient at Shohada Hospital in Tehran. Eleven (91.7%) of the 12 studies reported on trichinellosis among wild animals, while one (8.3%) study detected anti-*Trichinella* IgG in 8 (2.2%) of the 364 at-risk human beings tested. Nevertheless, most of these studies were carried out in northern Iran.

Conclusion: This review found *T. saginata* to be the most prevalent and of greater economic and public health significance in Iran. However, *T. solium* and *Trichinella* spp. were of little significance to human health. More studies should focus on other regions besides northern Iran.

KEYWORDS
cysticercosis, foodborne zoonoses, Iran, taeniosis, trichinellosis

1 | BACKGROUND

Taeniosis, cysticercosis and trichinellosis are foodborne parasitic zoonoses with significant health, social and economic implications (FAO/WHO, 2014). Human taeniosis is caused by three adult tapeworm species: *Taenia saginata* (beef tapeworm), *Taenia solium* (pork tapeworm) and *Taenia asiatica* (Asian tapeworm) whose adult stages develop only in the intestine of the human host. Transmission of human taeniosis occurs mainly through consumption of undercooked or raw meat or offals from cattle (for *T. saginata*) or from pigs (for *T. solium* and *T. asiatica*) (Ito, Nakao, & Wandra, 2003; Van De, Le, Lien, & Eom, 2014). Likewise, humans get infected with trichinellosis through consumption of undercooked or raw pork that is infected.

Cysticercosis refers to a parasitic tissue infection caused by larval cysts of *Taenia* spp. in humans and animals (Eom, Jeon, & Rim, 2009; Garedaghi, Saber, & Khosroshahi, 2012; Qingling et al., 2014; Satoskar, Simon, Hotez, & Tsuji, 2009). Though it is responsible for bovine cysticercosis in cattle, the larval stage of *T. saginata* does not cause cysticercosis in humans. On the other hand, the adult stage of *T. solium* causes human taeniosis while the larval stage causes cysticercosis (including neurocysticercosis) in humans. Neurocysticercosis (NCC), a severe form of cysticercosis, is caused by the presence of the larval stage of *T. solium* in the central nervous system (Symeonidou et al., 2018). *T. asiatica* is comparable to *T. saginata* except that pigs are the preferred intermediate host, while the liver is the preferred location of the *T. asiatica* cysts. The parasite causes taeniosis in humans, but it is still not clear whether it causes cysticercosis in humans (Eom & Rim, 1993).

Trichinellosis is also a parasitic disease caused by nematodes of the genus *Trichinella*, with nine species and at least 12 genotypes being recognized (Murrell & Pozio, 2000). Though *Trichinella spiralis* is the most widely distributed, others species like *Trichinella britovi*, *Trichinella pseudospiralis*, *Trichinella papuae* among others, have also been implicated in human diseases in different parts of the world (Pozio, Hoberg, Rosa, & Zarlenga, 2009; Takahashi, Mingyuan, & Waikagul, 2000). Pigs are the most important source of human trichinellosis infection, though a number of other animals are also epidemiologically important hosts (Dupouy-Camet, 2000; Leiby, Duffy, Murrell, & Schad, 1990).

The WHO classifies taeniosis and cysticercosis as neglected tropical diseases with a worldwide distribution (WHO, 2015). Approximately 45 to 60 million people are reportedly infected with *T. saginata* across the world (Carabin et al., 2011), with East Africa, Bali island in Indonesia and Tibet regions having relatively higher rates (>20% of the population). This parasite is also said to be endemic in the Middle East, America and Europe (White & Brunetti, 2015). Transmission of *T. asiatica* shows an important ethno-geographical association, given the specific conditions needed to complete its life cycle (i.e., consumption of raw or poorly cooked pig liver) (Ale et al., 2014). Presently, *T. asiatica* has only been reported in Asian countries, especially among rural populations with a tendency to eat undercooked visceral organs (liver, omentum, serosa and lung) of pigs (Eom et al., 2009).

Taenia solium is regarded as the most serious tapeworm species to humans. The 2010 WHO global burden of foodborne diseases study estimated that *T. solium* cysticercosis was responsible for 370.710 illnesses, resulting in 28,144 deaths and 2.78 million disability-adjusted life years (DALYs) (Torgerson et al., 2015). People living in areas with inadequate sanitation and hygiene, and with presence of free-roaming pigs (WHO, 2015), throughout Africa, Asia and South and Central America, are particularly at risk of infection with *T. solium* (Coyle et al., 2012; Murrell, 2005). Neurocysticercosis is endemic in most developing countries, where favourable conditions like a warm climate, severe poverty, illiteracy, free-ranging pigs and poor sanitation exist (Wallin & Kurtzke, 2004).

Impacts

- *Taenia saginata* infections were most prevalent with a significant number of bovine cysticercosis and human taeniosis cases being reported in different parts of Iran, making it a public health concern.
- Taeniosis resulting from *Taenia* spp. was restricted to wild boars, rook and pigs (domesticated and wild) in Iran, making it of little significance to public health in Iran.
- Except for one seropositive case, there was no publication on human trichinellosis in Iran. However, *T. britovi*, *T. spiralis*, *T. murrelli* and *T. nelsoni* were detected among several carnivores, rodents and wild boars in Iran.
- The Islamic religious laws, which strictly forbid consumption of pork among Muslims, could be the reason for the near absence of human taeniosis resulting from *T. solium* and human trichinellosis in Iran.
- Based on the review, prevalence of foodborne zoonoses in a large portion of Iran has not yet been studied. This necessitates more studies covering the whole country and focusing on a wide range of organisms, to determine their actual prevalence in Iran.

A number of *Trichinella* spp. have been detected in domestic and wild animals all around the world except in Antarctica (Pozio, 2007; Pozio & Murrell, 2006). Although humans are accidental hosts (Kennedy, Hall, Montgomery, Pyburn, & Jones, 2009), human trichinellosis is estimated to affect at least 11 million people in about 55 countries (Kapel, Webster, & Gamble, 2005; Pozio, 2007) with about 10,000 clinical cases reported each year (Pozio, 2007). Rodents, particularly rats, are primarily responsible for retaining the endemicity of the disease, while carnivores and omnivores get infected through ingestion of infected rodents or other carnivores or omnivores (Mahdavi, 2009).

Cultural differences in eating habits and religious dietary restrictions remain key in influencing the global distribution of taeniosis, cysticercosis and trichinellosis. As such, foodborne pathogenic diseases like cysticercosis and trichinellosis were believed to be practically non-existent in Islamic countries such as Iran, owing to the Islamic dietary laws which prohibit consumption of pork (Najmieh, 1992). However, while the few cases of foodborne zoonoses that have been reported in parts of Iran may not be significant, they still warrant some attention given the increased cross-border movements, immigration and wildlife hunting activities practised in some regions. This study therefore sought to conduct a review of existing literature to ascertain the epidemiology of taeniosis, cysticercosis and trichinellosis in Iran.

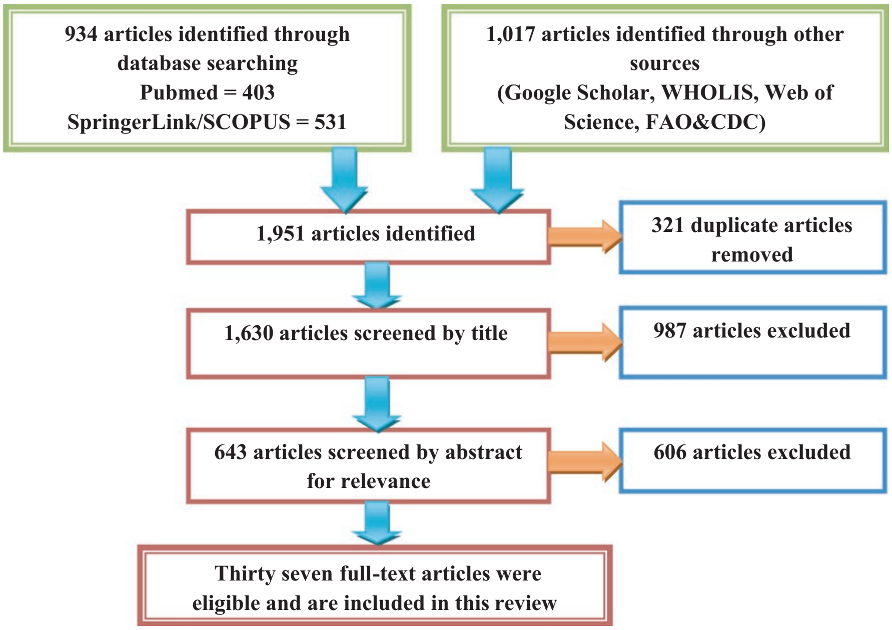

FIGURE 1 The PRISMA flow chart diagram describing the articles analysis process for inclusion in the systematic review (Adapted and modified from Moher et al., 2009). [Colour figure can be viewed at wileyonlinelibrary.com]

2 | METHODS

2.1 | Review design

In this systematic review, the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) system was used to search for articles published between 1967 and 2018 and reporting on taeniosis, cysticercosis and trichinellosis in Iran. We systematically searched for articles reporting on the three diseases within Iran in PubMed, Web of Science, Google Scholar, SpringerLink, SCOPUS, WHOLIS, FAO and Center for Disease Control and Prevention databases. To maximize the search and reduce selection bias, the exercise was restricted to English articles only using a number of key terms, among them: "*T. solium*," "*T. saginata*," "*T. asiatica*," "human tapeworms," "cysticercosis," "neurocysticercosis," "taeniosis," "*Trichinella*," "*T. spiralis*," "trichinellosis," "trichinosis," "beef tapeworm" and "pig tapeworm" in Iran. During the search, articles were first selected from the various databases using their titles and thereafter screened for eligibility based on the content of their abstracts. A full-text review was conducted on all the articles. During the review process, data were extracted from each of the selected articles by filling a table containing several subsections, including year of study, disease type/parasite, study design, study region, sample size and author. Extraction of information followed the PRISMA checklist (Appendix S1) and the PRISMA flow chart (Figure 1).

2.2 | Inclusion and exclusion criteria

Only articles describing findings on taeniosis, cysticercosis and trichinellosis in Iran were included in this review. All non-verified sources of information and studies conducted outside the borders of Iran were excluded.

2.3 | Study article selection

After assembling articles from the different databases, duplicates were excluded and titles together with abstracts of the remaining articles critically evaluated. Those that did not address prevalence, and/or incidence of taeniosis, cysticercosis or trichinellosis in humans and animals within Iran were excluded. Articles that were not written in English were also excluded together with those that focused on other foodborne diseases besides taeniosis, cysticercosis or trichinellosis in Iran. Risk of bias was reduced by inclusion of published reports only, and exclusion of studies whose sampling strategy was not comprehensive, such as unidentified sample source(s) or where the sample size was missing.

3 | RESULTS

The PRISMA flow chart for selecting suitable articles for this review is shown in Figure 1. A total of 934 articles were sourced from indexed scientific databases: PubMed, SpringerLink and SCOPUS and another 1,017 articles from other databases like Google Scholar, Web of Science, WHOLIS, FAO and CDC databases to make a total of 1,951 articles. All the 1,951 articles were listed in MS Excel, and 321 articles presenting duplicate titles were removed to obtain 1,630 articles. Further screening was done by title and relevance, and a total of 987 articles excluded from the review, leaving a subset of 643 articles. Abstracts of the 643 articles were assessed for eligibility, and 606 articles that failed to meet the eligibility criteria were excluded at this point, leaving 37 eligible articles for review. Of the 37 articles that underwent full review, 10 (27.0%) reported on human taeniosis, 15 (40.5%) on cysticercosis and 12 (32.5%) on trichinellosis. Geographically, the 37 studies were confined to 19 of the 31 provinces of Iran, representing 55.9% of the country's provinces (Figures 2 and 3).

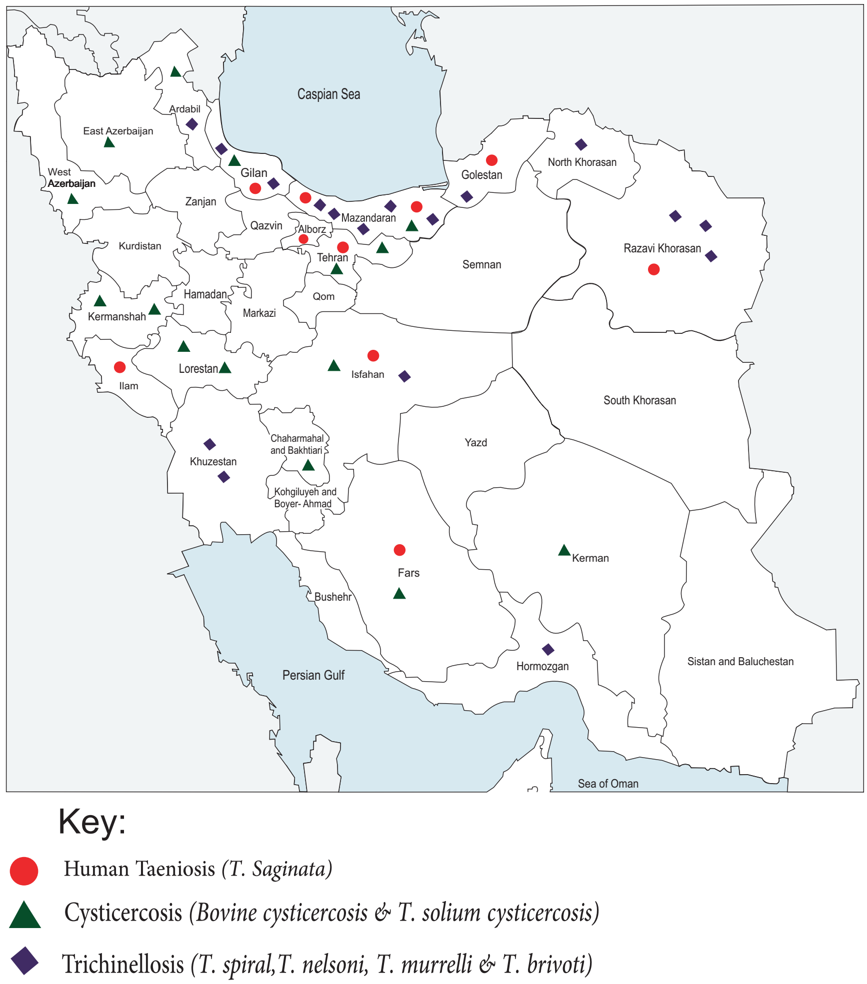

FIGURE 2 Map of Iran showing the distribution of foodborne zoonoses per province. [Colour figure can be viewed at wileyonlinelibrary.com]

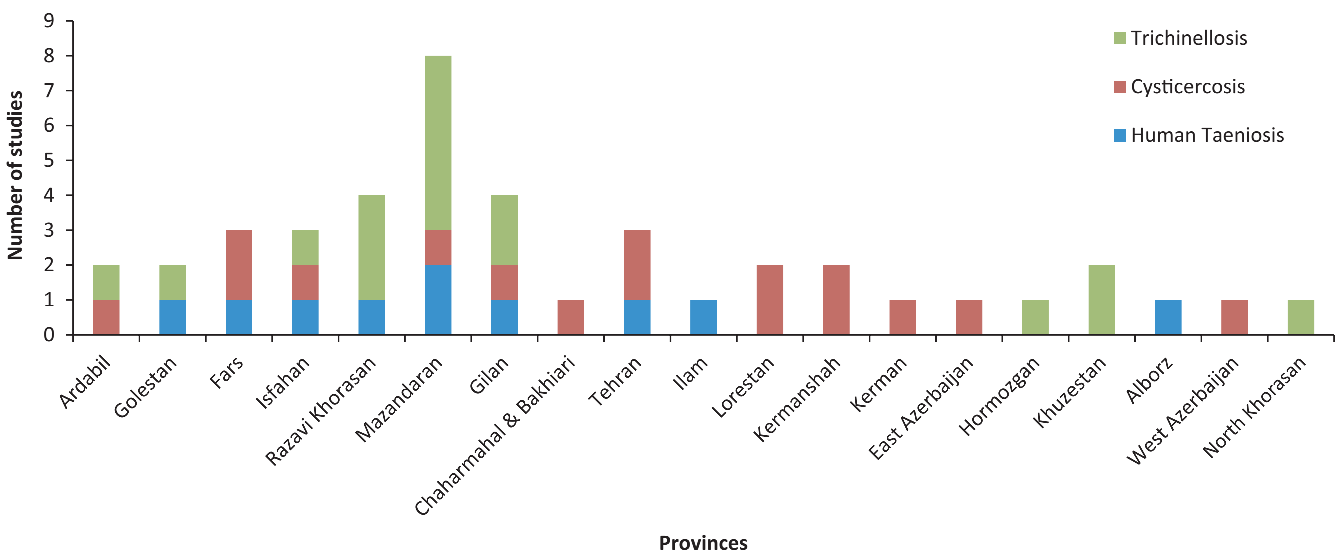

FIGURE 3 Summary of reported studies on foodborne zoonoses (taeniosis, cysticercosis and trichinellosis) in various provinces of Iran. [Colour figure can be viewed at wileyonlinelibrary.com]

3.1 | Taeniosis (*T. saginata*)

A total of 10 articles reported on human taeniosis in Iran, 6 (60%) of which were case reports, while 4 (40%) were studies on samples (stool, urine, blood, resected appendices) obtained from human subjects (Table 1). All the human taeniosis cases were as a result of *T. saginata* infection, with no single case of human taeniosis being linked to *T. solium*. Most (70%) of the studies on human taeniosis were

TABLE 1 Studies on taeniosis, cysticercosis and trichinosis in Iran

	Year of study	Disease	Study design/technique used	Study region/area studied	Sample size	Author
A. Human taeniasis (*Taenia saginata*)						
1	2003–2004	Human taeniosis (*T. saginata*)	Administration of anti-*Taenia* drug to randomly selected people	Mazandran Province, northern Iran	417 randomly selected people	Kia et al. (2005)
2	NP	Human taeniosis (*T. saginata*)	Descriptive, cross-sectional study	Shiraz University, Fars Province, Iran	39 catering personnel at a school canteen	Neghab et al. (2006)
3	1993–2001	Appendicular taeniosis (*T. saginata*)	Microscopic and histopathological examination of appendices	Esfahan Province, central Iran	2,379 surgically resected appendices	Kia et al. (2004)
4	2006–2008	Human taeniosis (*T. saginata*)	Stool examination	Karaj city, Tehran Province, Iran	13,915 stool specimen from men and women	Nasiri et al. (2009)
5	NP	Appendicular taeniosis (*T. saginata*)	Case report of one male patient	Ilam Province, Iran	One patient with abdominal pain	Ahmadi and Seifmanesh (2011)
6	NP	Human taeniosis (*T. saginata*)	Case report of a 29-year-old woman	Mazandaran Province, northern Iran	One patient with abdominal pain	Saravi et al. (2016)
7	NP	Human taeniosis (*T. saginata*)	Case report of a 47-year-old woman	Mashhad city, Khorasan-Razavi Province, north-east Iran	One patient with history of intermittent epigastric pain	Sheikhian (2013)
8	NP	Human taeniosis (*T. saginata*)	Case report of a female patient (Gastrointestinal endoscopy)	Rasht, Gilan Province, northern Iran	One female patient with history of chronic abdominal pain	Shafaghi et al. (2015)
9	NP	Human taeniosis (*T. saginata*)	Case report of a 35-year-old man	Shahid Rajae hospital, Alborz Province Iran	One male patient	Heidari et al. (2016)
10	NP	Human taeniosis (*T. saginata*)	Case report of a 54-year-old female patient (microscopic and histopathological tests)	Hakim Jorjani hospital, Golestan, north-eastern Iran	One patient with intermittent abdominal pain, diarrhoea and vomiting	Soosaraei et al. (2017)
B. Bovine cysticercosis (*T. saginata* cysticercosis)						
11	2010–2011	Bovine cysticercosis	Visual inspection by meat inspectors	Bistoons Kermanshah Province, Iran	100,040 carcasses of slaughtered cattle	Faraji et al. (2015)
12	2010–2011	Bovine cysticercosis	Postmortem inspection conducted on 500 slaughtered cattle	Meshkinshahr Abattoir, Ardabil Province north-west Iran	Various organs of 500 cattle	Garedaghi et al. (2012)
13	2011	Bovine cysticercosis	Morphological examination and conformation with PCR	Esfahan abattoir, central Iran	7,371 cattle carcasses	Hosseinzadeh et al. (2013)
14	2006–2013	Bovine cysticercosis	Retrospective study of daily condemnation records of cattle in an abattoir	Kermanshah Province, west Iran	361,787 cattle	Hashemnia et al. (2015)

(Continues)

TABLE 1 (Continued)

	Year of study	Disease	Study design/technique used	Study region/area studied	Sample size	Author
15	2013–2014	Bovine cysticercosis	Inspection of internal organs and skeletal muscles	Tabriz, East Azerbaijan Province Iran	640 cattle	Mirzaei et al. (2016)
16	2011	Bovine cysticercosis	Examination of slaughtered carcases for metacestodes	Fars Province, southern Iran	500 cattle	Oryan et al. (2012)
17	2005–2007	Bovine cysticercosis	Routine examination of cattle carcasses for infection	Iran	4,543,105 cattle	Khaniki et al. (2010)
18	NP	Bovine cysticercosis	Examination of cattle carcasses for infection	Fars Province, southern Iran	9,501 cattle	Oryan et al. (1995)
19	2011–2015	Bovine cysticercosis	Examination of cattle carcasses for infection	West Azerbaijan Province, west Iran	11,773 cattle carcasses	Nazari (1992)
20	NP	Bovine cysticercosis (Rumen cysticercosis)	Case report	Lorestan Province, western Iran	Two indigenous cattle	Eslami et al. (2003)
C. *Taenia solium* cysticercosis						
21	2012	Hepatic cysticercosis (*T. solium*)	Case report of hepatic cysticercosis in a rook	Chaharmahal and Bakhtiari Province, Iran	One rook (*Corvus frugilegus*) bird	Nourani et al. (2014)
22	NP	Cysticercosis (*T. solium* larvae)	Examination of wild boars for different helminths	Protected regions, north, north-east and south-west, Iran	57 wild boars	Eslami and Farsad-Hamdi (1992)
23	NP	Neurocysticercosis (*T. solium* cysticercosis)	Case report of a 63-year-old male patient	Shohada Hospital Tehran Province, Iran	One male patient with headache and nausea	Farahani et al. (2013)
24	2000–2001	Cysticercosis (*Cysticercus cellulosae*)	Examination of various tissues for taeniid larvae	Lorestan Province, Iran	12 wild boars	Solaymani-Mohammadi et al. (2003)
25	NP	Cysticercosis (*T. solium* larvae)	Examination of various organs	Tehran, Iran	24,000 and 4,800 carcasses of domesticated and wild swine, respectively	Afshar (1967)
D. Trichinellosis (*Trichinella brivoti, Trichinella spiralis, Trichinella murrelli, Trichinella nelsoni*)						
26	1967–1972	Trichinellosis (*T. spiralis*)	Physical examination of tissues	Caspian region, northern Iran	21,143 wild boars, 16 brown bears, 63 golden jackals, three jungle cats, 30 rodents and 20 shrews	Mobedi et al. (1973)
27	1967 and 1976	Trichinellosis (*T. spiralis*)	Physical examination	Gilan, Mazandaran, Golestan, North Khorasan and Khorasan Razavi Province in the Caspian area	830 rodents and carnivores	Mobedi and Hamidi (1976)
28	1969 and 1976	Trichinellosis (*T. spiralis*)	Physical examination of thin muscle tissue compressed between microscope slides	Bandar Abbas area, Hormozgān Province South Iran	237 rodents and carnivores (foxes, stray dogs and golden jackals)	Hamidi and Mobedi (1977)

(Continues)

TABLE 1 (Continued)

	Year of study	Disease	Study design/technique used	Study region/area studied	Sample size	Author
29	2009–2010	Trichinellosis (*T. brivoti*)	Digestion of muscle samples and isolation of *Trichinella* sp larvae	Khuzestan Province, south-west Iran	32 road-killed animals (14 dogs and 18 jackals)	Mirjalali et al. (2016)
30	2010–2011	Trichinellosis (*T. brivoti*)	Histopathological examination and molecular identification of *Trichinella* spp	Mashhad Province, Khorasan Razavi Province, north-east Iran	120 stray dogs, 25 rodents, 26 wild boars, two foxes and two hyenas	Borji et al. (2012)
31	2015–2016	Trichinellosis (*T. brivoti*)	Digestion and molecular methods	Mazandaran Province, northern Iran	35 wild boars	Rostami et al. (2017)
32	2016–2017	Trichinellosis (*T. brivoti*)	Multiplex PCR	Khorasan Razavi Province, northern Iran	Stray dogs and golden jackals	Shamsian et al. (2018)
33	NP	Trichinellosis (*T. brivoti*)	Trichinoscopy and PCR using four reference strains for comparison	Ardabil Province, north-western Iran	One leopard (*Panthera pardus saxicolor*)	Mowlavi et al. (2009)
34	NP	Trichinellosis (*T. brivoti*)	Molecular identification and serological survey	Mazandaran Iran	79 wild boars and 364 at-risk human beings	Rostami, Riahi, et al. (2018))
35	NP	Trichinellosis (*T. brivoti*)	Physical examination of tissues	Gilan Province and Mazandaran Province, northern Iran	Golden jackals	Afshar and Jahfarzadeh (1967)
36	NP	Trichinellosis (*T. nelsoni*)	Physical examination	Khuzestan, south-west Iran	10 Mongoose (*Herpestes auropunctatus*)	Mowlavi et al. (2000)
37	NP	Trichinellosis (*T. murelli*)	DNA analysis by Polymerase chain reaction	Gilan Province, northern Iran	Wild boars	Kia et al. (2009)

Note. NP: not provided.

confined to the northern part of Iran. Kia, Masoud, Yalda, Mahmoudi, and Farahani (2005) macroscopically and microscopically examined stool passed by 417 people, at least 36 hr after taking a dose of anti-*Taenia* drug (niclosamide and bisacodyl tablets), in 20 villages of Mazandaran Province and found 2 (0.5%) people to be infected with *T. saginata*. Nasiri, Esmailnia, Karim, Nasir, and Akhavan (2009) examined stool specimens submitted by 13,915 human subjects selected by randomized cluster sampling from all areas of Karaj City in Tehran Province, central Iran, and found *Taenia* proglottids alongside other intestinal parasitic infections in 4 (0.028%) of the samples.

Neghab, Moosavi, and Moemenbellah-Fard (2006) examined blood, urine and three stool samples collected on 3 consecutive days from 39 catering personnel at students' canteens in Shiraz, southern Iran, and detected *T. saginata* infection in one of the 39 people tested, while Kia, Afshar-Moghadam, and Kazemzade (2004) examined 2,379 surgically excised human appendices at the Isfahan Medical University Teaching Hospital in Iran and reported two (0.08%) cases of appendicular taeniosis caused by *T. saginata*.

Besides these four studies, a number of case reports of human taeniosis have also been reported in Iran. Saravi, Fakharb, Nematiana, and Ghasemic (2016) observed a large number of *T. saginata* eggs in the appendix lumen of a 29-year-old female patient from Mazandaran Province who was suffering from acute abdominal pain with a 1-day history of colic pain, anorexia, vomiting and nausea, while Sheikhian (2013) reported the presence of a 6-metre-long tapeworm (*T. saginata*) in the stomach of a 40-year-old woman following an upper gastroduodenal endoscopy procedure of the patient's upper gastrointestinal tract at Imam Reza Hospital, Mashhad, north-east Iran. Likewise, Shafaghi, Rezayat, Ghanaei, and Maafi (2015) performed an upper gastrointestinal endoscopy on a 55-year-old woman with a history of chronic abdominal pain, dyspepsia and epigastric fullness from a village around Rasht, Gilan Province, northern Iran, and found a large adult *T. saginata* in the stomach.

Soosaraei, Alizadeh, Fakhar, Banimostafavi, and Hezarjaribi (2017) examined a 54-year-old female patient with the history of eating undercooked beef at Hakim Jorjani Hospital in Gorgan, Golestan Province, north-east Iran, and established that the patient had a *T. saginata* infection, that was also implicated in the intestinal perforation and peritonitis observed in the patient, while Heidari et al. (2016) recovered an adult *T. saginata* tapeworm from a 35-year-old adult man with a history of eating undercooked beef at Shahid Rajaei Hospital, Karaj in Alborz Province, central Iran.

3.2 | Cysticercosis

In this review, a total of 15 studies reported on cysticercosis, 10 (66.7%) of which focused on bovine cysticercosis among cattle, 1 (6.7%) on human neurocysticercosis and 4 (26.6%) on *Taenia* spp. cysticercosis among different animals, including domestic and wild pigs, wild boars and a rook. Most (52.9%) of the studies on cysticercosis were conducted in the northern part of Iran.

3.2.1 | *Taenia saginata* cysticercosis (bovine cysticercosis)

More than 70% of the bovine cysticercosis studies were conducted in the western and northern parts of Iran. Garedaghi et al. (2012) examined various organs of 500 cattle slaughtered at Meshkinshahr Abattoir, Ardabil Province, north-western Iran, and established that samples from 15 (3%) cattle were infected with *T. saginata* cysticercosis. The authors identified the tongue, masseter, cardiac, triceps and thigh muscles as the main predilection sites of the cysts. Likewise, Oryan, Moghaddar, and Gaur (1995) examined 9,501 cattle in Fars Province, southern Iran, and reported a 7.7% *T. saginata* cysticercosis infection among the cattle. The researchers also identified the shoulder, masseter, tongue and heart muscles as the most common predilection sites. In another study to determine the prevalence of *T. saginata* cysts among 500 cattle slaughtered at Shiraz slaughterhouse in Fars Province, southern Iran, Oryan, Goorgipour, Moazeni, and Shirian (2012) conducted a visual inspection of the omentum, mesentery, peritoneal cavity, liver, lungs, kidneys, spleen, striated muscles, heart and subcutaneous area of each carcass and found *T. saginata* cysts in 3 (0.6%) male cattle.

Eslami, Helan, and Gharouni (2003) reported the presence of *T. saginata* cysts between the serous and muscle layer of the rumen of two indigenous cattle slaughtered in Khorramabad slaughterhouse in Lorestan Province, west Iran, while Mirzaei, Nematolahi, Ashrafihelan, and Rezaei (2016) visually examined internal organs of 640 cattle slaughtered at Tabriz abattoir in East Azerbaijan Province, north-west Iran, and established that 11 (1.71%) of the 640 cattle were infected with *T. saginata* cysts. Hosseinzadeh, Setayesh, Shekarforoush, and Fariman (2013) conducted a gross examination of traditional predilection sites of 7,371 cattle carcases in Isfahan abattoir located in Isfahan Province, central Iran, and established that 72 cases (0.97%) were infected with the larval stage of *T. saginata*, which was differentiated from other parasitic infections by biomolecular-based assay.

Another study by Faraji, Nazari, and Negahdary (2015) detected *T. saginata* cysticercosis in 29 (0.03%) of 100,040 cattle carcasses slaughtered between 2010 and 2011 in Bistoons, Kermanshah Province in Iran, while Hashemnia, Shahbazi, and Afshari Safavi (2015) in a study of the same region (Kermanshah Province) reported a bovine cysticercosis prevalence of 0.05% (183) among the 361,787 cattle that were studied. Nazari (2016) reported a bovine cysticercosis prevalence of 0.039% among 11,773 cattle slaughtered in Piranshahr slaughterhouse, located in West Azerbaijan Province, in the north-western part of Iran, while Khaniki, Raei, Kia, Haghi, and Selseleh (2010) conducted a cross-sectional study of 4,534,105 cattle slaughtered in Iran between 2005 and 2007, in which a thorough inspection of the liver of each carcass revealed a bovine cysticercosis prevalence of 0.25%. Collectively, these 6 studies reported a bovine cysticercosis prevalence of between 0.25% and 3% among cattle in Iran.

3.2.2 | *Taenia* species cysticercosis

A total of five studies reported on *Taenia* spp. cysticercosis in Iran, one (20%) on human neurocysticercosis and four (80%) on *Taenia* spp. cysticercosis among domestic pigs, wild pigs, wild boars and a rook. Afshar (1967) investigated porcine cysticercosis in 24,000 carcasses of domesticated pigs slaughtered in Tehran and 4,800 carcasses of wild pigs killed in Mazandaran Province and Gilan Province. The researchers examined the heart, tongue, diaphragm, neck, shoulder, intercostals and abdominal muscles in domesticated pigs and neck, shoulder, intercostal and abdominal muscles in wild pigs and reported an infectivity rate of 0.02%–0.03% and 4% for domestic and wild pigs, respectively. Eslami and Farsad-Hamdi (1992) studied 57 wild boars (*Sus scrofa*) from the protected regions of Iran and found 4 (7%) of them to be infected with *Taenia* spp. cysticercosis.

Another study by Solaymani-Mohammadi et al. (2003) examined the peritoneal cavity, subcutaneous tissues and muscles, including the tongue, for taeniid larvae in 12 wild boars from Lorestan Province, western Iran. Scolices of all taeniid larvae found were cut and mounted in lactophenol after which the shape, number, size, and arrangement of rostellar hooks were used for identification according to Verster (1969) and Khalil, Jones, and Bray (1994). The researchers established that 8.3% were infected with *T. solium* cysts, alongside other helminths. Nourani, Dehkordi, Soltani, and Khosravi (2014) described the first pathological findings of hepatic cysticercosis caused by *Taenia* spp. larvae in a rook (*Corvus frugilegus*) at the Department of Pathobiology, School of Veterinary Medicine, Shahrekord University, in Chaharmahal and Bakhtiari Province, southwestern Iran. This was done by gross examination of the liver of a rook which revealed numerous white and cystic foci measuring 2 mm in size throughout the affected liver. Tissue samples from the hepatic lesions were taken for histopathological examination, which revealed multiple focal granulomatous inflammation scattered throughout the liver.

Farahani, Moradi, Sedighi, and Soleimani (2013) described a case of neurocysticercosis in a 63-year-old male patient referred to Shohada Hospital in Tehran Province, northern Iran. A CT scan conducted on the patient's brain revealed multiple cystic deep parieto-occipital lesions that induced midline shifting and moderate hydrocephalus. Further, a CT-guided stereotactic biopsy diagnosed neurocysticercosis. The patient had a history of ischaemic heart disease, diabetes mellitus in addition to having experienced headache and nausea for 2 months with unconsciousness that worsened during 14 days prior to the hospital visit. Unfortunately, information on the patient's travel history and ethnicity was not provided by the researchers.

3.3 | Trichinellosis

A total of 12 articles reported on *Trichinella* species, out of which 11 (91.7%) were conducted among wild animals (foxes, mongoose, stray dogs, golden jackals, hyena, gebril, leopard, wild boars and rodents) and one (8.3%) on human beings. Four species of *Trichinella* were reported in the 12 studies. *T. britovi* featured in 6 (50%) studies, *T. spiralis* in 4 (33.3%), *T. murelli* in 1 (8.3%) and *T. nelsoni* in 1 (8.3%) of the 12 trichinellosis studies that were conducted in Iran. Only one study reported on trichinellosis in human beings in Iran. Most (79%) of the trichinellosis studies were however confined to the northern part of the country.

3.3.1 | Trichinellosis among wild animals

The four *Trichinella* species, *T. britovi*, *T. spiralis*, *T. murrelli* and *T. nelsoni*, were encountered among different wild animals in Iran. Mowlavi et al. (2009) detected the first ever case of *T. britovi* in the muscles of a leopard (*Panthera pardus saxicolor*) that was accidentally shot in Germi County, Ardabil Province, north-western Iran. The larval stage of *T. britovi* was detected by trichinoscopy in muscle samples of the shoulders, neck and abdomen and the species identified by multiplex PCR amplification. An earlier study by Mowlavi, Massoud, and Rokni (2000) investigated 10 mongoose (*Herpestes auropunctatus*) in Khuzestan Province, south-west Iran, and detected *T. nelsoni* in 3 (30%) of the 10 mongoose consequently terming the mongoose as new reservoir hosts for *Trichinella* spp.

Mirjalali et al. (2016) investigated muscle samples of 18 road-killed jackals (*Canis aureus*) in Khuzestan Province, south-west Iran using PCR and found *T. britovi* larvae in two of the samples, while Rostami et al. (2017) isolated *T. britovi* larvae from 2 (5.7%) of the 35 hunted wild boars in Mazandaran Province, northern Iran, by PCR amplification. In another study, Rostami, Riahi, et al. (2018) reported a 3.7% *T. britovi* infection in 79 wild boars using amplification of CO1 and 5S rRNA gene primers in Mazandaran Province, northern Iran, while Shamsian et al. (2018) reported larvae of *T. britovi* in 1.7% of the stray dogs and 8.3% of the golden jackals studied in Khorasan Razavi Province, north-eastern Iran.

Mobedi, Arfaa, Mabadi, and Movafagh (1973) conducted a study in the Caspian region over a 5-year period and reported varying *T. spiralis* prevalence levels among the different wild animals that were studied. A relatively low *T. spiralis* prevalence (0.02%) was reported among wild boars and brown bears (6.25%), compared to the 60.3% and 66.7% prevalence reported among golden jackals (*C. aureus*) and jungle cats (*Felis chaus*), respectively. Hamidi and Mobedi (1977) microscopically examined muscle tissue obtained from 236 rodents and carnivores collected from Bandar Abbas area in Hormozgan Province, southern Iran, and detected *T. spiralis* in 23% of 17 foxes, 25% of 12 stray dogs and in all (100%) the three golden jackals, while no parasites were reported among the 204 rodents investigated.

Kia, Meamar, Zahabiun, and Mirhendi (2009) isolated *T. murrelli* larvae from the thigh muscles of a wild boar (*S. scrofa*) captured from Gilan Province, northern Iran, while Sadighian, Arfaa, and Movafagh (1973) documented cases of trichinellosis in stray dogs, golden jackals (*C. aureus*), red foxes (*Vulpes vulpes*), striped hyenas (*Hyaena hyaena*) and Persian gerbil (*Meriones persicus*) in Esfahan area, central Iran. Likewise, Borji, Sadeghi, Razmi, Pozio, and Rosa (2012) conducted a study on a number of carnivores, including 120 stray dogs, 26 wild boars, 25 rodents, two foxes and two hyenas in Khorasan Razavi Province, north-east Iran, using muscle tissues and identified *T. britovi* (using multiplex PCR) in 3 (2.5%) stray dogs, while Afshar and Jahfarzadeh (1967) reported trichinellosis among wild boars in Gilan Province and Mazandaran Province in northern Iran.

3.3.2 | Trichinellosis in humans

One case of human trichinellosis was reported in Mazandaran Province, northern Iran, by Rostami, Khazan, et al. (2018) following detection of anti-*Trichinella* IgG in 8 (2.2%) of the 364 at-risk individuals studied using enzyme-linked immunosorbent assays (ELISAs) at a 95 confidence interval. The researchers further noted that the risk factors associated with *Trichinella* infection were higher among consumers of wild boar meat and also among hunters.

4 | DISCUSSION

Taeniosis, cysticercosis and trichinellosis are well-known foodborne parasitic diseases of humans with significant public health and economic importance (Ng-Nguyen, Stevenson, & Traub, 2017), yet little is known about the prevalence of these foodborne zoonoses in Iran. Indeed, in Iran, being one of the biggest Muslim countries in the world, consumption of pork and meat from carrion is prohibited for religious reasons, while hunting of wild boar is merely authorized for the ethnic Armenians, Jews and Zoroastrians in the country. As a result, foodborne diseases like taeniosis, cysticercosis and trichinellosis are widely believed to be practically non-existent in Islamic countries like Iran. However, increased cross-border movements, illegal hunting and consumption of wild animals by non-Muslims may be increasing the risk of human taeniosis and trichinellosis in regions that were once considered disease-free.

In the current review, taeniosis, cysticercosis and trichinellosis were collectively reported in 19 (61.1%) of the 31 provinces of Iran, most of which were located to the northern part of the country. This excludes a large portion of the country and therefore generalization of the results to reflect the prevalence across the whole country would not be accurate, given the social, cultural and religious differences that exist among the various communities residing in different regions across the country. Nevertheless, the seemingly little attention given to cysticercosis and trichinellosis in Iran could be attributed to the fact that Iran is an Islamic country, where such diseases are considered insignificant.

4.1 | Human taeniosis resulting from *T. saginata* infection

In the current review, all human taeniosis infections reported in Iran were as a result of *T. saginata* infection; following recovery of adult tapeworm proglottids from a number of patients presenting with varied symptoms at different hospitals in Iran. Besides the case studies, human taeniosis (*T. saginata*) prevalence ranging from 0.025% to 0.5% was reported among study subjects in the current review. In comparison, studies conducted elsewhere have shown relatively higher prevalence levels of human taeniosis resulting from *T. saginata* infection especially in cattle-breeding areas of the world. For instance, human taeniosis prevalence reported in areas regarded as endemic were between 0% and 13.9% in Africa, 0.24% and 17.25% in Latin America and 0% and 3.02% in Asia (Coral-Almeida et al., 2015).

Human taeniosis resulting from *T. saginata* infection in Iran was attributed to consumption of inadequately cooked contaminated beef (Heidari et al., 2016; Ahmadi & Seifmanesh, 2011; Kia et al., 2005; Nasiri et al., 2009; Sheikhian, 2013; Saravi et al., 2016; Soosaraei et al., 2017). King, Jessica, and Fairley (2015) also acknowledge that consumption of "measly" (i.e., cyst-infected) uncooked or undercooked beef is the usual means of transmission. Likewise, Heidari et al. (2016) attributed the presence of *T. saginata* infections in rural areas of Iran to poor meat inspection systems and lack of sustainable education against this kind of infection, while Kia et al. (2005) attributed *T. saginata* infection to the peculiar dietary habits of consuming inadequately cooked beef by some rural households. Therefore, curbing the consumption of raw beef, effective meat inspection, better management of sewage, proper use of latrines can prevent infection and spread of taeniosis among humans (Abdo, Sayed, Hussein, & Arafa, 2009; Fahmy et al., 2015; Okello & Thomas, 2017).

Even though 70% of all studies on *T. saginata* taeniosis were conducted in the northern part of Iran, as per the current review, a previous study by Arfaa (2010) reported a countrywide distribution of *T. saginata*, though the author noted that the parasite was more prevalent in rural areas of Mazandaran Province where cattle breeding is common (Arfaa, 2010). This could partly be the reason for the considerable attention given to the northern part of Iran by many researchers studying *T. saginata* taenisosis and related meatborne diseases in Iran.

4.2 | Bovine cysticercosis (*T. saginata* cysticercosis)

In the current review, most studies on *T. saginata* cysticercosis among cattle were reported in seven of the 31 provinces of Iran, most of which are located to the western and northern parts of the country. However, few other studies were carried out in central and southern parts of Iran; pointing to a possible countrywide distribution. To establish the actual prevalence of bovine cysticercosis, countrywide studies incorporating all regions of Iran are necessary.

Collectively, prevalence of bovine cysticercosis among cattle in Iran ranged between 0.6% and 7.7% (Faraji et al., 2015; Hashemnia et al., 2015; Hosseinzadeh et al., 2013; Mirzaei et al., 2016; Oryan et al., 2012). These rates compared fairly to the 3.6%–7.5% prevalence rates reported among cattle slaughtered in local abattoirs in Ethiopia (Ibrahim & Zerihun, 2012; Kebede, Tilahun, & Hailu, 2009), 1.6% reported in Egypt (Abdo et al., 2009), 0.11% in Croatia (Zdolec et al., 2012), 0.21% in Mexico (González et al., 2015) and 9.07% reported among buffaloes slaughtered in Egypt (Fahmy et al., 2015). However, these rates were much lower compared to the 22.9% reported in Hawassa municipal abattoir in Ethiopia (Belachew & Ibrahim, 2012) and 26.2% reported in Nigeria (Opara, Ukpong, Okoli, & Anosike, 2006; Usip, Isaac, Amadi, Utah, & Akpaudo, 2011).

Variation in prevalence of bovine cysticercosis in different countries and even across regions within the same country may be attributed to the level of animal husbandry and the kind of sanitary and hygienic practices that exist among area residents. In addition, the choice of diagnostic technique used can dictate the accuracy of the results. For instance, most of the available data on bovine cysticercosis in Iran were generated by routine meat inspection. Like was the case in Iran, routine meat inspection remains the cornerstone for diagnosis of bovine cysticercosis in many countries, especially the developing ones with limited resources (Dorny & Praet, 2007).

The fact that the greatest frequency of cysts in affected cattle is often found in the masseter muscles, heart muscles, triceps muscles, thigh muscles and even the tongue makes the method of diagnosis very important (Garedaghi et al., 2012). Because, an inattentive meat inspector may easily miss out viable cysticerci that normally blend with the colour of meat thus underestimate the prevalence, thus exposing meat consumers to risk of ingesting the larvae. In addition, precision of the visual identification is also questionable as the cysticerci can be confused with lesions caused by other infections (Ogunremi, MacDonald, Geerts, & Brandt, 2004). Official meat inspection reports are therefore considered an underestimation of the real prevalence as meat inspection has a low sensitivity for the detection of cysts in muscles (Dorny et al., 2000).

Some researchers estimate the sensitivity of meat inspection for detection of bovine cysticercosis to be as low as 16.5% or between 10% and 30% (Eichenberger et al., 2013). Laranjo-González, Devleesschauwer, Gabriël, Dorny, and Allepuz (2016) concur that reporting prevalence rate of bovine cysticercosis based on meat inspection usually underestimates the actual prevalence. However, the level of detection of bovine cysticercosis by routine meat inspection may be improved by training and motivation of meat inspector as well as ensuring the level of compliance with inspection protocols is adhered to and that the quality of inspection facilities is maintained (Laranjo-González et al., 2016). Dupuy et al. (2010) demonstrated the importance of compliance with inspection protocols after reporting an increase in prevalence from 1% to 9% obtained by routine meat inspection in the Brittany region in France by simply cutting the heart into 2–3 mm thick slices, while complete cutting of the predilection sites of the parasite (detailed meat inspection) increased a zero prevalence rate of bovine cysticercosis to 23% in Belgium (Laranjo-González et al., 2016).

On the other hand, more sensitive diagnostic methods such as seroepidemiological studies and immunohistochemical tests have proved to be even more reliable and accurate. Eichenberger et al. (2011) carried out a seroepidemiological survey of *T. saginata* cysticercosis and demonstrated prevalences of between 2 and 50 times higher through seroepidemiology than those obtained by routine meat inspection. In another study, Dorny et al. (2000) examined 1,164 serum samples collected from 20 export abattoirs in Belgium for circulating parasite antigen using a monoclonal antibody-based sandwich enzyme-linked-immunosorbent assay (Ag-ELISA) and found 36 (3.09%) serum samples to be positive in the Ag-ELISA, while meat inspection on the same animals detected cysticerci in only 3 (0.26%) carcasses. These studies are a clear indication that the classical meat inspection technique is capable of detecting only a minor fraction of the carcasses infected with cysticerci, thus underestimating the actual prevalence.

In areas where animal husbandry practices are poor, prevalence of parasitic infections like *T. saginata* cysticercosis is likely to be high particularly among free-ranging cattle which are more likely to consume contaminated water or forage (González et al., 2015). Heavy infestation with *T. saginata* cysticerci often leads to condemnation of carcasses, making it economically important. Therefore, irrespective of region, accurate determination of *T. saginata* prevalence is paramount for its control and prevention.

4.3 | Taeniosis resulting from *T. solium* infection

Of the 37 articles reviewed in the current study, no single case of *T. solium* taeniosis was reported among humans in Iran. On the contrary, relatively higher infection rates have been reported in other areas across the world such as Vietnam, where up to 13% of the people in rural hotspots were reportedly infected with *T. solium* (Ng-Nguyen et al., 2017). Given that *T. solium* taeniosis is transmitted to humans through consumption of pork, Islamic dietary laws which strictly forbid pork consumption among Muslims could have been responsible for the absence of *T. solium* taeniosis among humans in Iran. In the current review, a few studies however reported on *T. solium* cysticercosis among wild boars (Eslami & Farsad-Hamdi, 1992; Solaymani-Mohammadi et al., 2003) as well as domesticated and wild pigs (Afshar, 1967). Generally, the *Taenia* spp. cysticercosis prevalence rates reported in Iran are relatively low compared to those reported in countries like Vietnam where *Taenia* spp. cysticercosis occurs in over 50 of the 63 provinces of the country (Ng-Nguyen et al., 2017).

Surprisingly, in this review, a study by Nourani et al. (2014) reported the larval stage of *Taenia* spp. in a rook (*C. frugilegus*) from Shahr-e Kord Province, Chaharmahal and Bakhtiari Province, southwest of Iran. This was the first ever case of *Taenia* spp. cysticercosis in a rook in Iran, making the researchers to conclude that rooks were also intermediate hosts for *Taenia* spp. and could therefore play an active role in the transmission of the parasite to other birds, animals or even humans. Besides the rook, *Taenia* spp. have previously been reported to form cysticerci in tissues of numerous other unusual intermediate hosts, like rabbits, camels, dogs, cats and humans (Konyaev, Nakao, Ito, & Lavikainen, 2017). Although *T. solium* is still regarded of less significance in Islamic countries like Iran, increased travels and immigration coupled with illegal hunting and consumption of game meat by minority groups of non-Muslims in Islamic countries can introduce human taeniosis into areas that were originally free of such diseases. Ng-Nguyen et al. (2017) singled out consumption of raw meat, inadequate or absent meat inspection and control, poor sanitation in some endemic areas, and use of untreated human waste as a fertilizer for crops as some of the risk factors responsible for the transmission of Taeniosis and cysticercosis.

4.3.1 | *Taenia solium* cysticercosis (neurocysticercosis)

In the current review, one case of neurocysticercosis was reported in a 65-year-old male patient at Shohada Hospital emergency department in Iran, following a CT scan on his brain that revealed multiple cystic deep parieto-occipital lesions, which induced midline shifting and moderate hydrocephalus (Farahani et al., 2013). It was however not clear how this isolated case was contracted since the history of travel or the patient's ethnicity was not provided by the authors. However, the single case reported in Iran can be termed as negligible, in comparison with the rates reported in endemic areas such as Peru where an analysis of 12 population-based community studies demonstrated that neurocysticercosis was endemic in highland areas and high jungles, with seroprevalences ranging between 6% and 24%.

Islamic dietary law that forbids the consumption of pork among Muslims appears to play a significant role in the curbing taenisos in Iran. Foyaca-Sibat, Ibañez-Valdés, and Moré-Rodríguez (2010) concurs that hygienic conditions, eating habits and to a large extent religious restrictions on consumption of pork are determinants of the incidence and prevalence of *T. solium* cysticercosis. However, Remy (2009) cautions that with increased world travel, people who were previously not exposed to such parasitic illnesses are now increasingly becoming susceptible. This calls for the proper generation and utilization of epidemiological data alongside clinical suspicion and laboratory tests while making diagnosis in hospitals among patients to establish the incidence and actual prevalence of neurocysticercosis.

4.4 | Trichinellosis

In the current a total of 12 articles reported on trichinellosis out of which, only one study focused on human trichinellosis (that also included wild boars) while the rest investigated trichinellosis in wild animals.

4.4.1 | Human trichinellosis

In the single case of human trichinellosis in Mazandaran Province, northern Iran, Rostami, Khazan, et al. (2018) reported a 2.1% seroprevalence rate. This was relatively low compared to prevalence rates reported in Turkey (4%), Greenland (22%), Indonesia (19.8%), Argentina (4.5%), Papua New Guinea (10%), Estonia (3.3%), East Greenland (3.1%), Laos (19.1%) and China (3.1%–5.3%) (Rostami, Riahi, et al., 2018). According to Pozio (2007), different eating habits exhibited by different communities are responsible for the transmission and spread of the trichinellosis from animals to humans (Pozio, 2007). Islam being the religion of a majority of the Iranian people, Islamic dietary laws could be the main reason for the near absence of human trichinellosis in Iran. While pork is considered as a major source of human trichinellosis infection, meat from wild boars, horses, bears, badgers, dogs and walruses are also known to play an important role (Alonso, Herrero, Vieites, & Espiñeira, 2011; Murrell & Pozio, 2011).

The wild boars—considered as important sources of trichinellosis—are indigenous in many countries, with recent outbreaks of trichinellosis reported worldwide being attributed to consumption of their meat (Faber et al., 2015; Fichi et al., 2015; Padovani et al., 2014). Such outbreaks indicate the potential role that wild boars play as reservoirs for human trichinellosis infection (Faber et al., 2015). In Iran, wild boar population has grown rapidly in recent years and they are now reported in dense populations in different parts of the country, making them potential reservoirs of zoonotic diseases such as trichinellosis (Mansouri, Sarkari, & Mowlavi, 2016).

Rostami et al. (2017) identified *T. britovi* as the prevalent species circulating among wild boars in Iran and concluded that there was a hidden burden of *Trichinella* spp. infection among wild boar population in Iran. While hunting of wild boar is forbidden in Iran except for religious minorities (e.g., Jews, Christians, Zoroastrians), there is still illegal hunting and consumption of wild boar meat among populations, putting them at risk (Rostami et al., 2017). This calls for more studies since the single study conducted in Mazandaran Province to the northern part of the country makes the geographic range of the reported study quite narrow and thus not sufficient enough to deduce the actual prevalence of trichinellosis in Iran.

4.4.2 | Trichinellosis among animals

In the current review, *T. britovi* and *T. spiralis* were the most prevalent species detected among wild animals particularly carnivores and wild boars in Iran, while two different studies reported *T. nelsoni* and *T. murelli* among mongoose and wild boars, respectively, in Iran. Wild boars are considered the second most important potential sources of trichinellosis for humans (Rostami et al., 2017; Rostami, Riahi, et al., 2018). In comparison with the *T. britovi* prevalence rate of 3.7%–5.7% reported among wild boars in Iran, a study conducted on the global seroprevalence of *Trichinella* infection among the wild boars in 15 countries revealed a 6% *Trichinella* spp. seroprevalence among wild boars with 9%, 7%, 3% and 3% seroprevalence reported among wild boars in North America, Europe, Asia and Oceania, respectively.

The researchers emphasized that the common feeding habit among wild boars of scavenging on animal carcasses makes them highly susceptible to parasitic infections. On the other hand, a contaminated wild boar carcass is capable of infecting a large number of people (Rostami, Riahi, et al., 2018). Given that Iranian Armenians, Jews and Zoroastrians may consume wild boar meat after hunting (Mahdavi, 2009; Rostami, Khazan, et al., 2018), educational programmes for hunters and consumers are necessary especially in high-risk regions of the country.

Occurrence of *Trichinella* in herbivorous animals which until recently were mostly considered as *Trichinella* free is increasing. Flis, Popczyk, and Rataj (2017) noted that approximately 250 mammals and bird species may act as reservoir host for *Trichinella* spp., making the parasite have unlimited capability to infect human beings. While there were no reported cases of trichinellosis among domestic animals in Iran, the few cases reported among wild animals (mainly the wild boars) in Iran confirm the existence and circulation of *Trichinella* spp. parasites in Iran which necessitates further research.

5 | CONCLUSION

All human taeniosis and bovine cysticercosis cases in Iran were attributed to the adult and larval stages of *T. saginata*, respectively, making the parasite most common and of greater economic and public health significance. *T. solium* taeniosis and trichinellosis are however of little public health significance with just one human trichinellosis and one neurocysticercosis case reported in Iran. However, presence of *Trichinella* spp. among wild animals implies that there is a potentially high risk of transmission to human, especially among the minority non-Muslims who practice hunting in the country. There is a need to conduct more studies covering the whole country to accurately ascertain the prevalence of taeniosis, cysticercosis and trichinellosis in Iran.

ACKNOWLEDGEMENTS

The authors kindly acknowledge referenced authors for the data and information.

CONFLICT OF INTEREST

None.

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How to cite this article: Moazeni M, Khamesipour F, Anyona DN, Dida GO. Epidemiology of taeniosis, cysticercosis and trichinellosis in Iran: A systematic review. *Zoonoses Public Health*. 2019;66:140–154. https://doi.org/10.1111/zph.12547