Iran J Public Health, Vol. 51, No.2, Feb 2022, pp.292-305

Review Article

Listeria monocytogenes in Dairy Products of the Middle East Region: A Systematic Review, Meta-Analysis, and Meta-Regression Study

Moein Bashiry [1], Fardin Javanmardi [2], Musarreza Taslikh [2], Zhaleh Sheidaei [2], Ehsan Sadeghi [1], Abdol-Samad Abedi [2], Adel Mirza Alizadeh [2], Fataneh Hashempour-Baltork [2], Samira Beikzadeh [2], Seyed Mohammad Riahi [3], *Hedayat Hosseini [2], *Amin Mousavi Khaneghah [4]

1. *Department of Food Science and Technology, School of Nutrition Science and Food Technology, Kermanshah University of Medical Sciences, Kermanshah, Iran*
2. *Department of Food Science and Technology, National Nutrition & Food Technology Research Institute, Faculty of Nutrition Sciences & Food Technology, Shahid Beheshti University of Medical Sciences, Tehran, Iran*
3. *Department of Epidemiology and Biostatistics, Cardiovascular Diseases Research Center, School of Medicine, Birjand University of Medical Sciences, Birjand, Iran*
4. *Department of Food Science and Nutrition, Faculty of Food Engineering, University of Campinas (UNICAMP), Rua Monteiro Lobato, São Paulo, Brazil*

***Corresponding Author:** Email: hedayat@sbmu.ac.ir, mousavi@unicamp.br

(Received 15 Dec 2020; accepted 21 Mar 2021)

Abstract

Background: The contamination of food products by *Listeria monocytogenes* as a pathogen bacterium, threatening public health and raised a global concern for a long time. Dairy and meat products and ready-to-eat foods are recognized as the most common carriers for *L. monocytogenes*.

Methods: The related reports of the prevalence of *L. monocytogenes* in dairy products in Middle East countries from 2009 to 2020 were screened through some of the international databases such as Science Direct, Web of Science, Scopus, PubMed, and Google Scholar. While a random effect model was applied to estimate pooled or overall prevalence, 95% confidence intervals (95%CI) were used.

Results: Results showed severe heterogeneity (84.2%) in studies and estimated the overall prevalence of *L. monocytogenes* dairy food products from the Middle East region of 3.5% (CI: 2.2-5). The highest and lowest prevalence was associated with Jordan (17.6% CI: 9.8-26.9) and Iraq (1.6% CI: 0.3-3.7), respectively. Based on the type of product, the highest and lowest prevalence of *L. monocytogenes* was recognized for raw cow milk (5.8% CI: 2.7-9.7) and pasteurized cow milk (1.1% CI: 0-8), respectively.

Conclusion: There is no justification for severe heterogeneity (I^2) of subgroups as prevalence is heterogenic innately, but Jordan and row cow milk subgroups were found to have a considerable effect on overall pooled prevalence. Thus, they were the reason for prevalence changes.

Keywords: *Listeria monocytogenes*; Dairy products; Middle East; Systematic review; Meta-analysis

Introduction

Listeria is a genus from the *Listeriaceae* family *that* includes more than 20 species categorized into three main clades (1). It is a facultatively anaerobic, gram-positive, non-sporulating, and psychrotrophic bacterium (2). Some *Listeria* species are recognized as pathogenic such as *L. monocytogenes,* known as pathogens for both humans and animals, and *L. ivanovii* is considered pathogenic for animals (3). *L. monocytogenes* are highly important in terms of public health and grow easily at temperatures ranging from -0.4 °C to 45°C and tolerate osmotic stress up to 14% salt concentration. It also can undergo a broad zone of pH 4.0 to 9.6 (optimum pH 6–8). The water activity of 0.90 is distinguished as the lowest level of water activity that *L. monocytogenes* can survive (4, 5).

Listeriosis resulted from the consumption of contaminated food products by *L. monocytogenes* such as cheese, non-pasteurized milk, unwashed raw vegetables, and undercooked meat, and it is identified as one of the primary foodborne diseases for humans (6-10). The contamination of milk by *L. monocytogenes* is attributed to both infected and healthy animals besides poor hygiene conditions or practices (11, 12). Therefore, among different foods, milk, mainly raw milk, and other kinds of dairy products are particular sources for *L. monocytogenes*.

L. monocytogenes threaten human health by causing listeriosis. At the same time, diarrhea, vomiting, fever, headache, gastroenteritis, and myalgia are mild symptoms. Moreover, septicemia and meningitis that commonly resulted in stillbirth and abortion in pregnant women are the common invasive symptoms (8, 10, 13). According to the Center for Diseases Control (CDC), 467 listeriosis cases and 83 deaths were reported between 2011 and 2017 in the different states of the USA (14), while the number of confirmed cases of listeriosis reported by EU/EEA countries in 2016 was 2555 (15). Available data about the listeriosis epidemiology in the Middle East, especially Iran, are rare. Because in the Iranian health system, listeriosis cases are not reported precisely (16).

Studies for investigating the prevalence of *Listeria* spp. have been conducted based on different groups of foods, including meat, seafood, milk, dairy products, ready-to-eat foods, and eggs (4, 17). Contamination is different in various regions due to differences in livestock procedures conditions, storage and hygiene conditions, and technological practices (17). Several studies were carried out on the prevalence of *L. monocytogenes*. These studies do not have a specific pattern, and researchers have been reported inconsistencies in different regions like Iran, Egypt, and Italy. For instance, an Iranian research group represented 37% of raw milk samples contaminated with *L. monocytogenes* (18). However, some other researchers (19-21) described no contamination for *L. monocytogenes* in raw milk. Moreover, *L. monocytogenes* was detected in fifty percent of cheese samples (22), while other authors (20, 23) could not find *L. monocytogenes* in Iranian cheese samples. Besides, Kabuki et al isolated *L. monocytogenes* in 6.3% of Iranian cheese samples (24). Inconsistent statistics in *L. monocytogenes* prevalence in dairy products are also reported in other countries. For instance, in Egypt, *L. monocytogenes* range from 3.3 to 6.6% in milk products (25), and researchers in other countries like Syria reported that *Listeria* spp. exists in 10.96% of raw milk samples (26), or *L. monocytogenes* was positive in 4.8% of cheese samples in Turkey (27). Dairy product contamination with *L. monocytogenes* has been reported for European countries as well. For example, contamination of 2.2% was reported for Italian raw milk with *L. monocytogenes* (28). Furthermore, meta-analysis research conducted in Europe using EFSA reports and prior studies about the prevalence, contamination of *L. monocytogenes* in different cheese types showed the prevalence from 0.8 to 11.8% in European countries (29).

Although many studies have estimated the prevalence value of *Listeria* spp. in different food samples, no systematic review or meta-analysis regarding *L. monocytogenes* contamination of milk products in the Asian or the Middle East coun-

tries was reported cohesively. Hence, summarizing research from different databases that studied *L. monocytogenes* contamination in the Middle East countries in dairy products and considering the risk of bias assessment was the objective of this work.

Methods

Search scheme

According to the Cochrane protocol (PRISMA guideline), this systematic review and meta-analysis study was carried out (30). In the first step, Science Direct, Web of Science, Scopus, PubMed, and Google Scholar databases were used to retrieve published original studies in the Middle East countries between 2009 and 2020. The following search keywords and MeSH terms were used: (Cheese OR Cream OR Kashk OR Milk OR "Dairy Products" OR "Ice cream" OR Butter OR Yoghurt OR Ghee OR Buttermilk OR Kefir OR Koumiss OR Whey) AND ("*Listeria monocytogenes*" OR "*L.monocytogenes*") AND ("The Middle East" OR Afghanistan OR Bahrain OR Iran OR Iraq OR Israel OR Jordan OR Kuwait OR Lebanon OR Oman OR Qatar OR Saudi Arabia OR Syria OR Turkey OR United Arab Emirates OR Yemen) AND (Prevalence OR Outbreak OR Incident OR Contamination). Searching in the mentioned databases and screening was conducted. The title, abstract, and full text of retrieved articles were screened for eligibility. Moreover, to cover almost all papers, the references list of reviewed articles was considered.

Inclusion/exclusion criteria

The articles' selection was based on our research criteria by two reviewers separately after screening the databases with the same keywords and procedures. In this step, each author was responsible for reviewing the papers in all parts (titles, abstracts, and full texts) to select the articles having the inclusion criteria; any differences were supposed to be resolved by consensus. Articles included in this study based on inclusion criteria (Eligibility criteria) including only dairy product samples, researches were done and reported in the middle east countries, available full-text in the English language; cross-sectional descriptive studies; *L. monocytogene* detection done with high accuracy technique (culture and PCR techniques); and prevalence data was presented clearly in the results of papers. Moreover, any other food samples like meat products or ready-to-eat-foods, reported prevalence of *L. monocytogene* in other countries, genetic, ecological, animal studies, case reports, thesis, books, non-English articles, and review articles were excluded (Fig. 1).

Data extraction and risk of bias assessment

Required data from selected articles including first author, publication year, method of *L. monocytogenes* detecting, type of dairy products, country, study area (province), sample size, and positive samples were extracted by two authors separately. Additionally, assessing the risk of bias of included studies was judged independently by the first author based on the JBI checklist with a minor modification (31).

Meta-analysis of data

In this meta-analysis, we applied random effect models for estimating pooled or overall prevalence and 95% confidence intervals (95%CI). The positive samples (p_i) divided into the total sample (n_i) indicates the prevalence of *L. monocytogene* in the dairy products ($I=p_i/n_i$). Overall prevalence was estimated using a Freeman-Tukey double arcsine transformation. Estimation of prevalence *L. monocytogene* was performed using the Metaprop command (32). I^2 statistics and Cochran's Q Heterogeneity were used for exploring heterogeneity among studies. I^2 is a variance variable (prevalence) divided by Q value. I^2 ranges between 0-100 percent, and I^2 >70% were considered heterogeneous (33, 34). A Forest plot was used to show *L. monocytogene* prevalence. In this study, subgroup analysis and meta-regression were performed to explore heterogeneity sources (35). Publication bias was not tested in this study because its aim is not to estimate the association between exposures and outcomes (35). Meta-

analysis was done by STATA 14.0 (2015; STATA 14.0 Statistical Software, College Station, TX, USA). Statistical significance was selected less than 0.05 ($P<0.05$).

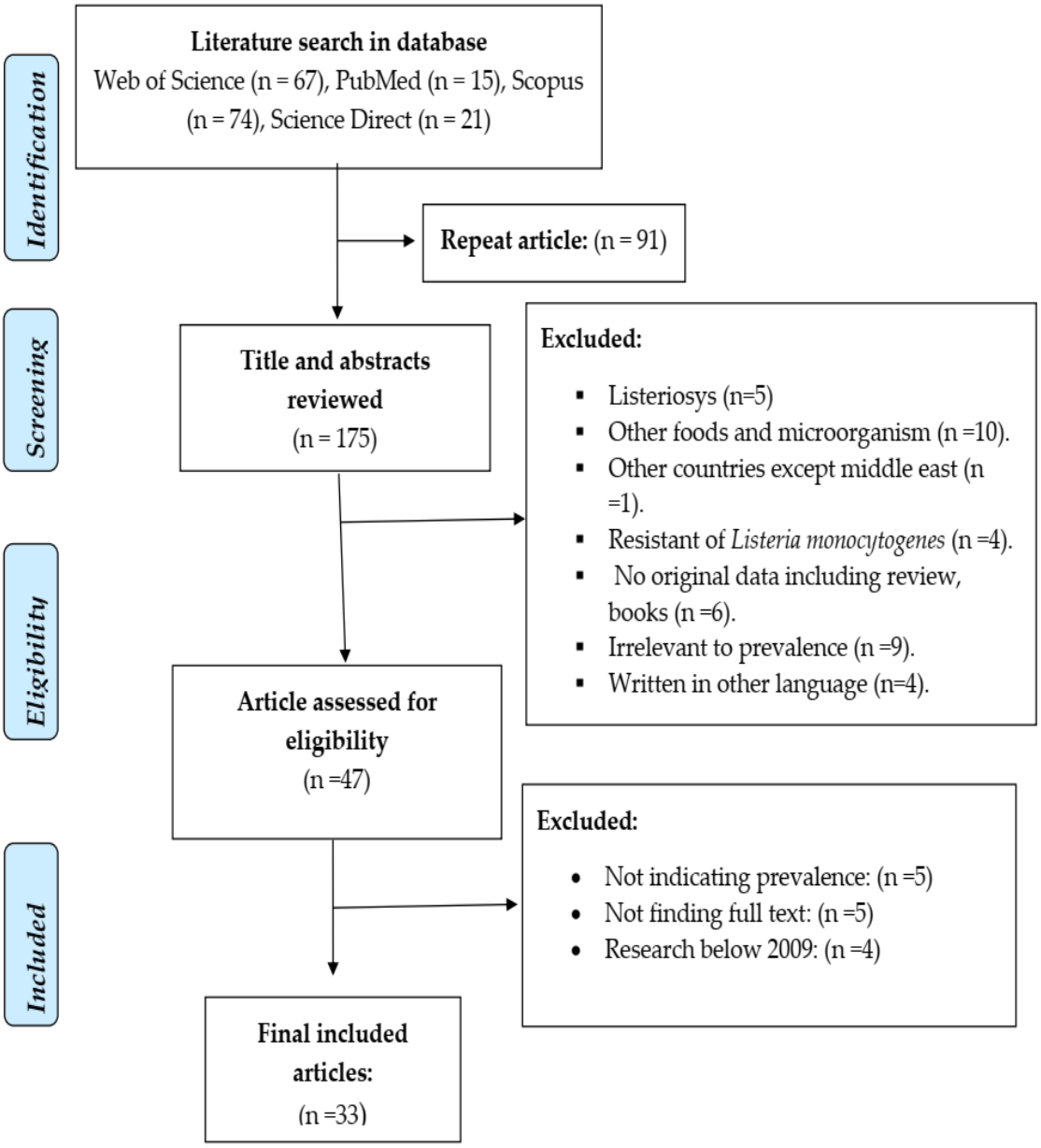

Fig. 1: The PRISMA flowchart diagram of the study.

Results and discussion

This systematic review and meta-analysis study was carried out on 76 key measures calculated from 32 papers related to dairy products. Articles included in this systematic review and meta-analysis from each country (the Middle East) were summarized in Table 1. Iran (n=13) and Turkey (n=10) had the most considerable number of articles on the prevalence of *L. monocytogenes*. However, some other countries like Kuwait, Bahrain, and Yemen found no related publication in this field. In this research, dairy products were

divided into eight main sub-groups, in which most studies included cheese and raw cow milk, as well as the overall prevalence for the presence of *L. monocytogenes* in dairy products, is illustrated in Fig. 2, which was 3.5 % (CI: 2.2%-5.0%).

Table 1: Summary of the studies reporting the Prevalence of *Listeria monocytogenes* in dairy products in the Middle East countries

Id	*Assessment technique*	*Food groups*	*Country*	*Region*	*Year*	*Sample size*	*Positive samples*	*Quality assessment*	*Ref.*
1	PCR	Cheese	Iran	Tehran	2012-2015	70	5	7	(46)
		Cream				20	2	7	
		Kashk				17	2	6	
2	PCR	Raw cow milk	Turkey	Samsun	2011-2012	100	5	7	(47)
		Cheese				70	9	7	
		Ice cream				20	0	7	
		Cream				20	0	7	
3	PCR	Raw cow milk	Iran	-	2013-2015	37	1	7	(48)
		Cheese		-		130	4	7	
4	PCR	Raw cow milk	Turkey	Southern Marmara	2009-2010	42	0	7	(49)
		Cheese				140	0	7	
		Cream				12	0	6	
		Yogurt				2	0	6	
5	PCR	Raw cow milk	Iran	Tehran	2008-2010	240	13	7	(41)
		Raw sheep Milk				206	5	7	
6	Culture	Cheese	Turkey	Van otlu	2011	120	34	7	(50)
7	Culture	Raw cow milk	Turkey	Sakarya	2008-2010	8	0	8	(51)
		Cheese				8	0	8	
8	Culture	Raw cow milk	Turkey	Aydin	2013	20	5	7	(52)
		Pasteurized cow milk				20	1	7	
		Yogurt				40	2	7	
		Cheese				50	5	7	
		Cream				10	1	7	
9	Culture	Raw cow milk	Iran	Tabriz	2014	18	9	7	(22)
10	Culture	Raw cow milk	Jordan	Karak	2011	20	9	7	(36)
		Cheese				20	7	7	
		Yogurt				20	8	7	
11	PCR and Culture	Raw cow milk	Iran	Fars and Khuzestan	2010-2011	156	3	8	(10)
		Raw sheep Milk				104	2	8	
12	PCR and Culture	Raw cow milk	Egypt	Sharkia Governorate	2015-2016	100	25	8	(22)
13	PCR	Kashk	Lebanon	Bekaa Valley	2009	83	6	8	(43)
		Cheese				81	17	8	
14	Culture	Raw cow milk	Iran	Sari	2013	100	0	8	(19)
		Pasteurized cow milk				100	0	8	
15	PCR	Pasteurized cow	Iran	-	2011	596	61	8	(54)

		milk							
16	PCR	Raw cow milk	Egypt	-	2013	100	1	5	(55)
17	PCR	Cheese	Turkey	Erzurum	2015	104	17	6	(56)
	Culture	Pasteurized cow milk	Turkey	-	2012	10	0	7	(57)
18		Cheese		-		60	1	7	
		Ice cream		-		20	0	7	
		Cream		-		10	0	7	
19	PCR	Raw cow milk	Iran	-	2015	60	0	7	(58)
20	Culture	Cheese	Jordan	Amman	2017	150	8	7	(59)
21	PCR and Culture	Raw cow milk	Iran	Yazd	2016	140	11	8	(8)
		Cheese				220	10	8	
		Cream				100	1	8	
		Ice cream				85	0	8	
22	Culture	Ice cream	Iran	Kermanshah	2013	67	0	8	(21)
		Pasteurized cow milk				59	0	8	
		Cheese				59	0	8	
23	PCR and Culture	Raw cow milk	Iran	Kerman	2011	100	5	6	(60)
24	PCR and Culture	Raw cow milk	Iran	Isfahan	2007-2009	138	1	8	(10)
		Raw sheep milk				122	6	8	
		Cheese				90	9	8	
		Ice cream				136	2	8	
		Yogurt				130	0	8	
		Cream				40	1	8	
		Kashk				71	0	8	
25	Culture	Yogurt	Turkey	Balikesir	2010-2011	100	3	7	(61)
		Cheese				100	5	7	
26	PCR	Cheese	Egypt	El Giza Governorate	2013-2014	50	0	8	(62)
		Raw cow milk				50	4	8	
27	Culture	Raw cow milk	Iran	Nooraba d	2010	120	3	7	(63)
		Cheese				60	3	7	
		Yogurt				180	0	7	
28	PCR	Cheese	Jordan		2011	350	39	7	(64)
29	Culture	Pasteurized cow milk	Turkey	Bursa	2012	10	0	6	(38)
		Cheese				60	1	7	
		Ice cream				20	0	7	
		Cream				10	0	6	
30	Culture	Row cow milk	Jordan	-	2016	305	32	8	(65)
31	PCR	Cheese	Turkey	Bolu	2016	40	0	8	(66)
		Ice cream				27	0	8	
32	Culture	Cheese	Turkey	Hatay	2019	20	0	8	(67)
33	PCR	Cheese	Iraq	Dehok	2016-2017	121	1	8	(68)
		Raw sheep milk				118	3	8	

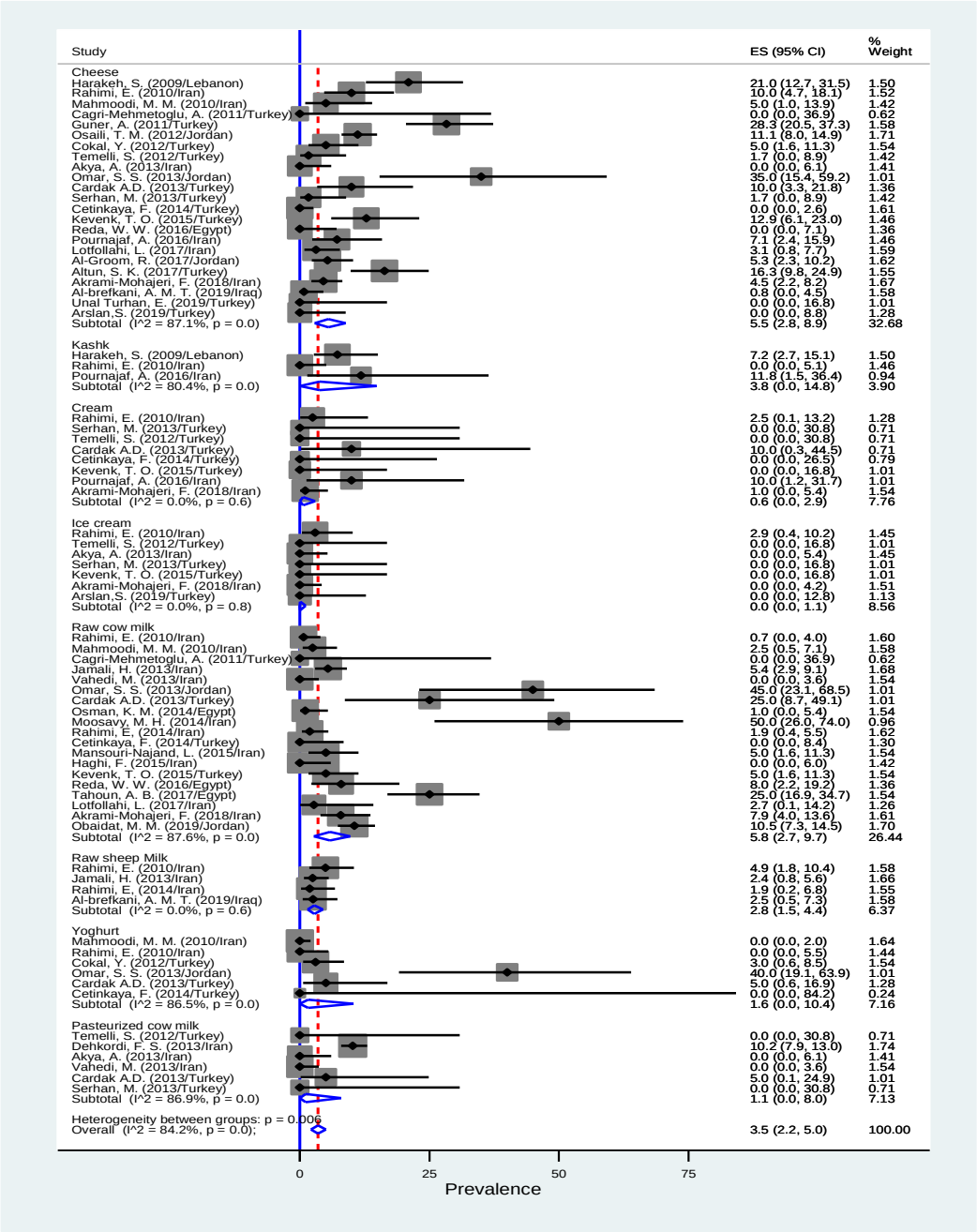

Fig. 2: The forest plot of prevalence of *Listeria monocytogenes* in dairy products based on food type/year of publication/country

Ice cream had the lowest mean prevalence of 0.0% (CI: 0.0-1.1%), followed by cream 0.6% (CI: 0.0-2.9%), pasteurized cow milk 1.1% (CI: 0.0.-8.0%), yogurt 1.6% (CI: 0.0-10.4%), raw ship milk 2.8% (CI: 1.5-4.4%), Kashk 3.8% (CI: 0.0-14.8%), cheese 5.5% (CI: 2.8-8.9%) and raw cow milk had the highest *L. monocytogenes* prevalence of 5.8% (CI: 2.7-9.7%). On the other hand, the prevalence rank order in terms of country showed the following order: Iraq 1.6% (CI: 0.3-3.7%), Turkey 2.2% (CI: 0.3-5.1%), Iran 2.5% (CI: 1.2-4%), Egypt 5.8% (CI: 0-20.6%), Lebanon

13.3% (CI: 8.4-19%) and Jordon 17.6% (CI: 9.8-26.9%).

The highest level of *L. monocytogenes* contamination in cheese (Fig.3) was observed in Jordan with 35% contamination (CI: 15.4-59.2%) (36).

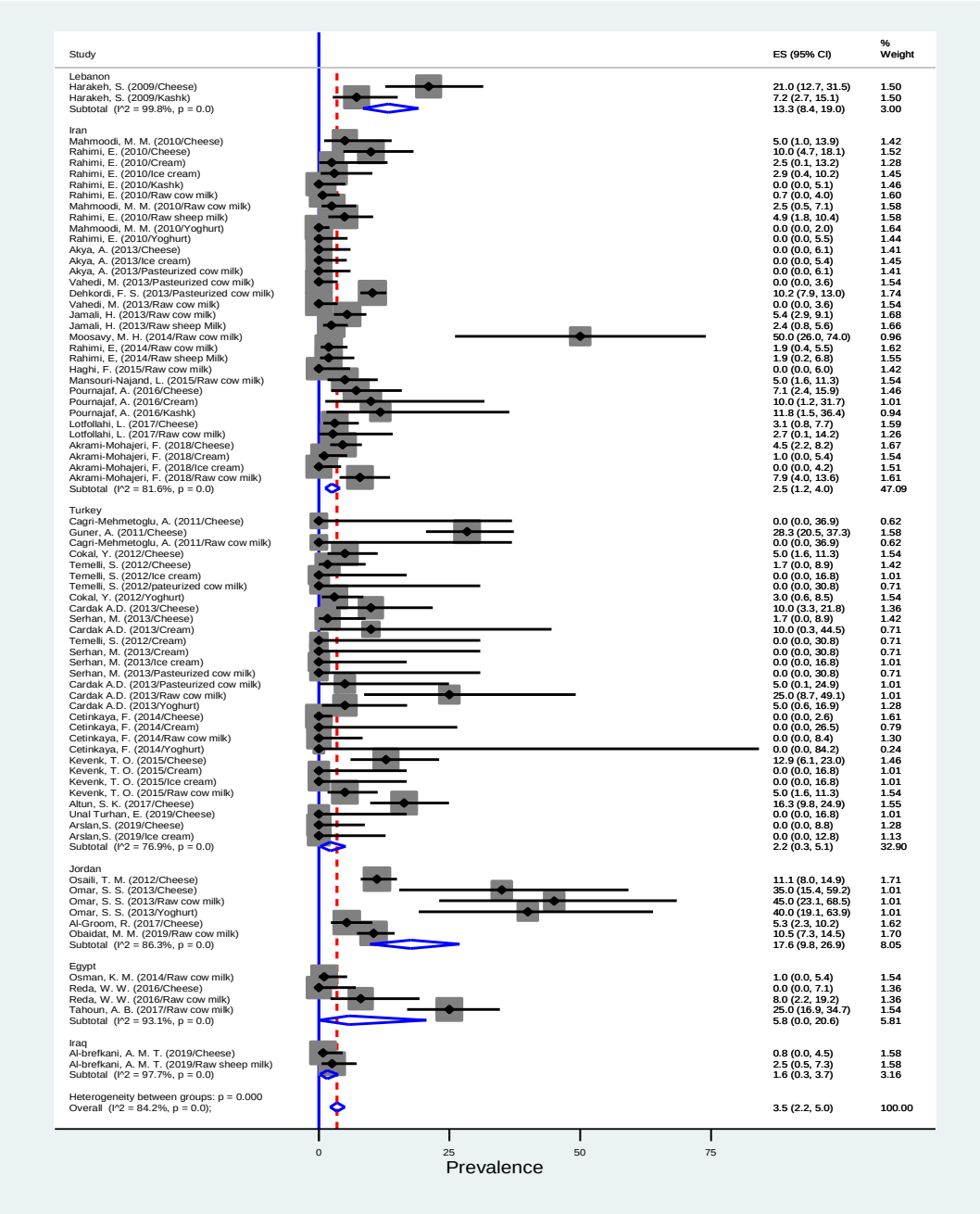

Fig. 3: The forest plot of prevalence of *Listeria monocytogenes* in dairy products based on country/year of publication/ food type

Moreover, the highest and lowest *L. monocytogenes* incidence in raw ship milk was observed in two studies carried out (10, 37) in Iran, which found values of 4.9 and 1.9%. The main reason cheese

faced a high prevalence of *L. monocytogenes* is probably related to raw milk origin and survival ability of *L. monocytogenes* in high salt concentration and resistance to different pH (38). *L. monocytegenes* can survive in some cheeses like white cheese after several weeks, dangerous for public health. The estimated mean prevalence of *L. monocytogenes* in cheese products in the Middle East (5.5%) was more than results from European reports (2.3%) (3). The only study on *L. monocytogenes* contamination in Iraq reported a mean prevalence of 1.6% (CI: 0.3%-3.7%) in cheese and raw ship milk (39). Milk contamination of *L. monocytogenes* is not specific to raw cow milk, but also pasteurized cow milk could carry *L. monocytogenes* in case of inadequate pasteurization or post-pasteurization contamination. Furthermore, the high prevalence of *L. monocytogenes* in raw milk could be associated with animal infection or contamination of livestock feed, and contamination of raw milk during breastfeeding and milk storage could be another reason (40, 41). Similarly, in a study conducted by the EU's Rapid Alert System for Food and Feedstuff between 2004 and 2009, 97 dairy products were positive for *Listeria* and 34 of them were pasteurized, and 22 samples were raw milk products (42). Moreover, the highest occurrence rate of *L. monocytogenes* in yogurt was found in Jordan (36), that 40% of samples were contaminated with *L. monocytogenes*. Moreover, in the only study on *L. monocytogenes* contamination in Lebanon, they reported a mean prevalence of 13.3% (CI: 8.4-19%) in cheese and Kashk (43). According to the results of this meta-analysis, contamination of cream and ice cream by *L. monocytogenes* was low.

Generally, occurrence evaluation of *L. monocytogenes* is necessary for dairy products as they are vehicles for this pathogen transmission that led to the highest death rate among infectious diseases (44). Preventing foods, especially dairy products, from being contaminated by *L. monocytogenes* is highly recommended. Additionally, adequate pasteurizing, forage quality, housing facilities, and milking hygienic conditions can affect milk's microbial quality (45).

The meta-regression test investigates potential contributing parameters that affect study heterogeneity. This test was used to examine the year of publication and the quality score for each included study in our study. The year of publication's meta-regression plot versus *L. monocytogenes* prevalence in dairy products showed no significant relationship (C=0.0006; *P*=0.88). As shown in Fig. 4, regarding the effect sizes of the research studies; there is a tendency to decrease in *L. monocytogenes* prevalence over the years between 2010 and 2020, which seems that during these years, various factors, including hygienic-sanitary quality of milk, storage conditions, and pasteurization method has improved as well as post-pasteurization contamination reduced. Generally, hygienic procedures in the Middle East have been introduced to some extent for quality improvement over the last decade. In this study, the quality assessment of research studies was conducted. We evaluated the methodological quality of the 32 research reports, using nine quality criteria relating to the prevalence studies. The items were determined to consist of sampling method, sample size adequacy, subject description in detail, data coverage analysis, applying valid method, response rate adequacy, using the standard method, and using appropriate statistical analysis. A meta-regression analysis was used to find the relationship between *L. monocytogenes* occurrence rate and the quality score of the included study. Figure 5 indicated that included papers' quality scores have no considerable effects on the prevalence of *L. monocytogenes* in dairy products.

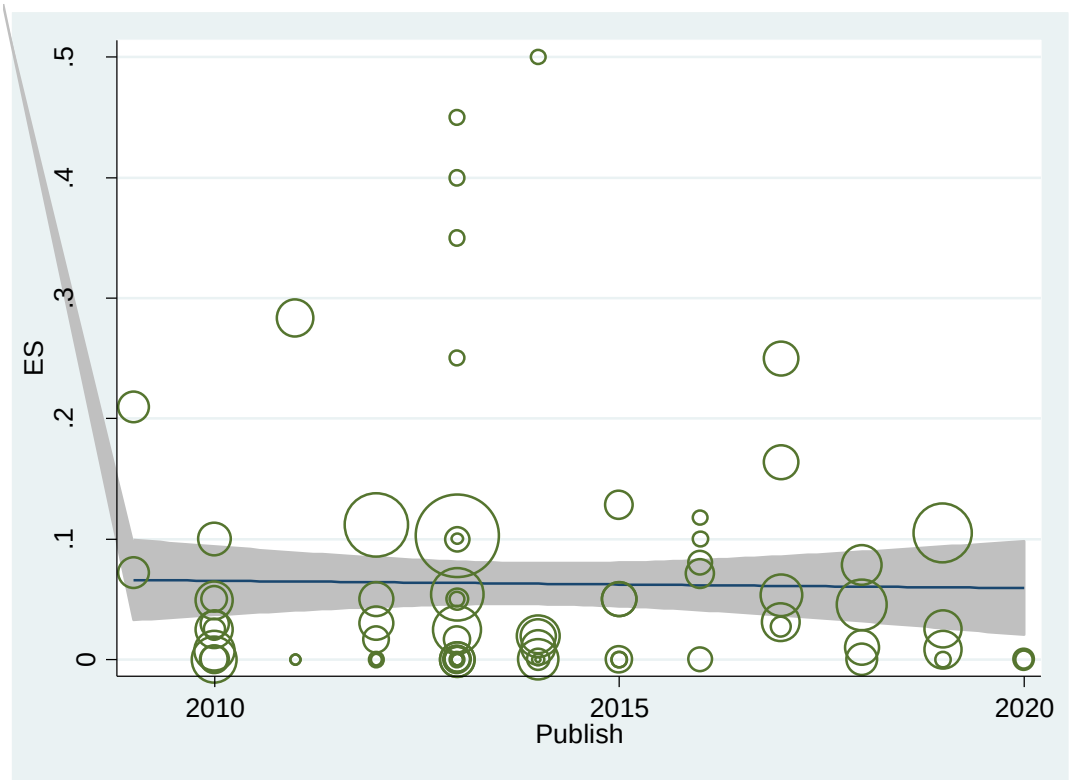

Fig. 4: The relationship between the prevalence *Listeria monocytogenes* with year of study

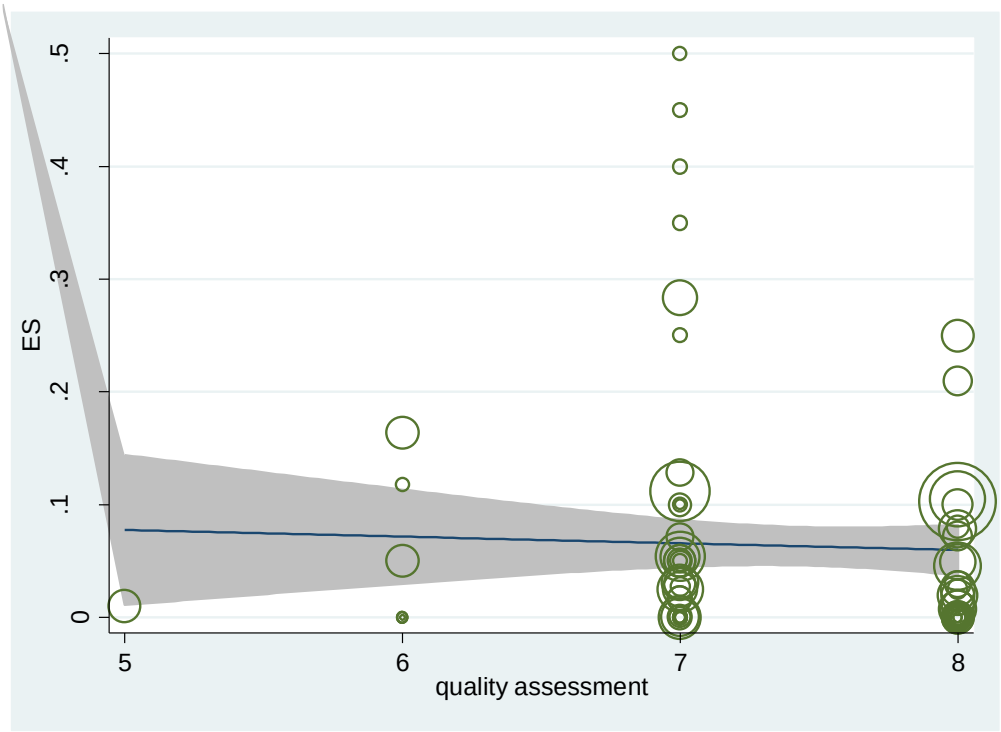

Fig. 5: The relationship between the prevalence of *Listeria monocytogenes* with quality score for included study

There are some limitations to this study. Although our search was comprehensive, there were limited studies in some countries or finding no studies on *L. monocytogenes* contamination. Moreover, no study was found about *Listeria* contamination in some samples, such as Kefir or Komis. Another limitation was that some of the available studies had limited sample sizes or a lack of data on *Listeria* contamination, or no full-text access. Despite these limitations, the authors tried to cover all the studies done in the Middle East region and showed a general view of the prevalence of *L. monocytogenes*. Moreover, researchers suggest that researchers aim to carry out secondary review articles (systematic review and meta-analysis study) to limit and make narrower the type of reviewed food samples and possibly widen reviewed regions. It helps to draw a much better image of the prevalence of *L. monocytogenes* in the world and finds critical and threatening points in *L. monocytogenes* contaminations affecting public health. Similarly, risk assessment studies for this pathogen in different dairy products in different regions and countries and even worldwide are suggested for future original research.

Conclusion

The prevalence *of L. monocytogenes* in dairy products in the Middle East based on defined subgroups was systematically reviewed and meta-analyzed. The order of contamination by *L. monocytogenes* among the investigated dairy products based on prevalence was raw cow milk> cheese> Kashk> raw ship milk> yogurt > pasteurized cow milk > cream > ice cream, demonstrating the required further attention in the production process of some products such as cheese and Kashk. The high prevalence of *L. monocytogenes* in some dairy products is probably related to the unhealthy production method and lack of adequate pasteurization temperature in these products, as well as environmental contamination by animal wastes, which can be a reason for this contamination. Consumption of raw milk and its products, especially cheese produced with insufficient heat treatment and the lack of appropriate control measures, might cause serious health problems.

Ethical considerations

Ethical issues (Including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc.) have been completely observed by the authors.

Acknowledgements

Research reported in this publication was supported by Elite Researcher Grant Committee under award number 984086 from the National Institutes for Medical Research Development (NIMAD), Tehran, Iran.

Conflict of interest

The authors declare that there is no conflict of interest.

References

1. Weller D, Andrus A, Wiedmann M, den Bakker HC (2015). *Listeria* booriae sp. nov. and *Listeria* newyorkensis sp. nov., from food processing environments in the USA. *Int J Syst Evol Microbiol*, 65(Pt 1):286-92.
2. Navratilova P, Schlegelova J, Sustackova A, Napravnikova E, Lukasova J, Klimova E (2004). Prevalence of *Listeria monocytogenes* in milk, meat and foodstuff of animal origin and the phenotype of antibiotic resistance of isolated strains. *Vet Med*, 49(7):243-252.
3. Martinez-Rios V, Dalgaard P (2017). Prevalence of *Listeria monocytogenes* in European cheeses: A systematic review and meta-analysis. *Food Control*, 84(4):205-14.
4. Hamidiyan N, Salehi-Abargouei A, Rezaei Z, et al (2018). The prevalence of *Listeria* spp. food contamination in Iran: A systematic review and meta-analysis. *Food Res Int*,107:437-50.
5. Välimaa A-L, Tilsala-Timisjärvi A, Virtanen E (2015). Rapid detection and identification

methods for *Listeria monocytogenes* in the food chain–a review. *Food Control*, 55(12):103-14.
6. McLauchlin J (1997). The pathogenicity of *Listeria* monocytogenes: a public health perspective. *Rev Med Microbiol*, 8:1-14.
7. Aygun O, Pehlivanlar S (2006). *Listeria* spp. in the raw milk and dairy products in Antakya, Turkey. *Food Control*, 17(8):676-9.
8. Akrami-Mohajeri F, Derakhshan Z, Ferrante M, et al (2018). The prevalence and antimicrobial resistance of *Listeria* spp in raw milk and traditional dairy products delivered in Yazd, central Iran. *Food Chem Toxicol,* 114:141-4.
9. Oliver SP, Jayarao BM, Almeida RA (2005). Foodborne pathogens in milk and the dairy farm environment: food safety and public health implications. *Foodborne Pathog Dis,* 2(2):115-29.
10. Rahimi E, Ameri M, Momtaz H (2010). Prevalence and antimicrobial resistance of *Listeria* species isolated from milk and dairy products in Iran. *Food Control*, 21(11):1448-52.
11. Wagner M, Lehner A, Klein D, Buber A (2000). Single-strand conformation polymorphisms in the hly gene and polymerase chain reaction analysis of a repeat region in the iap gene to identify and type *Listeria* monocytogenes. *J Food Prot*, 63(3):332-6.
12. Hassan L, Mohammed HO, McDonough PL (2001). Farm-management and milking practices associated with the presence of *Listeria monocytogenes* in New York state dairy herds. *Prev Vet Med*, 51(1-2):63-73.
13. World Health Organization & Food and Agriculture Organization of the United Nations (2004). Risk assessment of *Listeria monocytogenes* in ready-to-eat foods : technical report. FAO.
14. CDC (2018). Centers for Disease Control and Preventionnational Enteric Disease Surveillance. https://www.cdc.gov/nationalsurveillance
15. ECDC (2018). Surveillancereport: Annual Epidemiological Report. https://www.ecdc.europa.eu/en/surgical-site-infections/surveillance-and-disease-data/all-annual-epidemiological-reports
16. Zahedi Bialvaei A, Sheikhalizadeh V, Mojtahedi A, Irajian G (2018). Epidemiological burden of *Listeria monocytogenes* in Iran. *Iran J Basic Med Sci*, 21(8):770-80.
17. Sarfraz M, Ashraf Y, Ashraf S (2017). A Review: Prevalence and antimicrobial susceptibility profile of *Listeria* species in milk products. *Matrix Sci Med*, 1(1):13-25.
18. Jami S, Jamshidi A, Khanzadi S (2010). The presence of *Listeria* spp. in raw milk samples in Mashhad, Iran. *World Appl Sci J*, 10(2):249-53.
19. Vahedi M, Nasrolahei M, Sharif M, Mirabi AM (2013). Bacteriological study of raw and unexpired pasteurized cow's milk collected at the dairy farms and super markets in Sari city in 2011. *J Prev Med Hyg*, 54(2):120-3.
20. Jalali M, Abedi D (2008). Prevalence of *Listeria* species in food products in Isfahan, Iran. *Int J Food Microbiol*, 122(3):336-40.
21. Akya A, Najafi F, Moradi J, Mohebi Z, Adabagher S (2013). Prevalence of food contamination with *Listeria* spp. in Kermanshah, Islamic Republic of Iran. *East Mediterr Health J*, 19 (5): 474-477.
22. Moosavy M-H, Esmaeili S, Mostafavi E, Amiri FB (2014). Isolation of *Listeria monocytogenes* from milks used for Iranian traditional cheese in Lighvan cheese factories. *Ann Agric Environ Med*, 21(4):728-9.
23. Shamloo E, Jalali M, Mirlohi M, Madani G, Metcalf D, Merasi MR (2015). Prevalence of *Listeria* species in raw milk and traditional dairy products in Isfahan, Iran. *Int J Environ Health Eng,* 4:1.
24. Kabuki D, Kuaye A, Wiedmann M, Boor K (2004). Molecular subtyping and tracking of *Listeria monocytogenes* in Latin-style fresh-cheese processing plants. *J Dairy Sci,* 87(9):2803-12.
25. Ismaiel AA-R, Ali AE-S, Enan GJFS (2014). Biotechnology. Incidence of *Listeria* in Egyptian meat and dairy samples. *Food Sci Biotechnol*, 23:179-85.
26. Al-Mariri A, Younes A, Ramadan L (2013). Prevalence of *Listeria* spp. in raw milk in Syria. *Bulg J Vet Med*, 16(2):112-122.
27. Kahraman T, Ozmen G, Ozinan B, Omer Goksoy E (2010). Prevalence of Salmonella spp. and *Listeria monocytogenes* in different cheese types produced in Turkey. *Br Food J*, 112(11):1230-6.
28. Dalzini E, Bernini V, Bertasi B, et al (2016). Survey of prevalence and seasonal variability of *Listeria monocytogenes* in raw cow milk from Northern Italy. *Food Control,* 60:466-70.

29. Veronica M-R, Paw D (2018). Prevalence of *Listeria monocytogenes* in European cheeses: A systematic review and meta-analysis. *Food Control*, 84:205-14.
30. Liberati A, Altman DG, Tetzlaff J, et al (2009). The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate health care interventions: explanation and elaboration. *PLoS Med*, 6(7):e1000100.
31. Institute JB (2017). The Joanna Briggs Institute critical appraisal tools for use in JBI systematic reviews: checklist for prevalence studies. *Crit Apprais Checkl Preval Stud*, 54(1):12-21.
32. Nyaga VN, Arbyn M, Aerts M (2014). Metaprop: a Stata command to perform meta-analysis of binomial data. *Arch Public Health*, 72(1):39.
33. Higgins J (2008). *Assessing risk of bias in included studies*. The Cochrane Collaboration. Chichester, UK: Wiley-Blackwell.
34. Riahi SM, Mokhayeri Y (2017). Methodological issues in a meta-analysis. *Curr Med Res Opin*, 33(10):1813.
35. Mokhayeri Y, Riahi SM, Rahimzadeh S, et al (2018). Metabolic syndrome prevalence in the Iranian adult's general population and its trend: a systematic review and meta-analysis of observational studies. *Diabetes Metab Syndr*, 12(3):441-53.
36. Omar SS, Dababneh BF, Qatatsheh A, et al (2011). The incidence of *Listeria* species and other indicator bacteria in some traditional foods sold in Karak city, Jordan. *J Food Agric Environ*, 9(2):79-81.
37. Rahimi E, Momtaz H, Behzadnia A, Baghbadorani ZT (2014). Incidence of *Listeria* species in bovine, ovine, caprine, camel and water buffalo milk using cultural method and the PCR assay. *Asian Pac J Trop Dis*, 4(1):50-3.
38. Temelli S, Ata Z, Anar S, et al (2012). Detection of *Listeria* spp. and *Listeria monocytogenes* in retail dairy products using the Vitek immunodiagnostic assay system LDUO method and ISO method. *Milchwissenschaft*, 67(4):374-7.
39. Al-Brefkani AM, Mammani IM (2019). Seasonal Changes in the Occurrence of *Listeria Monocytogenes* in Duhok Province. *Sci J Univ Zakho*, 7(1):5-9.
40. Sağun E, Sancak YC, İşleyici Ö, Ekici K (2001). The presence and prevalence of *Listeria* species in milk and herby cheese in and around Van. *Turk J Vet Anim Sci*, 25(1):15-9.
41. Jamali H, Radmehr B, Thong KL (2013). Prevalence, characterisation, and antimicrobial resistance of *Listeria* species and *Listeria monocytogenes* isolates from raw milk in farm bulk tanks. *Food Control*, 34(1):121-5.
42. Motarjemi Y, Moy G, Todd E (2014). *Encyclopedia of food safety*. Academic Press.
43. Harakeh S, Saleh I, Zouhairi O, et al (2009). Antimicrobial resistance of *Listeria monocytogenes* isolated from dairy-based food products. *Sci Total Environ*, 407(13):4022-7.
44. EFSA E (2014). European Food Safety Authority. European Centre for Disease Prevention and Control. The European Union summary report on trends and sources of zoonoses, zoonotic agents and food-borne outbreaks in 2012. *EFSA J*, 12(2): 3547-312.
45. Sanaa M, Poutrel B, Menard J, Serieys F (1993). Risk factors associated with contamination of raw milk by *Listeria monocytogenes* in dairy farms. *J Dairy Sci,* 76(10):2891-8.
46. Pournajaf A, Rajabnia R, Sedighi M, et al (2016). Prevalence, and virulence determination of *Listeria monocytogenes* strains isolated from clinical and non-clinical samples by multiplex polymerase chain reaction. *Rev Soc Bras Med Trop*, 49(5):624-7.
47. Kevenk TO, Gulel GT (2016). Prevalence, Antimicrobial Resistance and Serotype Distribution of *Listeria monocytogenes* Isolated from Raw Milk and Dairy Products. *J Food Saf*, 36:11-8.
48. Lotfollahi L, Chaharbalesh A, Rezaee MA, Hasani A (2017). Prevalence, antimicrobial susceptibility and multiplex PCR-serotyping of *Listeria monocytogenes* isolated from humans, foods and livestock in Iran. *Microb Pathog,* 107:425-9.
49. Cetinkaya F, Mus TE, Yibar A, et al (2014). Prevalence, serotype identification by multiplex polymerase chain reaction and antimicrobial resistance patterns of *Listeria monocytogenes* isolated from retail foods. *J Food Saf*, 34:42-9.
50. Guner A, Telli N (2011). A Survey on the Presence of *Listeria monocytogenes* in Various

Semi-Hard Cheeses from Different Regions of Turkey. *J Anim Vet Adv*, 10(14):1890-4.
51. Cagri-Mehmetoglu A, Yaldirak G, Bodur T, et al (2011). Incidence of *Listeria monocytogenes* and Escherichia coli O157:H7 in two Kasar Cheese processing environments. *Food Control*, 22:762-6.
52. Cardak AD (2013). Gross composition and the presence of *Listeria monocytogenes* and Salmonella spp. In raw milk and dairy products in Aydin, Turkey. *J Food Agric Environ*, 11(3-4):55-62.
53. Tahoun AB, Elez RMA, Abdelfatah EN, et al (2017). *Listeria monocytogenes* in raw milk, milking equipment and dairy workers: molecular characterization and antimicrobial resistance patterns. *J Glob Antimicrob Resist*, 10:264-70.
54. Dehkordi FS, Barati S, Momtaz H, Ahari SNH, Dehkordi SN (2013). Comparison of Shedding, and Antibiotic Resistance Properties of *Listeria monocytogenes* Isolated From Milk, Feces, Urine, and Vaginal Secretion of Bovine, Ovine, Caprine, Buffalo, and Camel Species in Iran. *Jundishapur J Microbiol*, 6(3):284-94.
55. Osman KM, Samir A, Orabi A, Zolnikov TR (2014). Confirmed low prevalence of *Listeria* mastitis in she-camel milk delivers a safe, alternative milk for human consumption. *Acta Trop,* 130:1-6.
56. Altun SK, Yigin A, Demirci M, et al (2017). Detection of *Listeria monocytogenes* and Brucella spp. in a Turkish home-made cecil cheese by real-time PCR. *Res J Biotechnol*, 12(1):78-83.
57. Serhan M, Mattar J (2013). Characterization of four lebanese artisanal goat milk cheeses: Darfiyeh, Aricheh, shankleesh and Serdale by physico-chemical, microbiological and sensory analyses. *J Food Agric Environ,*11(4):97-101.
58. Haghi F, Zeighami H, Naderi G, et al (2015). Detection of major food-borne pathogens in raw milk samples from dairy bovine and ovine herds in Iran. *Small Rumin Res*, 131:136-40.
59. Al-Groom R (2017). Extant of microbial contamination of cheddar cheese from markets and restaurants in Amman-Jordan. *J Pure Appl Microbiol*, 11(3):1427-33.
60. Mansouri-Najand L, Kianpour M, Sami M, Jajarmi M (2015). Prevalence of *Listeria monocytogenes* in raw milk in Kerman, Iran. *Vet Res Forum,* 6(3):223-6.
61. Cokal Y, Dagdelen A, Cenet O, Gunsen U (2012). Presence of L. *monocytogenes* and some bacterial pathogens in two Turkish traditional foods, Mihalic cheese and Hosmerim dessert. *Food Control*, 26(2):337-40.
62. Reda WW, Abdel-Moein K, Hegazi A, et al (2016). *Listeria* monocytogenes: An emerging food-borne pathogen and its public health implications. *J Infect Dev Ctries,* 10(2):149-54.
63. Mahmoodi MM (2010). Occurrence of *Listeria monocytogenes* in Raw Milk and Dairy Products in Noorabad, Iran. *J Anim Vet Adv,* 9(1):16-9.
64. Osaili TM, Al-Nabulsi AA, Taha MH, et al (2012). Occurrence and antimicrobial susceptibility of *Listeria monocytogenes* isolated from brined white cheese in Jordan. *J Food Sci*, 77(9):M528-32.
65. Obaidat MM, Stringer AP (2019). Prevalence, molecular characterization, and antimicrobial resistance profiles of *Listeria* monocytogenes, Salmonella enterica, and Escherichia coli O157:H7 on dairy cattle farms in Jordan. *J Dairy Sci,* 102(10):8710-20.
66. Arslan S, Özdemir F (2020). Prevalence and antimicrobial resistance of *Listeria* species and molecular characterization of *Listeria monocytogenes* isolated from retail ready-to-eat foods. *FEMS Microbiol Lett*, 367(4): fnaa006.
67. Unal Turhan E (2019). The presence of pathogenic bacteria in traditional cheese sold in local market in Hatay province, Turkey. *Appl Ecol Environ Res*, 17(3):7135-45.
68. Al-Brefkani AMT, Mammani IMA (2019). Characterisation of *Listeria monocytogenes* from Food and Human Clinical Samples at Duhok, Kurdistan Region of Iraq. *J Pure Appl Microbiol*, 13(4):2215-2226.