Criteria Grid
Best Practices and Interventions for the Prevention and Awareness of Hepatitis C

Best Practice/Intervention:	Jafari S. et al. (2010) Tattooing and the risk of transmission of hepatitis C: a systematic review and meta-analysis. International Journal of Infectious Diseases, 14(11):e928-e940.
Date of Review:	June 13, 2015
Reviewer(s):	Christine Hu

Part A

Category:	**Basic Science** ☐ **Clinical Science** ☐ **Public Health/Epidemiology** ☐ **Social Science** ☐ **Programmatic Review** ☒
Best Practice/Intervention:	**Focus:** **Hepatitis C** ☒ **Hepatitis C/HIV** ☐ **Other:** _____ **Level:** **Group** ☒ **Individual** ☐ **Other:** _____ **Target Population:** **Tattooed individuals with hepatitis C** **Setting:** **Health care setting/Clinic** ☒ **Home** ☐ **Other:** _____ **Country of Origin:** **Canada** **Language:** **English** ☒ **French** ☐ **Other:** _____

Part B

	YES	NO	N/A	COMMENTS
Is the best practice/intervention a meta-analysis or primary research? ***Please go to Comments section****.*	☒	☐	☐	Meta-analysis; systematic review to determine the risk of hepatitis C transmission among tattooed individuals
The best practice/intervention shows evidence of "scale up" ability	☐	☐	☒	Increased studies of HCV transmission through tattooing may provide further clarification of the current population at risk of HCV infection.
The best practice/intervention shows evidence of transferability	☐	☐	☒	
The best practice/intervention shows evidence of adaptation	☐	☐	☒	

Do the methodology/results described allow the reviewer(s) to assess the generalizability of the results?	☒	☐	☐	
	YES	**NO**	**N/A**	**COMMENTS**
Are the best practices/methodology/results described applicable in developed countries?	☒	☐	☐	The 83 studies included in the meta-analysis were originated from various developing and developed countries.
Are the best practices/methodology/results described applicable in developing countries?	☒	☐	☐	
The best practice/intervention has utilized a program evaluation process	☒	☐	☐	Quality of studies included in meta-analysis was assessed based on MOOSE guidelines. Statistical analyses were performed with RevMan 5 and HEpiMA
Consultation and feedback with community has taken place	☐	☒	☐	
The best practice/intervention is sensitive to gender issues	☐	☐	☒	Some of the studies included in this review accounted for gender difference.
The best practice/intervention is sensitive to multicultural and marginalized populations	☒	☐	☐	HCV infection risk from tattooing may depend on the background prevalence of HCV prevalence in the population.
The best practice/intervention is easily accessed/available electronically	☒	☐	☐	Free PDF available for download from http://www.sciencedirect.com/
Is there evidence of a cost effective analysis? If so, what does the evidence say? ***Please go to Comments section***	☐	☒	☐	
How is the best practice/intervention funded? ***Please go to Comments section***	☐	☒	☐	No funding stated
Is the best practice/intervention dependent on external funds?	☐	☒	☐	

Other relevant criteria: _____	☐	☐	☐	- The review found strong association between tattooing and risk of HCV transmission - Suggest prevention programs to focus on youth and young adults, prisoners, the population most likely to get tattoos and HCV prevalent populations.

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Review

Tattooing and the risk of transmission of hepatitis C: a systematic review and meta-analysis

Siavash Jafari [b], Ray Copes [a], Souzan Baharlou [c], Mahyar Etminan [d], Jane Buxton [a,*]

[a] British Columbia Centre for Disease Control, 655 West 12th Avenue, Vancouver, British Columbia, Canada V5Z 4R4
[b] Community Medicine, University of British Columbia, Vancouver, British Columbia, Canada
[c] British Columbia Children's Hospital, Vancouver, British Columbia, Canada
[d] Centre for Clinical Epidemiology and Evaluation, Vancouver Hospital, Vancouver, British Columbia, Canada

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SUMMARY

Objectives: In this systematic literature review we sought to determine whether tattooing is a risk factor for the transmission of hepatitis C.
Methods: A comprehensive search was performed to identify all case-control, cohort or cross sectional studies published prior to November 2008 that evaluated risks related to tattooing or risk factors of transmission of hepatitis C infection.
Results: A total of 124 studies were included in this systematic review, of which 83 were included in the meta-analysis. The pooled odds ratio (OR) and 95% confidence interval (CI) of the association of tattooing and hepatitis C from all studies was 2.74 (2.38–3.15). In a subgroup analysis we found the strongest association between tattooing and risk of hepatitis C for samples derived from non-injection drug users (OR 5.74, 95% CI 1.98–16.66).
Conclusions: Findings from the current meta-analysis indicate that tattooing is associated with a higher risk of hepatitis C infection. Because tattooing is more common among the youth and young adults and hepatitis C is very common in the imprisoned population, prevention programs must focus on youngsters and prisoners to lower the spread of hepatitis infection.

1. Introduction

There has been an increase in the global prevalence of tattooing in recent years. In the USA, 36% of people under 30 have tattoos.[1] Studies from Canada indicate that around 8% of high school students have at least one tattoo,[2,3] and among those who did not have a tattoo, 21% were eager to have one. Tattooing requires injection of pigments into the dermal layer of skin by puncturing the skin 80 to 150 times a second. Since tattoo instruments come into contact with blood and bodily fluids, viral and microbial infections may be transmitted if the instruments are used on more than one person without being sterilized or without proper hygiene techniques. Also, because tattoo dyes are not kept in sterile containers they might play a carrier role in transmitting infections. In light of the increase in the worldwide prevalence of tattoos, it has been postulated that tattooing may play an important role in the transmission of blood-borne diseases such as hepatitis B and hepatitis C.

In the USA, approximately 2.3% of adults aged 20 years or older are positive for anti-hepatitis C virus (HCV) antibody, and between 55% and 84% of these have a chronic infection;[4,5] however only 5% to 50% of infected adults are aware of their status.[6–8] It is estimated that 210 000 to 275 000 people are currently infected with hepatitis C in Canada, of whom only 30% are aware of their infection.[9]

Tattooing among prisoners is another issue of importance. The overall prevalence of hepatitis C among inmates is estimated to be around 25.2% to 37.4%.[10–14] Close to half of inmates may not know their serostatus, and the rates may vary between men and women.[10–14] Reusing and sharing tattoo needles is reported to be a common practice among almost 45% of inmates.[13] Given that the annual cost of each new case of hepatitis C for the healthcare system is estimated at around US$25 000 to US$30 000,[15] the number of new cases of hepatitis that may arise as a result of tattooing has important clinical as well as public health implications. Because the results from epidemiological studies regarding the risk of hepatitis among tattooed individuals are conflicting, we sought to systematically review the literature in order to quantify the risk of hepatitis in tattooed individuals.

2. Methods

2.1. Search strategy

We identified relevant studies and abstracts by searching MEDLINE (1966 to November 2008), EMBASE (1980 to November

* Corresponding author. Tel.: +1 604 660 6061; fax: +1 604 660 0197.
E-mail address: jane.buxton@bccdc.ca (J. Buxton).

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2008), Database of Abstracts of Reviews of Effects (DARE; 1991 to November 2008), ACP Journal Club (1991 to November 2008), International Pharmaceutical Abstracts (1970 to November 2008), BIOSIS Previews (1969 to November 2008), Web of Science (1961 to November 2008), and Pubmed. There was no language restriction in selecting the studies. The initial search strategy was developed from the MeSH subject headings 'hepatitis' and 'tattoo' in MEDLINE. Titles were reviewed for relevance from this search, and subject headings and abstracts were then examined. Appropriate subject headings and keywords were added to the search strategy. The scope notes in MEDLINE and EMBASE were also examined to ensure the correct subject headings were used based on their definitions; other subject headings were included based on previous indexing and the inclusion of keywords based on synonyms used in the scope notes. Consequently, broader MeSH subject headings such as 'tattooing', 'hepatitis', and 'hepatitis C' were included. Proceedings and conference abstracts were searched through the databases PapersFirst (1993) and ProceedingsFirst (1993) up to October 2008. Author names and year of published work from key papers were entered into the cited reference search in the Web of Science. We screened the references of retrieved studies and review articles for any potentially missed articles. In addition, we hand-searched the reference lists of retrieved studies as well as journals related to 'hepatitis', 'hepatology', 'blood', 'infection', 'epidemiology', and 'gastroenterology', and abstracts and books related to hepatitis. We contacted authors to ensure there was no overlap in the sample included in their studies whenever needed.

2.2. Selection criteria

We considered all observational studies that assessed the association between tattooing and hepatitis. Observational studies were included if they (1) clearly defined hepatitis C as either the primary or secondary outcome; (2) clearly defined tattoos as either primary or secondary exposure; (3) presented relative risks or odds ratios and their corresponding confidence intervals or provided enough data to compute these parameters. In the case of a study published in different phases or if data from a study were duplicated in more than one study, we only included the most recent study.

2.3. Data extraction

We created a spreadsheet and recorded study characteristics including author names, publication year, country of study, study design, sample size, study population type, mean age or range, gender of participants, type of risk factors or confounders adjusted for, outcome of interest (hepatitis C), and adjusted odds ratio (OR) and 95% confidence interval (CI). Included articles were reviewed in full by two independent reviewers (SJ and SB). In studies that provided several levels of exposure, each exposure was categorized and analyzed in the designated subgroup. To assess the quality of studies we created a quality assessment scale (0 to 9 points) based on Meta-analysis Of Observational Studies in Epidemiology (MOOSE) guidelines.[16] The scale includes reporting the inclusion/exclusion criteria, outcome definition, exposure definition, risk adjustment, possible sources of confounding, assessment of data, crude OR (95% CI) report, and adjusted OR (95% CI) report.

2.4. Statistical analysis

We performed several subgroup analyses to investigate the association between tattooing and hepatitis C among different populations. We conducted subgroup analyses based on the study population and study design (case–control, cohort, and cross-sectional). We also grouped studies into eight main mutually exclusive subgroups including: community samples, blood donors, hospital samples, injection drug users (IDUs), non-injection drug users (non-IDUs), drug users, prisoners, and high-risk population (street youth, HIV patients, tattooed in non-professional shops, and reused tattoo needles).

For all analyses, we weighted the study-specific adjusted log ORs by the inverse of their variances. Both fixed and random effect models were used to estimate the pooled adjusted OR. Statistical heterogeneity between studies was evaluated with Cochran's Q test and the I^2 statistic.[17] A sensitivity analysis was carried out to assess the individual influence of studies, and the analysis repeated excluding the studies with the largest weights. We used a funnel plot[18] and Egger's test[19] to assess the presence of publication bias. Statistical analyses and graphs were performed with RevMan 5 (Review Manager, version 5.0., The Cochrane Collaboration, 2008) and HEpiMA (Compute Methods Programs Biomed).

3. Results

Figure 1 shows the results of our search strategy and step-by-step inclusion and exclusion of the retrieved papers. Appendix A represents the search strategy used in this study. We identified a

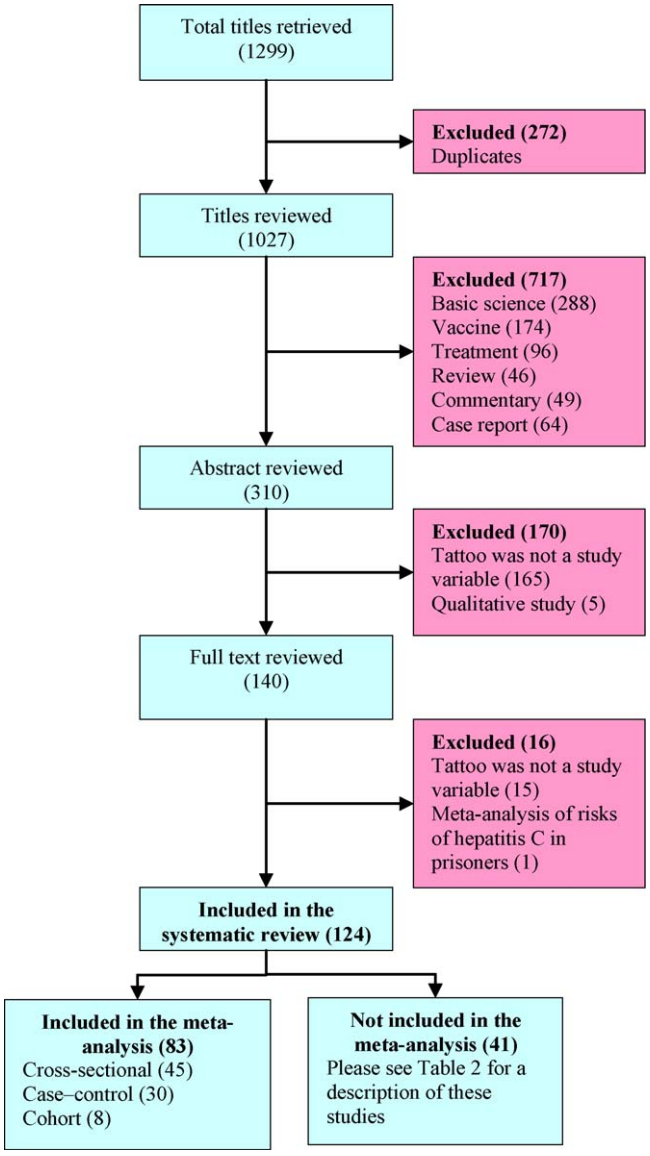

Figure 1. Selection of studies for inclusion in the systematic review and meta-analysis.

Table 1
Characteristics of studies included in both the systematic review and meta-analysis

	Author [Ref.][a]	Year	Location	Sample size	Study design	Sample derived from	Age, years	OR/RR	95% CI
1	Alavian	2002	Iran	389	CC	Blood donors	NR	6.10	2.10–18.30
2	Alizadeh	2005	Iran	427	CS	Prison	Any age	1.05	0.70–1.60
3	Amiri	2007	Iran	460	CS	Prison	Mean (SD) = 34.7 (8.9)	1.80	1.10–3.10
4	Babudieri	2005	Italy	973	CS	Prison	Mean = 36.9	1.91	1.26–2.92
5	Bair	2005	USA	1002	CS	Adolescents in detention	Range 10–18; mean = 15	1.90	0.20–1.95
6	Balasekaran	1999	USA	116	CC	Hospital	Mean (SD) = 44 (11)	5.90	1.10–30.70
7	Bari	2001	Pakistan	57/180	CC	Male adults	Range 20–70	0.90	0.30–2.70
8	Bollepalli	2007	USA	242	CS	HIV patients	Range 19–66; mean (SD) = 42.3 (9.3)	1.07	0.54–2.09
9	Bräu	2002	USA	1016	CS	Veterans	Range 22–99	2.20	1.30–3.70
10	Brandão	2002	Brazil	534	CC	Blood donors	Range 30–59	4.40	1.60–11.90
11	Briggs	2001	USA	1032	CS	Hospital: all individuals	Range 21–81	2.93	1.70–5.08
						People with no history of IDU	Range 21–81	3.02	1.60–5.66
12	Brillman	2002	USA	121	CC	Hospital, emergency patients	Mean = 43.9	6.30	1.90–24.30
13	Brusaferro	1999	Italy	743	CO	Hospital	Any age	2.50	1.10–5.60
14	Butler	2007	Australia	612	CS	Prison	Any age	2.27	1.50–3.44
15	Butler	2004	Australia	90	CS	Prison: all	Any age	10.80	5.10–16.40
				29	CS	Prison: IDUs	Any age	19.20	8.30–29.80
16	Campello	2002	Italy	2154	CO	General population	Range 17–67	4.18	1.50–15.22
17	Chang	1999	Taiwan	899	CS	Drug users	Any age	1.47	0.84–2.56
18	Christensen	2000	Denmark	325	CO	Prison	Any age	1.60	0.30–7.70
19	Coppola	2007	Italy	3579	CS	Healthy subjects	Mean (SD) = 33.19 (12.18)	8.56	4.67–15.68
20	Delage	1999	Canada	1335	CC	Blood donors	Any age	10.3	6.90–15.40
21	Dominguez	2001	Spain	2147	CS	Community-based	Range 5–70	7.55	2.71–21.02
22	Dominitz	2005	USA	1288	CS	Veterans	Any age	3.80	2.00–7.10
23	Gates	2004	Australia	25/96	CC	Prison	Male, mean (SD) = 29 (7.3); female, mean (SD) = 33 (11.5)	1.85	0.80–4.60
24	Goldman	2009	Canada	69/276	CC-M	Blood donors	Adults	3.47	1.49–8.08
25	Goodrick	1994	England	50/50	CC-M	Blood donors: all	Range 21–60	20.00	3.10–99.00
						Blood donors: non-IDU	Range 21–61	20.00	0.90–99.00
26	Gyarmathy	2002	USA	483	CS	Community	Any age	2.20	1.00–4.70
27	Habib	2000	Egypt	3999	CS	Community	Any age	0.90	0.30–3.00
28	Hahn	2001	USA	307	CS	IDUs	Under 30	0.88	0.51–1.52
29	Hajiani	2006	Iran	514	CS	Hospital	Any age	4.73	1.01–22.10
30	Haley	2001	USA	626	CS	Hospital: any tattoo	Any age	6.30	3.60–11.20
						Hospital: tattooed at prison	Any age	4.80	0.80–30.10
						Hospital: tattooed at commercial tattoo parlor	Any age	9.30	5.10–16.90
						Number of tattoos: 1	Any age	6.30	3.10–12.50
						Number of tattoos: 2	Any age	3.20	1.00–10.10
						Number of tattoos: 3	Any age	10.20	4.40–23.50
						Number of tattoos: >4	Any age	7.50	3.10–18.10
						Year tattoo done:			
						1939–1949	Any age	0.00	0.00
						1950–1959	Any age	0.00	0.00
						1960–1969	Any age	8.40	3.50–19.90
						1970–1979	Any age	7.80	3.80–15.90
						1980–1989	Any age	6.30	3.00–13.60
						1990–1992	Any age	9.50	2.80–32.20
31	Hammer	2003	USA	981	CO	Non-IDUs	>18	6.50	0.10–54.00
32	Hand	2005	USA	627	CC	Hospital	Range 14–99	2.90	1.90–4.60
33	Hellard	2004	Australia	642	CS	Prison	Mean = 31.6	2.70	1.40–5.20
						Any tattoo	Mean = 31.6	3.80	2.60–5.50
						Professional parlor	Mean = 31.6	2.20	1.60–3.20
34	Ho	1997	Taiwan	80	CS	Community	>7	0.52	0.16–1.62
35	Holsen	1993	Norway	70	CS	Prison	Range 16–51	5.44	1.68–9.21
36	Howe	2005	USA	740	CS	Non-IDUs, tattooed by friends	Median = 30	3.61	1.15–11.26
						Non-IDUs, tattooed in community	Median = 31	0.65	0.15–2.89
						Non-IDUs, tattooed in prison	Median = 32	1.13	0.36–3.44
37	Hwang	2006	USA	7960	CS	Students, all	NR	1.11	0.59–2.08
						1–2 tattoo		0.76	0.34–1.71
						>3 tattoo		2.44	1.04–5.76

Table 1 (*Continued*)

	Author [Ref.][a]	Year	Location	Sample size	Study design	Sample derived from	Age, years	OR/RR	95% CI
						Professional tattoo parlor		0.78	0.36–1.69
						Non-professional tattoo parlor		3.50	1.40–8.82
						New or autoclaved needle		0.64	0.27–1.53
						Reused needle		4.90	1.96–12.29
38	Judd	2005	UK	720	CS	IDUs	Any age	1.13	0.80–1.59
39	Kaldor	1992	Australia	430	CC	Blood donors: all	Any age	11.00	4.90–26.00
						Non-IDUs; no transfusion	Any age	27.00	8.40–87.00
40	Kerzman	2007	Israel	256	CC	Blood donors; former Soviet Union	Any age	2.00	0.70–5.50
				178	CC	Blood donors; native Israeli	Any age	1.10	0.10–9.20
41	Kim	2002	Korea	404	CC	Community	Any age	1.67	0.72–3.93
	Kim	2002	Korea	405	CC	Hospital	Any age	0.88	0.36–2.12
42	Ko	1992	Taiwan	87/122	CC	Community-based: all	Mean (SD) = 18.7 (0.3)	5.90	1.60–22.0
						Single tattoo	Mean (SD) = 18.7 (0.3)	5.40	1.40–21.0
						Multiple tattoos	Mean (SD) = 18.7 (0.3)	8.20	1.50–44.30
						Professional tattoo parlor	Mean (SD) = 18.7 (0.3)	2.90	0.30–30.10
						Non-professional tattoo parlor	Mean (SD) = 18.7 (0.3)	6.60	1.80–24.90
43	Lai	2007	Taiwan	285	CS	Prison	Mean (SD) = 34.1 (8.6)	2.97	1.37–6.43
44	Liao	2006	Taiwan	1000	CS	Drug users	Range 19–65	1.27	0.86–1.89
45	Liao	2006	Taiwan	297	CS	Prison	Range 16–69	2.24	1.03–4.88
46	Lim	2007	Australia	52	CS	IDUs	>18	4.18	1.24–14.10
47	Long	2001	Ireland	607	CS	Prison; non-IDUs	Range 15–73	11.60	1.40–237.30
48	Macías	2007	Spain	182	CS	Non-IDUs	Median = 34	3.50	1.30–9.60
49	Maggi	1999	Italy	2403	CC	General population	Range 18–85	0.94	0.34–2.60
50	Mariano	2004	Italy	598/7221	CC	IDUs and blood transfusion	Range 15–56	5.60	2.80–11.00
51	Mathei	2005	Belgium	310	CS	Drug users	Mean (SD) = 33.5 (6.6)	7.99	1.01–63.50
52	Medhat	2002	Egypt	6033	CS	Community	Any age	1.10	0.50–2.80
53	Mele	1995	Italy	5242	CC	Community	NR	2.50	0.80–7.79
54	Müller	2001	Hungary	45 839	CS	Blood donors	Range 19–74	5.07	2.88–8.93
55	Murphy	2000	USA	758/1039	CC	Blood donors	Any age	3.90	2.50–6.10
56	Mussi	2007	Brazil	1008	CS	HIV patients	Mean = 37.2	3.80	2.00–7.00
57	Neal	1994	UK	224	CC	Blood donors	Mean = 34.6 to 36.6	3.30	1.20–8.70
58	Nguyen	2007	Vietnam	837	CS	Community	Mean = 42.3	13.37	1.86–96.15
59	Nishioka	2003	Brazil	345	CS	Blood donors	Range 18–63	6.41	1.29–31.84
60	Nurgalieva	2007	Kazakhstan	290	CS	Community	Range 10–64	14.4	1.76–118.3
61	Nyamathi	2006	USA	198	CC	Homeless IDUs	Range 18–65	3.64	1.27–10.37
						Homeless non-IDUs	Range 18–65	4.51	1.36–14.97
62	O'Brien	2008	Canada	920	CC	Blood donors	NR	3.80	2.00–7.30
63	Pallas	1999	Spain	1215	CS	Prison	Mean (SD) = 30.6 (9.9)	3.20	1.40–7.10
64	Parana	1999	Brazil	143	CO	Hospital	Any age	30.0	3.36–268.11
65	Paris	2003	Thailand	381	CS	Community	Range 20–45	2.00	0.70–6.00
66	Pourahmad	2007	Iran	1432	CC	Prison	Range 25–61	2.95	2.34–3.70
67	Richards	2006	Georgia	272	CS	Hospital	Range 18–74	2.60	1.20–5.70
68	Roy	2001	Canada	437	CO	Street youth	Mean = 19.5	1.80	0.95–3.60
69	Sahajian	2006	France	988	CS	Hospital	>18	2.75	1.01–7.51
70	Salleras	1997	Spain	215	CC	Pregnant women	Mean (SD) = 28.5 (4)	18.15	0.45–759.10
71	Samuel	2001	USA	2898	CO	IDUs, tattooed in prison	>16	3.40	1.60–7.50
	Samuel	2001	USA	2898	CO	IDUs, tattooed in community	>18	1.70	0.90–2.90
72	Sanchez	2000	Peru	2827	CO	Blood donors	Any age	0.77	0.25–2.25
					CO	Blood donors	Any age	0.65	0.23–1.86
73	Sandhu	1999	Canada	336	CS	Hospital; dialysis patients	Range 18–55; mean (SD) = 57.4 (15.4)	3.80	1.00–12.13
74	Shev	1995	Sweden	102	CC	Blood donors	Range 25–53	9.30	2.44–53.06
75	Shi	2007	Taiwan	1897	CC	Military	All 20 years old	5.00	1.83–13.65
76	Shopper	1995	USA	500	CS	Students	Range 14–70	12.19	5.40–28.00
77	Sun	2001	Taiwan	554	CC	Community	Range 30–64	2.20	0.60–8.10
78	Talamini	2004	Italy	495	CC	Hospital	Range 18–84	8.49	1.11–67.4
79	Thaikruea	2004	Thailand	495	CC	Blood donors	>18	1.60	0.96–2.67
80	Utsumi	1995	Japan	201	CC	Prison	Mean (SD) = 45 (13)	1.57	0.63–3.92
81	Wada	1999	Japan	95	CS	Hospital	Mean (SD) = 24.4 (6.1)	5.30	1.79–15.92
82	Watson	1999	Australia	757	CS	Community	Range 13–50	0.58	0.10–3.30
83	Wolff	2007	Brazil	597	CC	Hospital	Male, mean (SD) = 40.3 (8.7); female, mean (SD) = 38.9 (9.8)	1.20	0.70–2.10

SD, standard deviation; OR, odds ratio; RR, relative risk; CI, confidence interval; CC, case–control study design; CC-M, case–control matched; CS, cross-sectional study design; CO, cohort study design; IDU, injection drug user; NR, not reported.

[a] For references see Appendix 2.

total of 1299 citations related to risk factors of hepatitis. A total of 272 studies were excluded as duplicates, 717 studies were excluded after reviewing titles, 170 excluded after reviewing abstracts, and 16 were excluded after reviewing the full text. A final number of 124 papers from 30 countries that reported an association between tattooing and the risk of transmission of hepatitis C were included in this systematic review (Appendix B).

Characteristics of the 83 studies (45 cross-sectional, 30 case–control, and eight cohort) with a total of 132 145 participants that were included in the meta-analysis are represented in Table 1.

A total of 41 studies were not included in the meta-analysis. The reasons for not including these studies in the meta-analysis are explained in Table 2.

3.1. Tattoo and hepatitis

Results of the current meta-analysis indicate a strong association between tattooing and the risk of hepatitis C when all studies are combined (pooled OR 2.24, 95% CI 2.01–2.50). In a subgroup analysis we found the strongest association between tattooing and

Table 2
Characteristics of studies included in the systematic review only

Author [Ref.][a]	Year	Country	Sample size	Study design	Sample derived from	Age, years	Reason for exclusion from meta-analysis
Abildgaard	1991	Denmark	1	CR	Hospital	Mean = 40	Case report
Bourliere	2002	France	1183	CS	Hospital	Mean (SD) = 41.1 (12.7)	Tattoo data for genotype study
Brind	1996	UK	25	CS	Elderly patients	>65	Not enough data
Champion	2004	UK	362	CO	Prison	>21	Not enough data
Chen	1995	Taiwan	114	CS	Hospital	Mean (SD) = 49 (15)	Not enough data
Cheung	2000	USA	8558	CS	Veterans	Range 28–89, mean 48.4	Not enough data
Cunha	2007	Mozambique	1578	CS	Blood donors	Range 15–49	Combined data on tattoo/scarification
Dalgard	2002	Norway	116	CS	Hospital	Median: IDU = 32; non-IDU = 35	Not enough data; three documented cases of hepatitis C with tattooing
Deterding	2008	Spain	30	CS	Hospital	Older than 30	Not enough data
Dietemann-Molard	1991	France	1	CR	Hospital	Mean = 40	Case report
Ford	2000	Canada	520	CS	Prison	Any ages	Not enough data
Fox	2005	USA	469	CS	Prison	Any ages	Combined data on tattoo and piercing
Hajiani	2008	Iran	1264	CS	Hospital	Range 8–72	Not enough data
Haley	2003	USA	626	CS	Hospital	All ages	Duplicate
Kumar	2005	India	1900	CS	Hospital	Range 15–39	Combined data on acupuncture and tattoo
Lifson	2001	USA	201	CS	Homeless	Range 15–22	Not enough data
Limentani	1979	USA	34	CR	Hospital	Range 16–28	Case series
Luksamijarulkul	1997	Thailand	200	CS	Female sex workers	NR	Paper could not retrieved
Luksamijarulkul	1996	Thailand	150	CS	IDUs	NR	Paper could not retrieved
Martin	1992	USA	538	CC	Blood donors	Mean = 36.8	Combined data for tattoo and IDU
Meyer	1991	USA	50	CS	Hospital	Range 20–83	Not enough data
Michault	2000	France	1455	CS	Hospital, pregnant women	NR	Combined data on tattoo and piercing
Miller	2009	Australia	662	CS	Prison	>18	Not enough data
Murray	2003	USA	305	CS	Prison	Youth	Not enough data
Nishioka	2002	Brazil	NR	CS	TTD	NR	Data on TTD not HCV/HBV
Pallas	1999	Spain	779	CS	Prison	Mean (SD) = 27.2 (5.4)	Hepatitis B and hepatitis C co-infection data
Patino-Sarcinelli	1993	Brazil	1239	CC	Blood donors	Range 18–64	Not enough data
Polizzotto	2008	Australia	1449	CS	Blood donors	Any ages	Data on TTD not HCV/HBV
Post	2001	Australia	1	CR	Prison	Mean = 25	Case report
Poulin	2007	Canada	1607	CS	Prison	Mean: female = 35.5; male = 33.3	Combined data on HIV–HCV
Robotin	2004	Australia	912	CS	Hospital	Any ages	Not enough data
Sayad	2008	Iran	1721	CS	Residents	Any ages	Not enough data
Silverman	2000	USA	212	CC	Emergency out-patient	Range 18–55	Not enough data
Stein	2004	USA	198	CS	Homeless	Range 18–65	Not enough data
Sypsa	2001	Greece	6047	CS	Employees of 17 companies	Range 15–70; mean (SD) = 40 (10.1)	Not enough data
Tanwandee	2006	Thailand	1329	CC	Blood donors	Mean = 34	Combined data on tattoo and piercing
Thompson	1996	Australia	1	CR	Prison	Mean = 39	Case report
Vaziri	2008	Iran	888	CS	Hospital	Mean (SD) = 30.7 (7.6)	Data are not presented appropriately
Vescio	2008	Italy	NR	NR	Prison	NR	Meta-analysis
Yee	2001	USA	148	CR	Hospital	Range 18–72	Not enough data
Zeuzem	1996	Germany	160	CS	Hospital hepatitis cases	NR	Not enough data

CR, case report; CS, cross-sectional; CO, cohort; CC, case–control; SD, standard deviation; NR, not reported; IDU, injection drug user; TTD, transfusion transmitted disease; HCV, hepatitis C virus; HBV, hepatitis B virus.

[a] For references see Appendix 2.

the risk of hepatitis C for samples derived from non-IDUs (OR 5.74, 95% CI 1.98–16.66), followed by blood donors (OR 3.73, 95% CI 2.46–5.67), hospital samples (OR 3.20, 95% CI 2.25–4.56), IDUs (OR 3.06, 95% CI 1.29–7.25), high-risk populations (OR 2.80, 95% CI 1.63–4.82), community samples (OR 2.79, 95% CI 1.95–4.00), prison samples (OR 2.56, 95% CI 1.97–3.32), and drug users (OR 1.46, 95% CI 0.93–2.30) (Figures 2 and 3).

We conducted a subgroup analysis to investigate the effect of the country where the study had been conducted, study design, and professional parlor vs. non-professional parlor on the transmission of hepatitis C. We combined data from community samples, blood donors, and hospital samples in a single group (group 1) and data from IDUs, non-IDUs, drug users (any), prisoners, and high-risk populations in a second group (group 2) (Table 3). The association between tattooing and hepatitis C was the strongest in group 2 studies in Australia (OR 5.90, 95% CI 2.62–13.30), followed by group 1 studies in Iran (OR 5.61, 95% CI 2.31–13.62) and Canada (OR 5.15, 95% CI 2.65–9.98). The association between tattooing and hepatitis C was the strongest among case–control studies, followed by cross-sectional and cohort studies (Table 3). Also, the association between tattooing and hepatitis C was significant for tattoos done in non-professional parlors or done by friends (OR 2.80, 95% CI 1.29–6.08).

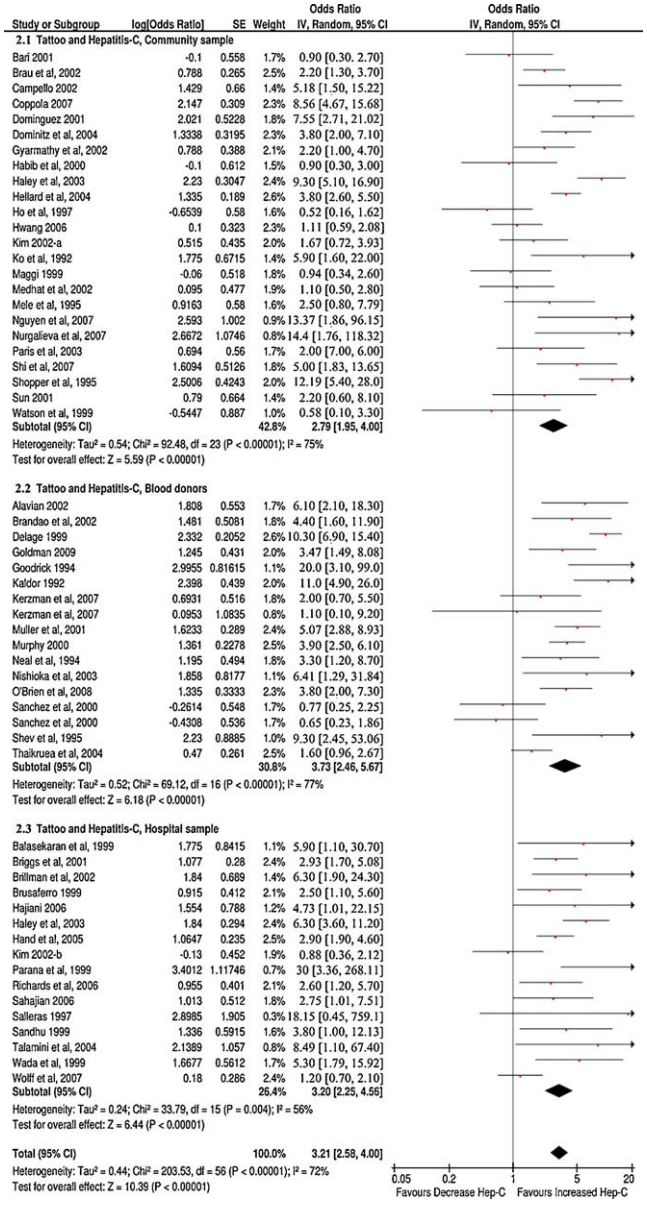

Figure 2. Tattooing and the risk of hepatitis C among the community samples, blood donors, and hospital samples.

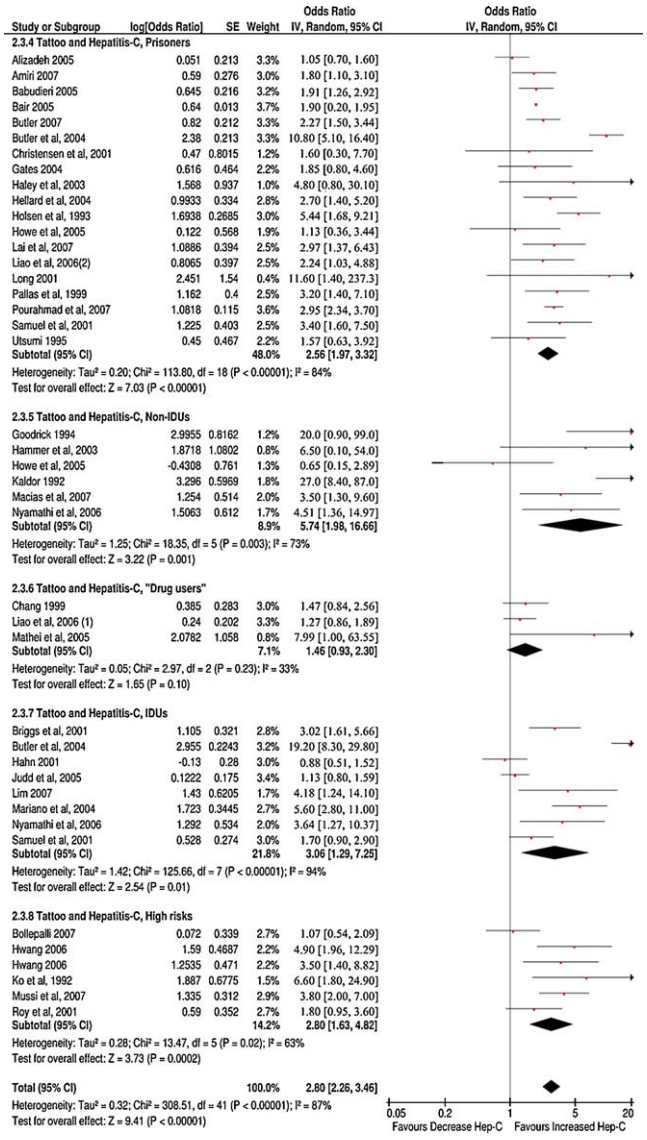

Figure 3.

We conducted a sensitivity analysis to review the effects of 11 studies with wide confidence intervals (References W37, W45, W53, W64, W71, W82, W85, W90, W101, W106, W113; Appendix B) on the pooled OR (95% CI). The analysis was conducted multiple times; first all 11 studies were removed from the analysis, and then one study was removed from the analysis at a time. We did not find a significant difference between pre- and post-sensitivity OR (95% CI) when all 11 studies were removed from the analysis (OR 2.12, 95% CI 1.91–2.36). We also found no significant difference between the pooled pre-sensitivity effect size (OR 2.74, 95% CI 2.38–3.15) and post-sensitivity effect size after removing any of these studies – Ref. W37, OR 2.22, 95% CI 2.00–2.48; Ref. W45, OR 2.24, 95% CI 2.01–2.49; Ref. W53, OR 2.21, 95% CI 1.98–2.46; Ref. W64, OR 2.24, 95% CI 2.01–2.50; Ref. W71, OR 2.24, 95% CI 2.01–2.49; Ref. W82, OR 2.23, 95% CI 2.00–2.49; Ref. W85, OR 2.23, 95% CI 2.00–2.49; W90, OR 2.23, 95% CI 2.00–2.48; Ref. W101, OR 2.24, 95% CI 2.01–2.50; Ref. W106, OR 2.24, 95% CI 2.01–2.50; and Ref. W113, OR 2.23, 95% CI 2.01–2.49, from the analysis (for references see Appendix B).

Table 3
Subgroup analysis for association between tattooing and hepatitis C

	Number of OR/RR included	Subgroup[a]	Pooled OR (random effect)	95% CI
Country				
Australia	4	BD, H, C	3.30	1.63–6.69
	7	IDU, non-IDU, DU, P, HR	5.90	2.62–13.30
Brazil	4	BD, H, C	4.30	1.25–14.73
	1	Not enough studies (IDU, non-IDU, DU, P, HR)	-	-
Canada	4	BD, H, C	5.15	2.65–9.98
	1	Not enough studies (IDU, non-IDU, DU, P, HR)	-	-
Iran	2	BD, H, C	5.61	2.31–13.62
	3	IDU, non-IDU, DU, P, HR	1.80	0.91–3.56
Italy	6	BD, H, C	3.32	1.56–7.09
	2	IDU, non-IDU, DU, P, HR	3.16	1.10–9.06
Taiwan	4	BD, H, C	2.40	0.78–7.36
	5	IDU, non-IDU, DU, P, HR	1.97	1.26–3.10
USA	13	BD, H, C	3.38	2.27–5.02
	14	IDU, non-IDU, DU, P, HR	2.10	1.75–2.51
Study design				
	33	Case–control studies	3.25	2.50–4.22
	10	Cohort studies	2.07	1.31–3.27
	49	Cross-sectional studies	2.83	2.32–3.45
Hepatitis C with tattoo place				
Professional parlors	4		1.28	0.68–2.39
Non-professional parlors/friend	4		2.80	1.29–6.08

OR, odds ratio; RR, relative risk; CI, confidence interval.
[a] Group 1: BD, blood donor sample; H, hospital sample; C, community sample. Group 2: IDU, sample from injection drug users; non-IDU, sample from non-injection drug users; DU, sample from drug users; P, sample from prison; HR, sample from high-risk population.

Table 4
Pre- and post-sensitivity analysis for I^2 test of heterogeneity

	Pre-sensitivity			Post-sensitivity			
	No. of ORs	OR (95%CI)	I^2	No. of ORs	OR (95%CI)	I^2	Studies that were the source of heterogeneity[a]
Community samples	24	2.79 (1.95–4.00)	75%	13	3.42 (2.67–4.37)	10%	W: 8, 25, 39, 43, 48, 51, 55, 68, 72, 108, 121
Blood donors	17	3.73 (2.46–5.67)	77%	12	4.32 (3.42–5.47)	0	W: 28, 37, 103, 115
Hospital samples	16	3.20 (2.25–4.56)	56%	14	3.68 (2.91–4.67)	0	W: 55, 122
Prison samples	19	2.56 (1.97–3.32)	84%	15	1.90 (1.85–1.95)	0	W: 3, 17, 49, 96
IDUs	8	3.06 (1.29–7.25)	94%	4	3.98 (2.67–5.93)	0	W: 17, 40, 52, 102
Non-IDUs	6	5.74 (1.98–16.66)	73%	3	4.13 (2.00–8.42)	0	W: 37, 50, 53
Drug users	3	1.46 (0.93–2.30)	33%	2	1.34 (0.97–1.84)	0	W71
High-risk samples	6	2.80 (1.63–4.82)	63%	4	4.17 (2.73–6.36)	0	W: 9, 99

OR, odds ratio; CI, confidence interval; IDU, injection drug user.
[a] For references see Appendix 2.

We examined the heterogeneity by excluding studies that did not report adjusted OR/relative risk (RR) from the analysis. Post-sensitivity pooled OR and I^2 of heterogeneity did not change significantly (pre-sensitivity OR 2.74, 95% CI 2.38–3.15, I^2 = 81%; post-sensitivity OR 2.41, 95% CI 1.86–3.14, I^2 = 75%). We also examined the source of heterogeneity in all subgroups and attempted to identify the studies that introduced heterogeneity and their effect on the pooled OR (95% CI). Table 4 presents the pre- and post-sensitivity pooled OR (95% CI) and the studies that were identified as a source of heterogeneity. As represented in Table 4, I^2 of heterogeneity improved to a non-significant level in all subgroups, however the pooled OR (95% CI) did not change significantly.

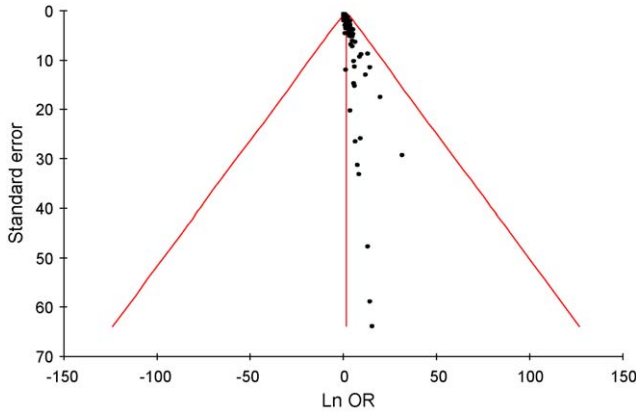

Figure 4. Funnel plot for publication bias.

We scored all the studies based on a 0–9 scale developed from MOOSE guidelines.[16] The mean score from all the studies was 7 with a range of 6 to 9. We found no association between study quality scores and the pooled measure of effect. However, results of our assessment indicate there is a possibility of publication bias for the outcome hepatitis C for studies of small effect size showing negative results (Figure 4). We believe that this is unlikely to change the overall results, since the majority of included studies were of high quality and precision. However this should be interpreted with caution in the face of heterogeneity in studies.

4. Discussion

Results of our systematic review indicate an increase in the risk of hepatitis C infection among those who have tattooed. The strength of our review is mainly in the large number of studies and multinational nature of the study participants. In light of the

observational nature of the studies in this review, the association between tattooing and hepatitis was strong in all subgroups and consistent across all study designs. We believe that having a tattoo is a strong risk factor for transmission of hepatitis C for two reasons. First, several studies have reported an association between tattooing and other infections including HIV,[20] hepatitis B,[21] leprosy,[22] and methicillin-resistant *Staphylococcus aureus*.[23] Secondly, some studies have shown that the risk of hepatitis infection increases with the increase in the surface area covered by a tattoo, as well as the number of tattoos received by an individual. For example, a study found that the RR (95% CI) for the association between tattooing and risk of hepatitis C for tattoos that covered a surface area of 1–4 cm^2 was 5.0 (2.6–9.6), whereas the RR for tattoos that covered an area of 20 cm^2 was 12.2 (4.6–32.2) (Ref. W98, Appendix B). Also, the incidence of hepatitis C after tattooing has been shown to have a direct association with the number of tattoo experiences (Ref. W44, Appendix B).

HCV has become the most common chronic blood-borne infection in the USA and the leading indication for liver transplantation.[24] Given that hepatitis C can spread through percutaneous[25,26] or mucous membrane exposure to blood,[27] needle-stick injury,[28] and tattooing using non-sterile equipment,[29] several measures should be implemented to prevent the transmission of hepatitis C among tattoo recipients. First, education programs for tattoo artists must be implemented to stress the importance of proper hygiene, as well as the potential for spread of blood-borne infections by tattoo needles. Second, parlor owners and tattoo artists should be required to keep records of their clients, to inform tattoo recipients about possible risks related to tattooing, and to report any adverse event related to tattooing to the health authorities. Third, because most tattoo recipients are young adults, education efforts should focus on this age group to promote tattoo-related risk awareness. When seeking tattooing services, clients should be advised to be alert to the use of equipment that has not been adequately sterilized or disinfected. HCV and other blood-borne pathogens can be transmitted if tools are not sterile or if the tattoo artist does not follow proper infection-control procedures (e.g., washing hands, using latex gloves, and cleaning and disinfecting surfaces and instruments). Fourth, clinicians should consider screening for hepatitis C among those who have recently received tattoos or have a history of receiving a tattoo. And last, current tattooing regulations and policies need to be updated to enforce infection control measures among tattoo artists.

The risk from tattooing may depend on the background prevalence of hepatitis C in the population. For instance, our results indicate that the OR/RR for the association between tattooing in prison and the risk of transmission of hepatitis C is lower compared to that from community samples. However, results of prior research indicate that the prevalence of hepatitis C among inmates in some countries is more than 20 times higher than that in the general population, which indicates that tattooing in prison presents a higher risk compared to tattooing outside prison.[30] We calculated the population attributable fraction for the association between tattooing and the risk of hepatitis C for tattoos done in prison and out of prison based on a tattooing prevalence of 11% to 27%[14] among inmates and 8% in the general population.[2,3] Results indicate that in countries with data close to these assumptions, 12% to 25% of hepatitis C infections in prison and 6% of the hepatitis C infections in the community are related to tattooing. These findings indicate that there is a clear need for establishing comprehensive programs that provide safer tattooing practices in prisons. One such program was initiated in Canada in 2006, but the program was terminated before the potential benefits could be evaluated. Similar programs may be able to prevent not only the transmission of hepatitis C, but also the transmission of other blood-borne infections.

Our study is subject to several limitations, mainly because of the observational nature of the studies included in the review. First, although some studies were published relatively recently, information on the history of tattooing was taken in the past, which may not reflect the current population risk of hepatitis infection. Second, publication bias in this study indicates a lack of publication of some studies with non-significant effects, which may amplify the OR/RR towards a higher association. However the association between tattooing and risk of transmission of hepatitis C was so strong in seven out of eight subgroups that this leaves no place for doubt in considering tattooing as an important risk factor in the transmission of hepatitis C. To lower the spread of hepatitis infection, prevention programs must focus on the youth and young adults, the populations most likely to get tattoos, and prisoners, the population that faces the higher prevalence of hepatitis C.

Conflict of interest: None of the authors in this study have any conflict of interest in the tattoo industry. There was no source of funding for this study.

Appendix A. Search strategy

(1) MEDLINE (1966 to most recent) using the optimally sensitive strategy developed for the identification of relevant papers

1 exp Tattooing/
2 tattoo$.tw.
3 body art.tw.
4 piercing.tw.
5 or/1-4
6 exp hepatitis/
7 exp hepatitis C/
8 jaundice.pt.
9 or/6-8
10 and/5,9
11 exp case-control studies/
12 exp cross-Sectional Studies/
13 exp cohort studies/
14 exp case report/
15 exp risk factors/
16 case control.pt.
17 cohort.pt.
18 cross sectional.pt.
19 population based.pt.
20 matched case control.pt.
21 systematic review/
22 meta-analysis/
23 case report.pt.
24 case series.pt
25 or/11-24
26 and/10,25

(2) EMBASE (1980 to most recent)

1. exp tattooing/
2. tattoo$.tw.
3. body art.t.w.
4. ear piercing.tw.
5. piercing.tw.
6. body piercing.tw.
7. or/1,6
8. exp hepatitis C/
9. exp hepatitis/
10. jaundice.ab.
11. or/8,10
12. exp case-control studies/
13. exp cross-Sectional Studies/
14. exp cohort studies/
15. exp case report/

16. risk factors.tw.
17. exp Meta analysis/
18. ((meta adj analy$) or meta-analysis$).tw.
19. (systematic adj (review$1 or overview$1)).tw.
20. liverlit.ab.
21. bloodlit.ab.
22. bibligraph$.ab.
23. hand-search$.ab.
24. manual search$.ab.
25. relevant journals.ab.
26. or/12,25
27. and/7,11,26

(3) We hand searched the following journals using key words such, tattooing, risk factors of hepatitis B/C, correlates of hepatitis B/C, and hepatitis non-A non-B

- American Journal of Epidemiology
- Blood
- Canadian Journal of Public Health
- Canadian Medical Association Journal
- Current Hepatitis Reports
- Epidemiology: The International Society for Epidemiology
- European Journal of Epidemiology
- Gastroenterology
- Gastroenterology journals
- Hematology
- Hepatitis
- Hepatitis Foundation
- Hepatitis Monthly
- Hepatology
- Hepatology Research
- Infectious disease
- Infectious Diseases Society of America
- Journal of Hepatology
- Journal of Viral Hepatitis
- Journal of Virology
- Liver
- Liver International
- Medical virology
- National Institutes of Health (NIH)

(4) Searched for gray literature in Google and Google scholars for: abstracts, full papers, power point presentations, organizational publications, and abstracts of conferences related to risk factors of transmission of hepatitis, hepatitis C, and hepatitis non-A non-B.

Appendix B. List of papers included in the systematic review.

W1. Abildgaard N, Peterslund NA. Hepatitis C virus transmitted by tattooing needle. Lancet 1991;338:460.

W2. Alavian SM, Gholami B, Masarrat S. Hepatitis C risk factors in Iranian volunteer blood donors: a case–control study. J Gastroenterol Hepatol 2002;17:1092–7.

W3. Alizadeh AH, Alavian SM, Jafari K, Yazdi N. Prevalence of hepatitis C virus infection and its related risk factors in drug abuser prisoners in Hamedan, Iran. World J Gastroenterol 2005;11:4085–9.

W4. Amiri ZM, Rezvani M, Shakib RJ, Shakib AJ. Prevalence of hepatitis C virus infection and risk factors of drug using prisoners in Guilan province. Eastern Mediterr Health J 2007;13:250–6.

W5. Babudieri S, Longo B, Sarmati L, Starnini G, Dori L, Suligoi B, et al. Correlates of HIV, HBV, and HCV infections in a prison inmate population: results from a multicentre study in Italy. J Med Virol 2005;76:311–7.

W6. Bair RM, Baillargeon JG, Kelly PJ, Lerand SJ, Williams JF, Lyerla R, Alter MJ. Prevalence and risk factors for hepatitis C virus infection among adolescents in detention. Arch Pediatr Adolesc Med 2005;159:1015–8.

W7. Balasekaran R, Bulterys M, Jamal MM, Quinn PG, Johnston DE, Skipper B, et al. A case–control study of risk factors for sporadic hepatitis C virus infection in the southwestern United States. Am J Gastroenterol 1999;94:1341–6.

W8. Bari A, Akhtar S, Rahbar MH, Luby SP. Risk factors for hepatitis C virus infection in male adults in Rawalpindi-Islamabad, Pakistan. Trop Med Int Health 2001;6:732–8.

W9. Bollepalli S, Mathieson K, Bay C, Hillier A, Post J, Van Thiel DH, Nadir A. Prevalence of risk factors for hepatitis C virus in HIV-infected and HIV/hepatitis C virus-coinfected patients. Sex Transm Dis 2007;34:367–70.

W10. Bourliere M, Barberin JM, Rotily M, Guagliardo V, Portal I, Lecomte L, et al. Epidemiological changes in hepatitis C virus genotypes in France: evidence in intravenous drug users. J Viral Hepat 2002;9:62–70.

W11. Bräu N, Bini EJ, Shahidi A, Aytaman A, Xiao P, Stancic S, et al. Prevalence of Hepatitis C and coinfection with HIV among United States veterans in the New York City metropolitan area. Am J Gastroenterol 2002;97:2071–8.

W12. Brandão AB, Fuchs SC. Risk factors for hepatitis C virus infection among blood donors in southern Brazil: a case–control study. BMC Gastroenterol 2002;2:18. This article is available from: http://www.biomedcentral.com/1471-230X/2/18.

W13. Briggs ME, Baker C, Hall R, Gaziano JM, Gagnon D, Bzowej N, Wright TL. Prevalence and Risk factors for hepatitis C virus infection at an urban veterans administration medical center. Hepatology 2001;34:1200–5.

W14. Brillman JC, Crandall CS, Florence CS, Jacobs JL. Prevalence and risk factors associated with hepatitis C in ED patients. Am J Emerg Med 2002;20:476–80.

W15. Brind AM, Watson JP, James OF, Bassendine MF. Hepatitis C virus infection in the elderly. Q J Med 1996;89:291–6.

W16. Brusaferro S, Barbone F, Andrian P, Brianti G, Ciccone L, Furlan A, et al. A study on the role of the family and other risk factors in HCV transmission. Eur J Epidemiol 1999;15:125–32.

W17. Butler T, Kariminia A, Levy M, Kaldor J. Prisoners are at risk for hepatitis C transmission. Eur J Epidemiol 2004;19:1119–22.

W18. Butler T, Boonwaat L, Hailstone S, Falconer T, Lems P, Ginley T, et al. The 2004 Australian prison entrants' blood-borne virus and risk behaviour survey. Aust N Z J Public Health 2007;31:44–50.

W19. Campello C, Poli A, Dal MG, Besozzi-Valentini F. Seroprevalence, viremia and genotype distribution of hepatitis C virus: a community-based population study in northern Italy. Infection 2002;30:7–12.

W20. Champion JK, Taylor A, Hutchinson S, Cameron S, McMenamin J, Mitchel A, Goldberg D. Incidence of hepatitis C virus infection and associated risk factors among Scottish prison inmates: a cohort study. Am J Epidemiol 2004;159:514–9.

W21. Chang CJ, Lin CH, Lee CT, Chang SJ, Ko YC, Liu HW. Hepatitis C virus infection among short-term intravenous drug users in southern Taiwan. Eur J Epidemiol 1999;15:597–601.

W22. Chen TZ, Wu JC, Yen FS, Sheng WY, Hwang SJ, Huo TI, Lee SD. Injection with nondisposable needles as an important route for transmission of acute community-acquired hepatitis C infection in Taiwan. J Med Virol 1995;46:247–51.

W23. Cheung RC. Epidemiology of hepatitis C virus infection in American veterans. Am J Gastroenterol 2000;95:740–7.

W24. Christensen PB, Krarup HB, Niesters HGM, Norder H, Georgsen J. Prevalence and incidence of bloodborne viral infections among Danish prisoners. Eur J Epidemiol 2000;16: 1043–9.
W25. Coppola RC, Masia G, Pradat P, Trepò C, Carboni G, Argiolas F, Rizzetto M. Impact of hepatitis C virus infection on healthy subjects on an Italian island. J Viral Hepat 2000;7: 130–7.
W26. Cunha L, Plouzeau C, Ingrand P, Gudo JPS, Ingrand I, Mondlane J, et al. Use of replacement blood donors to study the epidemiology of major blood-borne viruses in the general population of Maputo, Mozambique. J Med Virol 2007;79:1832–40.
W27. Dalgard O, Bjøro K, Hellum K, Myrvang B, Skaug K, Gutigard B, Bell H; Construct Group. Treatment of chronic hepatitis C in injecting drug users: 5 years' follow-up. Eur Addict Res 2002;8:45–9.
W28. Delage G, Infante-Rivard C, Chiavetta JA, Willems B, David PI, Fast M. Risk factors for acquisition of hepatitis C virus infection in blood donors: results of a case–control study. Gastroenterology 1999;116:893–9.
W29. Deterding K, Wiegand J, Grüner N, Wedemeyer H. Medical procedures as a risk factor for HCV infection in developed countries: do we neglect a significant problem in medical care? J Hepatol 2008;48:1018–21.
W30. Dietemann-Molard A, Braun JJ, Sohier B, Pauli G. Hepatitis C virus transmitted by tattooing needle. Lancet 1991;338:60.
W31. Dominguez A, Bruguera M, Vidal J, Plans P, Salleras L. Community-based seroepidemiological survey of HCV infection in Catalonia, Spain. J Med Virol 2001;65:688–93.
W32. Dominitz JA, Boyko EJ, Koepsell TD, Heagerty PJ, Maynard C, Sporleder JL, VA Cooperative Study Group 488. Elevated prevalence of hepatitis C infection in users of United States veterans medical centers. Hepatology 2005;41:88–96.
W33. Ford PM, Pearson M, Sankar-Mistry P, Stevenson T, Bell D, Austin J. HIV, hepatitis C and risk behaviour in a Canadian medium security Federal penitentiary. Q J Med 2000;93: 113–9.
W34. Fox RK, Currie SL, Evans J, Wright TL, Tobler L, Phelps B, et al. Hepatitis C virus infection among prisoners in the California state correctional system. Clin Infect Dis 2005;41:177–86.
W35. Gates JA, Post JJ, Kaldor JM, Pan Y, Haber PS, Lloyd AR, et al. Risk factors for hepatitis C infection and perception of antibody status among male prison inmates in the Hepatitis C Incidence and Transmission in Prisons Study cohort, Australia. J Urban Health 2004;81:448–52.
W36. Goldman M, Xi G, Yi QL, Fan W, O'Brien SF. Reassessment of deferrals for tattooing and piercing. Transfusion 2009;49: 648–54.
W37. Goodrick MJ, Gray SF, Rouse AM, Waters AJ, Anderson NA. Hepatitis C (HCV)-positive blood donors in southwest England: a case control study. Transfus Med 1994;4:113–9.
W38. Gyarmathy VA, Neaigus A, Miller M, Friedman SR, Des Jarlais DC. Risk correlates of prevalent HIV, hepatitis B virus, and hepatitis C virus infections among non-injecting heroin users. J Acquir Immune Defic Syndr 2002;30:448–56.
W39. Habib M, Mohamed MK, Abdel-Aziz F, Magder LS, Abdel Hamid M, Gamil F, et al. Hepatitis C virus infection in a community in the Nile Delta: risk factors for seropositivity. Hepatology 2001;33:248–53.
W40. Hahn JA, Page-Shafer K, Lum PJ, Ochoa K, Moss AR. Hepatitis C virus infection and needle exchange use among young injection drug users in San Francisco. Hepatology 2001;34:180–7.
W41. Hajiani E, Hashemi J, Masjedizadeh R, Shayesteh AA, Idani E, Rajabi T. Seroepidemiology of hepatitis C and its risk factors in Khuzestan Province, south-west of Iran: a case–control study. World J Gastroenterol 2006;12:4884–7.
W42. Hajiani E, Hashemi SJ, Masjedizadeh AR. Seroepidemiology of hepatitis B virus infection in Khuzestan Province, southwest of Iran. Hepatitis Monthly 2008;99:34–8.
W43. Haley RW, Fischer RP. The tattooing paradox. Are studies of acute hepatitis adequate to identify routes of transmission of subclinical hepatitis C infection? Arch Intern Med 2003;163:1095–8.
W44. Haley RW, Fischer RP. Commercial tattooing as a potentially important source of hepatitis C infection clinical epidemiology of 626 consecutive patients unaware of their hepatitis C serologic status. Medicine (Baltimore) 2001;80: 134–51.
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