



Review

The prevalence of *Listeria* spp. food contamination in Iran: A systematic review and meta-analysis

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ABSTRACT

Listeria monocytogenes can cause circling disease, encephalitis, meningitis, septicemia, and mastitis in dairy cattle. Contamination from the environment can contaminate foods with *Listeria* spp. Consumption of foods containing *L. monocytogenes* can lead to listeriosis in susceptible people (adults with a compromised immune system), pregnant women, and infants. The objective of this study was to determine the prevalence of *Listeria* spp. and *L. monocytogenes* in various foods in Iran. We searched PubMed, Science direct, Scopus, Google scholar, and Iranian local databases including Iranian scientific information database and Magiran for relevant studies up to May 2015 using related keywords. In our preliminary search, we retrieved 1344 articles. After removing duplicates and reviewing titles/abstracts, 117 articles were considered, out of which, 75 articles had sufficient quality for inclusion in this meta-analysis. The prevalence of *Listeria* spp. contamination was about 18.3% in poultry, 8.5% in raw meat, 14.6% in ready-to-eat (RTE) foods, 10% in sea foods, 7.3% in traditional dairy, 3.2% in commercial dairy, and 0.1% in eggs. The findings showed that *L. monocytogenes* was most prevalent in ready to eat (9.2%), seafood (5.1%), poultry (5%), traditional dairy (4%), raw meat (2.6%), commercial dairy (1.4%), and egg (0.2%), respectively. Furthermore, the presence of *L. monocytogenes* particularly in RTE foods (that are consumed without further heat processing) and under-cooked products could be a potential risk for public health. So, contamination should be controlled at all levels of the food chain.

1. Introduction

The genus *Listeria* is gram-positive, non-sporulation, facultative anaerobic, and psychotropic bacteria widely distributed in the natural environment (Navratilova et al., 2004; Williams et al., 2011). *L. monocytogenes* is pathogenic in humans and animals, while *L. ivanovii* is considered as an animal pathogen. That is rarely pathogenic for human beings (Cummins, Fielding, & McLauchlin, 1994; Elischerova, Cupkova, Urgeova, Lysý, & Sesevickova, 1990; Razavilar, 2003). The ability of growing across a broad range of temperature (0–45 °C) and in an external stress such as extreme pH (4.4–4.9), having water activity above 0.92, salt concentrations up to 14% osmotic stress tolerance, and survival under mild preservation treatment have introduced *Listeria* spp. as important food borne organisms (Linton, Webster, Pierson, Bishop, & Hackney, 1992; Liu, Lawrence, Ainsworth, & Austin, 2005; Sleator, Gahan, & Hill, 2003).

Listeriosis, caused by *L. monocytogenes* is one of the most important food-borne diseases in human beings (J McLauchlin, 1997). In the case of its outbreaks, mortality rate of > 30% has been reported, which can increase in vulnerable groups such as pregnant women, newborns, and the elderly (Carminati, Perrone, Giraffa, Neviani, & Mucchetti, 2004; Donato et al., 1994). Outbreaks of listeriosis is associated with a wide range of food types, especially in developed countries (Goulet et al., 2001; McClain & Lee, 1987). Major sources for outbreaks of listeriosis are dairy food products, non-pasteurized milk and soft or semi-soft cheese (Carminati et al., 2004; Donato et al., 1994). Groups at highest risk are pregnant women, new-born babies, adults with an underlying disease (cancer, AIDS, diabetes, chronic hepatic disorder, and transplant recipients), the elderly (> 65 years old), and other immune-challenged individuals (J. McLauchlin, Mitchell, Smerdon, & Jewell, 2004; Todd & Notermans, 2011). In addition, *L. monocytogenes* can infect a wide variety of animals such as sheep, cattle, goats, pigs, mice,

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rabbits, birds, and fish (Fleming et al., 1985). The mild symptoms of listeriosis are diarrhea, vomiting, fever, chills, convulsions, headache, muscle aches, gastroenteritis, and myalgia. In cases of invasive listeriosis, septicemia and meningitis are the most common forms of disease that might lead to abortion and stillbirth in pregnant women (Aygun & Pehlivanlar, 2006). Because of high incidence of *L. monocytogenes* in different food groups and high mortality rate of listeriosis, *L. monocytogenes* has been considered as a serious public health hazard especially in high risk groups (Farber & Peterkin, 1991). The presence of any *Listeria* spp. in foods can be an indicator of poor hygiene condition (Farber & Peterkin, 1991).

Studies conducted to assess the prevalence of food contamination with *Listeria* spp. in Iran have led to inconsistent results. For instance, Jami, Jamshidi, and Khanzadi (2010), showed that contamination with *L. monocytogenes* in raw milk was 37% (Jami et al., 2010); however, studies carried out by Vahedi, Nasrolahei, Sharif, and Mirabi (2013), Jalali and Abedi (2008), and Akya, Najafi, Moradi, Mohebi, and Adabagher (2013) represented that raw milk is not contaminated with *L. monocytogenes* (Akya et al., 2013; Jalali & Abedi, 2008; Vahedi et al., 2013). Moosavy et al. isolated *L. monocytogenes* in 50% of cheese samples (Moosavy, Esmaeili, Mostafavi, & Bagheri, 2014), while Jalali and Abedi (2008), Akya et al. (2013), Shamloo et al. (2015), and Haji Seyed Javadi (2002) could not detect these bacteria in cheese samples (Akya et al., 2013; Haji Seyed Javadi, 2002; Jalali & Abedi, 2008; Shamloo et al., 2015). In addition, Shahbazi, Rashedi, and Sohrabi (2013), reported that 12.85% of butter samples were positive *L. Monocytogenes* (Shahbazi et al., 2013). But Shamloo et al. (2015), Rahimi et al. (2012a, 2012b), and Norowzi, Moradi, and Shafiee (2013) found that butter is not contaminated with *L. monocytogenes* (Norowzi et al., 2013; E. Rahimi, Momtaz, et al., 2012b). Furthermore, a wide range of foods or food groups including dairy foods (raw milk, traditional cheese, traditional cream, curd, traditional butter, traditional ice cream, traditional yogurt, traditional dough, fenny, and commercial dairy), eggs, meats, and fish have been examined for the presence of *Listeria* spp. and *L. monocytogenes* in Iran.

The meta-analysis is a method to summarize the results found by a large amount of primary investigations dealing with the same research question, which provides a high quality of evidence (C. Xavier, Gonzales-Barron, Paula, Estevinho, & Cadavez, 2014a, 2014b). Since the results are derived from several studies, meta-analysis is usually more precise (Sutton, Abrams, & Jones, 2001). In the past few years, meta-analysis has been widely used in the realm of food safety (Barron, Bergin, & Butler, 2008; den Besten & Zwietering, 2012; Gonzales-Barron & Butler, 2011; McQuestin, Shadbolt, & Ross, 2009; Xavier et al., 2014a, 2014b). Particularly in estimating the overall prevalence of contamination with microorganisms in foods. While a large number of studies have assessed the prevalence of *Listeria* spp. contamination in several foods in different parts of Iran, we are not aware of any study trying to summarize the published data in this regard. Therefore, the present study aimed to summarize the studies that reported *Listeria* spp. contamination in Iranian foods. It further targeted at conducting meta-analysis to report single estimates for all foods and for the whole country based on food types.

2. Materials and methods

2.1. Search strategy

We searched PubMed, Science direct, Scopus, Google Scholar, and Iranian local databases including Iranian scientific information database (www.sid.ir) and Magiran (www.magiran.com) up to May 2015. To this end, the following keywords were used: “*Listeria*” and “*Listeria monocytogenes*” in combination with “Iran”, “food”, “milk”, “cheese”, “butter”, “cream”, “curd”, “ice cream”, “yogurt”, “dough”, “egg”, “meat”, “chicken”, “poultry”, “RTE”, “fish”, and “sea food”. Titles and abstracts of retrieved articles were reviewed independently by the

author (NH) and any discrepancy was resolved through discussion with the second author (ASA).

2.2. Eligibility criteria

Articles focusing on the prevalence of *Listeria* spp. contamination in any Iranian food product were included in the present systematic review. Duplicate reports and articles without clear sample size were then excluded.

2.3. Data extraction

We collected data on the basis of authors' last names, year of publication, food type assessed for contamination, sample size, number of positive samples contaminated with *Listeria* spp., *L. monocytogenes*, and the method used to assess the *Listeria* contamination. Data were extracted by a reviewer separately (NH) and disagreements were resolved by consulting with ASA.

2.4. Statistical analysis

The total sample size for each food product as well as the number of samples contaminated by *Listeria* spp. and *L. monocytogenes* were used to calculate the relative frequency (RF), which was then converted to log it RF. Later, its standard error (SE) was used as the effect size for meta-analysis (Egger, Smith, & Altman, 2001). The overall effect was derived using the random effects model, which takes the between study variation into account (Matthias Egger et al., 2001). Statistical heterogeneity among studies was evaluated using Cochran's Q test and I-squared (Higgins & Thompson, 2002). Sensitivity analysis was applied to explore the extent to which inferences might depend on a particular study or a number of publications. Publication bias was evaluated by BFegg's funnel plots (M. Egger, Davey Smith, Schneider, & Minder, 1997). Formal statistical assessment of funnel plot asymmetry was done by Egger's regression asymmetry test and Begg's adjusted rank correlation test (Matthias Egger et al., 2001). The statistical analyses were performed using STATA software version 11.2 (STATA Corp, College Station, TX). The P-values of < 0.05 were considered statistically significant.

3. Results and discussion

We retrieved 1344 articles in our preliminary search. After removing duplicates and reviewing titles/abstracts, 117 articles were considered. Out of these 117 papers, 75 articles had sufficient quality for inclusion in this review Figure 1. Studies included in the present systematic review assessed the prevalence of *Listeria* spp. contamination in dairy products (31 studies), eggs (2 studies), meat (11 studies), poultry (12 studies), ready-to-eat (RTE) foods (4 studies), and seafood products (17 studies). The characteristics of study that examined the prevalence of *Listeria* spp. contamination in dairy products, eggs, meats, poultry, RTE foods, and sea foods are presented in Tables 1–5, respectively.

3.1. Dairy products

The 59 effect sizes were derived from 31 articles on dairy products, which were conducted in Isfahan (Aghakhani et al., 2012; Jalali & Abedi, 2008; E. Rahimi, Ameri, & Momtaz, 2010; Shahbazi et al., 2013; Shamloo et al., 2015; Sohrabi, Rashedi, Panahi, & Shahbazi, 2013), Khuzestan (E. Rahimi, Momtaz, Behzadnia, & Baghbadorani, 2014), Lighvan Tabriz (Moosavy et al., 2014), Khorasan (Haji Seyed Javadi, 2002), Tehran (Haji Seyed Javadi, 2002; Hoveida, Amir Mozafari, & Furuhashi Tehrani, 2007; H Jamali & Radmehr, 2013; Lotfollahi, Pournajaf, & Nowrouzi, 2014; Norowzi et al., 2013; Safarpour Dehkordi, Barati, Momtaz, Hosseini Ahari, & Nejat Dehkordi, 2013),

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