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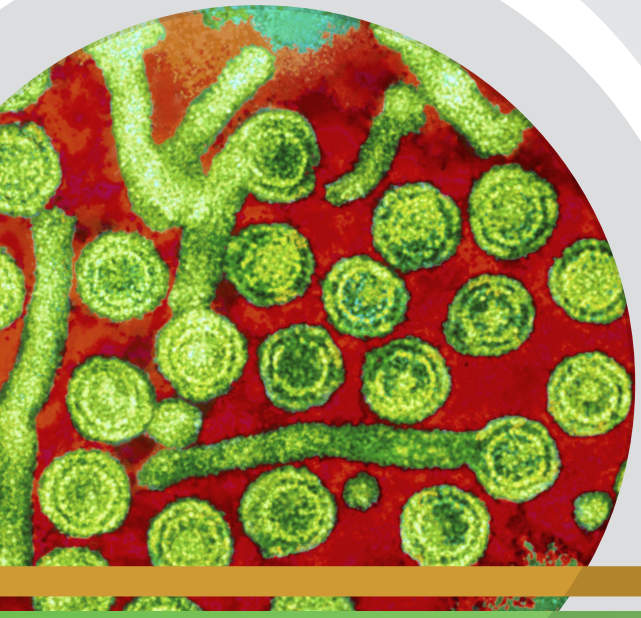

TECHNICAL REPORT

Hepatitis B and C epidemiology in selected population groups in the EU/EEA

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Hepatitis B and C epidemiology in selected population groups in the EU/EEA

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Abbreviations

Anti-HCV	Antibody to hepatitis C virus
EEA	European Economic Area
EMCDDA	European Monitoring Centre for Drugs and Drug Addiction
EPP	Exposure-prone procedures
EFTA	European Free Trade Association
EU	European Union
HAART	Highly active antiretroviral therapy
HBsAg	Hepatitis B surface antigen
HBV	Hepatitis B virus
HCC	Hepatocellular carcinoma
HCV	Hepatitis C virus
HIV	Human immunodeficiency virus
MSM	Men who have sex with men
PICO	Population intervention comparator outcome
PLHIV	People who live with HIV
PWID	People who inject drugs
RIVM	Dutch National Institute for Public Health and the Environment
SIGN	Scottish Intercollegiate Guidelines Network
SoHO	Substances of human origin
STI	Sexually transmitted infection
SVR	Sustained virological response
WHO	World Health Organization

Glossary

Homeless: People without a shelter of any kind, and people who live in temporary, insecure and inadequate poor quality housing.

Intranasal drug users: People who inhale or snort recreational drugs.

Migrants: The United Nations[1] defines migrant as an individual who has resided in a foreign country for more than one year irrespective of the causes, voluntary or involuntary, and the means, regular or irregular, used to migrate. Under such a definition, those travelling for shorter periods as tourists and business persons would not be considered migrants. However, common usage includes certain kinds of shorter-term migrants, such as seasonal farm workers who travel for short periods to work, planting or harvesting farm products.

Multiple-risk group: Population subgroup characterised by two or more risk factors for HBV or HCV infection, e.g. MSM with a HIV diagnosis.

People in prison: People who are in any form of detention or penitentiary facility, including people in centres for pre-trial, in prison for convicted crimes, in centres for juvenile offenders and in other correctional facilities. Individuals with a history of imprisonment are also included.

Public safety workers: A person serving a public agency in an official capacity, such as law enforcement officers, firefighters, ambulance crews, rescue workers and correctional officers.

PWID: People who inject recreational drugs intravenously. Can also include people who used to inject drugs.

Refugee: A person who, owing to a well-founded fear of persecution for reasons of race, religion, nationality, membership of a particular social group or political opinions, is outside the country of his nationality and is unable or, owing to such fear, is unwilling to avail himself of the protection of that country. Other factors can include external aggression, occupation, foreign domination or events seriously disturbing public order in either part or the whole of his country of origin or nationality[2,3,4].

Risk group: Population subgroup at higher risk of HBV/HCV infection or with a high burden of disease. For the purpose of this report, the WHO threshold of 2% prevalence of HBsAg and/or of anti-HCV was used as a reference[5].

Undiagnosed fraction: Proportion of HBV/HCV-infected people that have yet to be diagnosed.

Nosocomial: Referring to a disease contracted by a patient while under medical care.

Iatrogenic: Referring to a disease contracted due to the activity of a healthcare provider or due to medical treatment or diagnostic procedures.

[1] *United Nations, definition of 'migrant'*
[2] *Geneva Convention relating to the Status of Refugees, Art. 1A(2), as modified by the 1967 Protocol)*
[3] *1969 Organization of African Unity (OAU)*
[4] *1984 Cartagena Declaration on Refugees.*
[5] *World Health Organization. Guidelines on hepatitis B and C testing. Geneva: WHO; 2017.*

Executive summary

Hepatitis B virus (HBV) and hepatitis C virus (HCV) can cause acute and chronic hepatitis and potentially lead to the development of cirrhosis, liver cancer and death. In the EU/EFTA, an estimated 4.7 million people have a chronic hepatitis B virus infection, and 3.9 million people have chronic hepatitis C [1]. Many of these infections may go undiagnosed as chronic infection is often asymptomatic. In order to support EU/EEA Member States in scaling-up national testing strategies and effectively tailor testing initiatives towards groups at risk of HBV and HCV, ECDC has developed an evidence-based guidance document on testing for viral hepatitis in the EU/EEA. The project maps population groups at higher risk of HBV and HCV and/or with a high burden of disease and estimates the number of undiagnosed cases in these groups and in the general population in EU/EEA countries.

Initially, a comparative analysis of existing hepatitis B/C testing guidelines was performed in order to compile a list of population groups potentially at risk, or with a high burden, of HBV/HCV in the EU/EEA. Two systematic literature reviews were performed in order to collect, synthesise and analyse available data on the prevalence and incidence of HBV and HCV among at-risk population groups in EU/EEA countries and the proportion of undiagnosed cases (undiagnosed fraction) in these groups and the general population. Search strategies were developed for each review; literature searches were performed in bibliographical databases PubMed and Embase. Publications of interest were selected in a three-phase process: articles were screened for relevance by title and abstract, full-text, and during data extraction. Relevant data were extracted from all selected publications and the quality of each publication was appraised critically. Additional data sources were consulted to collect prevalence data in certain population groups and estimates of the undiagnosed fraction. In addition to these systematic reviews, a comparative analysis of existing hepatitis B/C testing guidelines was performed. Guidelines from EU/EEA Member States, supranational guidelines and English-language guidelines from other countries were collected, recommendations relating to hepatitis B/C risk groups were compiled, and the level of evidence on which recommendations were based was assessed.

The literature search for prevalence and incidence data yielded 5 511 unique publications, 539 of which were selected based on title and abstract. Six additional articles were found through a manual search or were known to ECDC or the project team. The full-text selection resulted in 148 articles eligible for inclusion. These included studies with data on prevalence and/or incidence of HBV and/or HCV in the following population groups: pregnant women, birth cohorts, people who inject drugs (PWID), dialysis/haemodialysis patients, healthcare workers, diabetics, recipients of substances of human origin (SoHO), people who have received medical/dental interventions, waste collection workers, anabolic steroid users, tattoo recipients, men who have sex with men (MSM), sex workers, people engaging in high-risk sexual behaviour, people with an STI, intranasal drug users, PLHIV, people in prison, migrants, travellers, transgender people, homeless people, public safety workers and household/family/sexual partners of infected people. Data were also found for groups with multiple risks (e.g. PWID in prison). Other sources, including websites and previous systematic reviews conducted by ECDC, were consulted for data on the prevalence of HBV and HCV in the following groups: general population, pregnant women, blood donors, PWID, MSM, people in prison, and migrants.

A qualitative approach was applied in order to compare national prevalence data for individual population groups with data for the general population and/or proxy populations, and measure them against the prevalence thresholds of 2% for HBV (HBsAg) and HCV (anti-HCV), as suggested by the latest WHO guidance [2].

For HBV, the following populations were found likely to be at higher risk of disease or have a high disease burden across the EU/EEA: dialysis/haemodialysis patients, PLHIV and PLHIV with multiple risks (MSM living with HIV, PWID living with HIV, PLHIV in prison). For HCV, the populations were: PWID, people in prison, PLHIV and PLHIV with multiple risks (PWID in prison, PWID living with HIV, homeless PWID, PLHIV in prison, MSM living with HIV), dialysis/haemodialysis patients, recipients of SoHO, diabetics, infants of mothers with chronic hepatitis C and other family members of people with chronic hepatitis C. Populations that were identified as possibly at risk of HBV in certain regions or under certain circumstances are: PWID, MSM, people in prison and migrants. For HCV, these populations were: MSM, healthcare workers and migrants. For other population groups, no data were found. Incidence data were very sparse and limited to certain population subgroups, such as MSM and PLHIV, and largely focussing on HCV infection. The available evidence indicates HCV transmission occurring at least among MSM, PLHIV and people in prison, while HCV incidence among dialysis/haemodialysis patients was reported as significant only in older studies.

The literature search for estimates of the undiagnosed fraction yielded very limited findings. Despite the heterogeneity, the undiagnosed proportion of HBV- and HBV-infected people was generally high among the general population in countries throughout the EU/EEA, suggesting widespread underdiagnosis. Based on these findings, it is advisable to scale up testing coverage and uptake, at least among population groups at higher risk, or with a higher burden, of HBV or HCV in order to achieve the WHO global goal of eliminating viral hepatitis and, in particular, meet the European regional targets of diagnosing 50% of people with chronic hepatitis B/C by 2020 (90% by 2030).

The findings presented in this report will be part of the process of developing a European guidance for HBV and HCV testing and may provide support EU/EEA countries in the development of national guidelines and in the design and scale-up of testing interventions.

1 Background

Hepatitis B virus (HBV) and hepatitis C virus (HCV) can cause acute and chronic hepatitis and potentially lead to the development of cirrhosis, liver cancer or death of infected patients [3,4]. Worldwide, an estimated 248 million [5] and 71.1 million [6] people are chronically infected with HBV and HCV, respectively. It has been estimated that across the EU/EFTA almost 4.7 million people have a chronic hepatitis B virus infection, and 3.9 million have chronic hepatitis C [1]. Since the onset of disease and initial development of liver damage are usually asymptomatic [7-9], HBV and HCV infection often go undetected for many years [10].

Transmission of HBV and HCV can occur sexually, through blood-to-blood contact or vertically (mother-to-child). In recent decades, various factors have contributed towards changes in HBV and HCV epidemiology in Europe, including improvements in blood transfusion and organ donor safety and healthcare standards, HBV vaccination programmes, harm reduction programmes targeting injecting drug use, as well as significant changes in patterns of injecting drug use and immigration. Currently, a number of population groups are considered to have a potentially high risk of disease or belong to a high-disease-burden group for HBV or HCV, for example groups at risk for transmission through needles (e.g. PWID) and iatrogenic infection (e.g. haemodialysis patients), through sexual transmission (e.g. MSM), through vertical transmission and other vulnerable groups which may be at risk through multiple transmission routes (e.g. PLHIV, people in prison and migrants from endemic countries) [11].

Treatment of chronic hepatitis B is becoming more effective and may lead to remission, depending on the timing of therapy during the natural course of the infection but also on the stage of the disease and the patient's age when treatment is started. [12]. Recently, new drug therapies have been introduced for HCV which achieve cure rates of over 90% [13]. The existence of more effective treatment options for HBV and HCV, and effective vaccination against HBV, prompted public health organisations to step up the response to these diseases: WHO formulated an action plan to eliminate viral hepatitis as a public health threat in the European Region by 2030, with 50% of people with chronic HBV/HCV infections diagnosed by 2020, and 90% by 2030 [14].

Scale-up of testing programmes is needed to decrease the undiagnosed fraction and speed up elimination. The continuum-of-care cascade, originally developed for HIV, is a model that outlines the sequential steps or stages of medical care that people initially unaware of their HBV/HCV infection go through, from initial diagnosis to receiving antiviral treatment, eventually getting cured or achieving a sustained virological response.

In the case of chronic viral hepatitis, a large gap exists in the first part of the continuum because the majority of asymptomatic infections are estimated to be undiagnosed [15]. Patients therefore are at risk of developing severe liver disease and can pass on the infection.

According to a survey on hepatitis B and C testing activities conducted by ECDC [16], 19 countries (90% of responding countries) include HBV in their national testing guidance; 18 countries (86%) include HCV. A specific guidance on testing for HBV and HCV exists in six (29%) and ten countries (48%) respectively. Thirteen countries have a policy on HBV/HCV testing for PWID. However, other potential risk groups were frequently omitted from guidance documents, including commercial sex workers, MSM, recipients of tattoos or piercings in unregulated settings, and homeless people. At the policy level, the most commonly cited barrier was a lack of policy documents or testing guidance (nine countries (43%) for HBV, eight countries (38%) for HCV). At the implementation level, the most commonly cited barrier to achieve higher testing coverage was the fact that risk groups were not targeted effectively (17 countries (81%) for HBV, 16 countries (76%) for HCV).

In response to requests by EU/EEA Member States that wanted to step up their testing efforts, ECDC agreed to develop an evidence-based public health guidance on testing for viral hepatitis in the EU/EEA.

Scope and objectives

Within the framework of developing an evidence-based public health guidance on testing for viral hepatitis in the EU/EEA, the scope of this project was to identify the population groups at increased risk of viral hepatitis and/or with a high burden of hepatitis B and C. This requires estimates of the disease burden and the undiagnosed fraction in the general population and in risk groups in EU/EEA countries. Systematic reviews were performed to retrieve data on the prevalence/incidence of HBV/HCV, the proportion of undiagnosed cases in selected population subgroups, and the proportion of undiagnosed cases in the general population.

2 Review methods

Two separate systematic literature reviews were performed in order to collect, synthesise and analyse available data on the prevalence and incidence of HBV and HCV in selected population groups in EU/EEA countries, and on the undiagnosed fraction within these groups and the general population. A rigorous high-quality methodology for systematic reviews was applied, following international methodology and reporting standards such as Cochrane [17] and PRISMA [18]. Research questions were framed (see below) and a search strategy was developed. Publications of interest were selected in a three-phase process, whereby articles are screened for relevance by title and abstract, full text, and during data extraction. Relevant data were extracted from all selected publications, and the quality of each publication was critically appraised. All steps are described in detail below.

2.1 Identification of potential high-risk/high-burden population groups

Prior to the systematic reviews, a comparative analysis of existing hepatitis B/C testing guidelines was performed in order to assess the level of evidence and inventorise population subgroups identified as priority groups for hepatitis B/C testing in the EU/EEA (Appendix 11). The project team and scientists from ECDC added further evidence to the findings so that a list of possible risk groups could be produced (Table 1). Two other 'groups of interest' not usually classified as being at higher risk or with a high burden of disease were included as a proxy for the general population, namely pregnant women and blood donors.

Table 1. Population subgroups possibly at risk of HBV/HCV or with a high burden of disease and other groups of interest

Groups at risk by transmission routes
• Transmission through percutaneous injuries – People who inject drugs – Nosocomial and iatrogenic exposure groups: dialysis/haemodialysis patients, diabetes patients, recipients of substances of human origin (including blood transfusion recipients, people who have received medical/dental interventions, healthcare workers • Other groups with exposure to needles: – Waste collection workers – Anabolic steroid users – Tattoo artists and recipients of tattoos, piercings and scarification – Recipients of mesotherapy, acupuncture or beauty therapies • Sexual transmission routes – MSM – Sex workers – Those engaging in, or with a history of, high-risk sexual behaviour – Sexual assault victims – Sexual partners of PWID – People infected with PLHIV, HBV+, HCV+ and STI – People having an STI screen/test • Intranasal transmission – Intranasal drugs users
Vulnerable groups and groups with mixed transmission routes
• PLHIV • People in prison • Migrants • Household/family/sexual partners of HBV/HCV-infected people (including children of infected mothers) • Travellers • Transgender people • Homeless people • Public safety workers • People in care homes/institutionalised people • Intellectually disabled people
Other groups of interest
• Pregnant woman • Blood donors • Birth cohorts

2.2 Research questions

This project addressed the following research questions:

1. Which population subgroups have a higher risk of acquiring HBV or HCV, and/or have a high burden of disease, among those identified by national/international guidelines?

2. What is the proportion of undiagnosed cases among the general population and these risk groups?

The PICO method was used to specify research questions 1 and 2 (Tables 2 and 3).

Table 2. PICO for research question 1

1	Which population subgroups have a higher risk of acquiring HBV/HCV, and/or have a high burden of disease?
P	Population subgroups possibly at higher risk for and/or with a high burden of hepatitis B or C (Table 1) in the EU/EEA
I	Not applicable
C	Not applicable
O	Quantitative outcomes: • Odds ration/relative ratio (OR/RR) for hepatitis B or C in population subgroups compared with general population • Incidence of hepatitis B/C in population subgroups compared with the general population • OR/RR for chronic hepatitis B or C in population subgroups compared with general population • Prevalence or positivity rate of chronic hepatitis B and/or C infection in population subgroups compared with the general population • Transmission rates of hepatitis B or C in population subgroups

Table 3. PICO for research question 2

2	What is the proportion of undiagnosed cases among the general population and population subgroups?
P	General population and population subgroups possibly at risk for and/or with a high burden of hepatitis B or C (Table 1) in the EU/EEA
I	Not applicable
C	Not applicable
O	Quantitative outcomes: proportion/frequency/distribution of undiagnosed cases for the general population and per population subgroup

In order to compare the prevalence of HBV/HCV in population subgroups with that of the general population in EU/EEA countries, prevalence data for the general population and proxy populations such as pregnant women and blood donors were also collected.

For a selection of population groups, namely pregnant women, blood donors, PWID, MSM, people in prison and migrants, data on prevalence of HBV and HCV were collected through two systematic reviews conducted by ECDC: a systematic review on hepatitis B and C prevalence in the EU/EEA [19] and an epidemiological assessment of hepatitis B and C among migrants in the EU/EEA [20]. In the current review, data on these groups were updated to include data published since 2015; it also includes incidence data published since 2005, with the exception of PWID and blood donors, for which data were updated using grey literature. In addition, data on prevalence and incidence of HBV and HCV in the general population were collected in another systematic ECDC review [19]. These data are used in the current review but were not updated.

2.3 Search strategy

Literature search

Publications were retrieved from PubMed and Embase on 14 February 2017. The search strings combined terms for HBV and HCV with terms for occurrence (e.g. incidence or prevalence) and population subgroups, or with terms relating to 'undiagnosed/unaware'. A detailed description of the strategy and the strings for each research question can be found in Appendix 2.

For research question 1, three separate searches were conducted; retrieved articles were pooled. An overview of the three different searches is shown in Table 4.

Table 4. Overview of searches for research question 1

Search	Populations	Outcomes of interest	Date limits
1	• MSM • Migrants	Prevalence	1 January 2015–14 February 2017
2	• People in prison • PWID • Pregnant women	Incidence	1 January 2005–14 February 2017

Search	Populations	Outcomes of interest	Date limits
3	Populations in Table 1, excluding populations listed above and blood donors	Prevalence Incidence	1 January 2005–14 February 2017

For research question 2, one search was conducted to collect data published between 1 January 2005 and 14 February 2017.

No language limitations were applied. A geographical search string was added to limit the searches to studies from EU/EEA countries. For the search in Embase, publication type was limited to review, article and article in press. Original research articles were included in the review; however, the reference lists of relevant systematic reviews retrieved in the literature search were checked manually for additional original articles.

The search results were transferred to an EndNote library. Duplicate records were removed automatically and manually.

Additional data sources and grey literature

A hand search was performed, checking the reference lists of good-quality systematic review articles to identify key references potentially missed during the literature search. A list of articles retrieved through the literature search was share with ECDC and the project team for review and validation. ECDC and the project team suggested additional relevant publications that were also added to the list of included articles. These steps were applied to both research questions.

Research question 1 was complemented with data previously collected by ECDC in systematic reviews on seroprevalence in specific risk groups and migrants [19,20]. Data on the prevalence of HBV and HCV infections in first-time blood donors in EU/EEA Member States were obtained from a recent publication [21] and the latest report from the Council of Europe [22]. The most recent prevalence data on PWID were obtained from the EMCDDA website, accessed on 6 June 2017 [23].

Research question 2 was complemented with data from a 2016 ECDC survey on testing and screening for HBV/HCV in the EU/EEA ('Hepatitis B and C testing activities, needs and priorities in the EU/EEA'); these data were also used to update the existing evidence on the burden of hepatitis B and C morbidity and mortality across EU/EEA Member States [16].

An overview of the different sources used to search for data per population group and outcome is presented in Table 5.

Table 5. Data sources searched per outcome and population group

Data sources	Data searched for
Systematic literature search in PubMed and Embase	Prevalence/incidence in populations included in Table 1 (excluding blood donors) Undiagnosed fraction
Hand search of reference lists of systematic reviews Publications suggested by ECDC/project team	Prevalence/incidence in populations included in Table 1 (excluding blood donors) Undiagnosed fraction
Recent publication on prevalence in blood donors [21]	Prevalence in blood-donors
Latest report from the Council of EU [22]	Prevalence in blood-donors
EMCDDA website [23]	Prevalence in PWID
ECDC systematic review on HBV/HCV prevalence [19]	Prevalence in general population, pregnant women, PWID, MSM, people in prison
ECDC systematic review on HBV/HCV prevalence in migrants [20]	Prevalence in migrants
ECDC survey on hepatitis B and C testing activities, needs, and priorities in the EU/EEA [16]	Undiagnosed fraction

2.4 Selection process

Peer-reviewed literature

A pre-defined set of inclusion and exclusion criteria is presented in Table 6 and 7. The criteria were refined during the screening process to maximise their sensitivity and specificity.

Table 6. Inclusion and exclusion criteria for research question 1

	Inclusion	Exclusion
Study design/type	• Surveillance studies • RCTs • Non-randomised, prospective comparative studies • Prospective observational studies • Retrospective observational studies • Cross-sectional studies • Meta-analysis or systematic review	• Narrative review • Case reports, outbreak investigations • Non-pertinent publication types (e.g. expert opinions, letters to the editor, editorials, comments) • Animal studies • Laboratory (e.g. genetic, biochemistry or molecular) studies • Mathematical modelling studies
Country	• EU/EEA countries	• Other countries
Study subject	• Hepatitis B or C	• Other or unspecified hepatitis
Study population	• Groups listed in Table 1 (except blood donors) • Haemodialysis patients in multicentre studies • PLHIV in representative studies* • Populations belonging to two or more risk groups (e.g. MSM living with HIV)	• General population • Primary studies included in the previous systematic reviews [19] • Prevalence studies in PWID (except for PWID with multiple risks) • Blood donors • Other populations • Studies on haemodialysis patients conducted in single centres • PLHIV if studies with more representative PLHIV populations exist for that country* • Migrants where data are not stratified per country of origin • Populations of patients diagnosed with cirrhosis, liver cancer or who have undergone liver transplant • Populations with multiple risks as part of a larger study within a single risk group, if the sample size was less than 50** • Populations with high HBV vaccination rates (for studies on HBV infection only) • Healthcare workers tested after exposure incidents only • Transplant patients, where donors have undergone testing prior to donation • Populations for which data on the same outcomes is available in a more recent publication • Subgroups of populations that are biased/are at greater risk e.g. travellers that returned with an illness or healthcare workers who had needlestick accidents
Outcomes	• Prevalence /incidence/proportion/ transmission rate of HBV/HCV in subpopulation, or OR/RR of infection in subpopulation compared to general population • Outcome based on HBsAg, anti-HCV, HBV DNA or HCV RNA measurement in study population	• Other outcomes not related to risk of acquiring HBV/HCV or burden of disease • Outcome based on measurement of other virological markers, or if markers were not specified, or self-reported infections

** Due to the large number of studies performed in PLHIV populations, an algorithm for study inclusion was developed. Where multiple studies existed for one country, only large, representative nationwide studies were included. If only smaller, less representative studies existed for a country, these were included. These exclusion criteria were not applicable for PLHIV subgroups with multiple risks.*
*** This criterion was not applicable to the subgroups for which limited sample sizes are expected such as: transgender persons, sex workers and intranasal drug users.*

Table 7. Inclusion and exclusion criteria for research question 2

	Inclusion	Exclusion
Study design/type	• Surveillance studies • RCTs • Non-randomised, prospective comparative studies • Prospective observational studies • Retrospective observational studies • Cross-sectional studies • Meta-analysis or systematic review • Mathematical modelling studies	• Narrative review • Case reports, outbreak investigations • Non-pertinent publication types (e.g. expert opinions, letters to the editor, editorials, comments • Animal studies • Laboratory (e.g. genetic, biochemistry or molecular) studies
Country	• EU/EEA countries	• Other countries
Study subject	• Hepatitis B or C	• Other or unspecified hepatitis

	Inclusion	Exclusion
Study population	• Groups listed in Table 1 • General population	• Other populations
Outcomes	• Proportion/frequency/distribution of undiagnosed cases	• Other outcomes not related to proportion of undiagnosed cases

All publications retrieved during the search were screened by title and abstract. Two reviewers performed the selection. First, a random sample of 5% was screened in duplicate, the results were compared and used to refine the inclusion and exclusion criteria. A further 5% was screened in duplicate, but as the level of concordance was less than 95%, inclusion and exclusion criteria definitions were again reviewed and a further 5% was screened in duplicate, for which a level of concordance of over 95% was achieved. The rest of the retrieved publications were split between the two reviewers. The full text of selected articles were subsequently screened by two reviewers, of which a random sample of 20% were screened in duplicate and which reached more than 95% concordance. The remaining 80% of publications were split between the two reviewers. In cases of uncertainty about inclusion or exclusion, not resolved after discussion, articles were included during both screening steps.

Peer-reviewed literature identified through other sources (e.g. hand search or suggested by ECDC or the project team, articles on blood donors) were subject to the same inclusion and exclusion criteria.

Grey literature

Grey literature (data from the EMCDDA website, ECDC systematic reviews and surveys) were included if they were deemed to be a relevant source of data, i.e. reporting relevant outcomes (see Tables 4 and 5) on hepatitis B/C in EU/EEA countries.

2.5 Data extraction

Peer-reviewed literature

Relevant data were extracted from included articles and recorded in a data extraction file (Microsoft Excel). A predefined set of variables covering study characteristics, sampling, laboratory testing, study population details and outcomes was extracted for each study. The complete list of variables is provided in Appendix 3.

The unit for data extraction was study, not article. A study is defined as a report of prevalence and/or incidence data on HBV and/or HCV for a defined population group, in a defined country, over a discrete period of time. Each data point captured per study is referred to as an estimate.

Grey literature

Data on disease prevalence in PWID per country were extracted from the EMCDDA website tables into synoptic tables. Data on prevalence in the general population, pregnant women, people in prison, MSM and migrants were extracted from ECDC systematic reviews into synoptic tables. Data on the undiagnosed fraction per country were extracted from the survey on HBV/HCV testing activities, needs, and priorities in the EU/EEA into a synoptic table. These were the only variables extracted from these data sources.

2.6 Quality assessment

Peer-reviewed literature

The quality of all included articles was assessed using an ad hoc checklist. As none of the included articles concerned studies with designs that can be critically appraised using standard checklists such as those available from SIGN [24], a list of relevant aspects from standard checklists was compiled, which were answered with 'yes' or 'no' for each study:

- The relevance and purpose of the research are clearly described
- The methods used are clearly described and appropriate for the purpose of the research
- The selection of the study population is adequate for the purpose of the research
- Data collection is adequate for the purpose of the research
- The theoretical background is clearly described
- Data are analysed in depth
- Results and conclusions are clearly described
- The study population is clearly described (including, where appropriate, case detection and case definition)
- The population is representative of the source population
- The denominator is chosen appropriately (e.g. in the case of surveillance studies)

Using this checklist, it was not possible to calculate an overall quality score for studies; therefore, all relevant articles were included in the data extraction tables, regardless of their quality and their limitations (checklist items answered with 'no'). However, articles were excluded if the methods and/or results provided an insufficient level of detail making it impossible to accurately extract data. Conclusion remarks from the quality assessment of each included article are reported in the data extraction tables (Appendices 5-10).

Grey literature

No quality assessment on was performed on data extracted from the EMCDDA website and ECDC survey on HBV/HCV testing activities, needs, and priorities in the EU/EEA, as no detailed methodology was available for the extracted data. Records included in the ECDC systematic review on HBV/HCV prevalence in the EU/EEA were evaluated for quality, based on a framework designed to assess the risk of selection bias, to determine the representativeness of the target population and the robustness of provided estimates. The ECDC epidemiological assessment of HBV/HCV among migrants in the EU/EEA included data from systematic reviews that had scored the quality of included studies based on the representativeness for the general population, sample size and year of the study.

2.7 Evidence summary

For the purpose of the analysis, the population groups of interest were categorised based on their level of risk, transmission route and/or vulnerability as follows:

- General population/proxy populations
- Birth cohorts
- Groups potentially at higher risk by transmission route (percutaneous injuries, sexual and intranasal)
- Vulnerable groups and groups with mixed transmission routes

A set of detailed summary tables was developed for each population group of interest, each virus and each outcome (Appendices 5-8). The summary tables contain the following information: study reference, country, study period, sampling approach, study design, population subgroup, study population and sample size, results (prevalence/incidence), critical appraisal and comments. In each table, findings are ordered by country, year of publication and multiple risk category. For HBV, prevalence is defined as HBsAg positivity. For HCV, prevalence is defined as anti-HCV positivity. Positivity to HCV RNA is also presented in the summary tables. If prevalence based on the results of a confirmation test was provided, this figure was included in the table and the unconfirmed result was excluded. The definition of HCV/HBV incidence varied between studies.

Synoptic tables were created per population subgroup, virus and outcome (prevalence/incidence) and are presented in the results section. The synoptic tables contain information on the number of studies which provide data by EU/EEA country and the range of prevalence/incidence estimates per country and the EU/EEA. Available estimates were rounded to one decimal point. Where subgroups with multiple risks were identified within a given population group (e.g. PLHIV: PWID living with HIV, MSM living with HIV, etc.), data were presented in columns per multiple-risk category. When no or limited data (<5 estimates) were found for a given outcome (prevalence/incidence) for a certain subgroup, the results were merely summarised in the text. For migrant studies, prevalence/incidence estimates were grouped by region, based on the global-burden-of-disease approach. For groups with multiple risks, current and former risks were grouped together for simplicity in some cases (e.g. data on PWID in prison include data on former or current PWID and former or current prisoners). Synoptic tables for incidence data show cases per 100 person-years only; estimates measured using other measurement units are shown in the footnotes.

3 Review results

3.1 Systematic literature search

Research question 1

The literature search identified 5 511 unique publications, 539 of which were selected based on title and abstract. Six additional articles were found in reference lists of systematic reviews or were known to experts (Section 3.2). The full text selection of 523 articles (22 were not available in full text) yielded 148 articles eligible for inclusion. A PRISMA flowchart [18] with reasons for exclusion is presented in Appendix 1.

Research question 2

The literature search identified 963 publications, 25 of which were selected based on title and abstract. Three additional articles were found in reference lists of systematic reviews or were known to experts (Section 3.2). Full text selection of 25 articles (three were not available in full text) yielded 14 articles eligible for inclusion. A PRISMA flowchart [18] with reasons for exclusion is presented in Appendix 1.

3.2 Additional data sources

Research question 1

In addition to the systematic literature search, ECDC and project team members identified three articles on birth cohorts that were not identified by the search [25-27]. These were included in the data synthesis. Searching the reference lists of 17 systematic reviews identified by the systematic literature search revealed two extra relevant articles which were included in the data synthesis [28,29]. In addition, one systematic review was identified by experts but did not reference any additional relevant publications [30].

For prevalence data on the general population, pregnant women, MSM, people in prison and migrants, data were extracted from two previous ECDC reviews [19,20]. Prevalence data on PWID were extracted from the EMCDDA website [23]. Data on blood donors were extracted from a recent journal article and a Council of Europe report [21,22].

Research question 2

In addition to the systematic literature search, ECDC and project team members identified one article that contained relevant data on the undiagnosed fraction [31] and was included in the data synthesis. Two articles referred to by excluded articles were screened for relevant data; of these, one was included in the data synthesis; the other one was excluded as it did not contain original data [32,33]. Additionally, data on the undiagnosed fraction were extracted from an ECDC survey on HBV/HCV testing activities [16].

3.3 Prevalence and incidence of HBV and HCV infections

The prevalence and incidence of HBV and HCV is analysed and presented here by population group.

General and proxy populations

The general population was not among the population groups included in the systematic literature search. However, 38 representative prevalence estimates from 15 countries were extracted from the previous systematic review on HBV/HCV prevalence in the EU/EEA [19]. In addition, two proxy populations were included: pregnant women and first-time blood donors. Twenty-five estimates of HBV prevalence and 11 estimates of HCV prevalence in pregnant women were retrieved from the previous ECDC systematic review and were updated with three HBV prevalence estimates and five HCV prevalence estimates from studies identified in the current literature search. Data on first-time blood donors were extracted from two sources [21,22], each contributing 28 and 20 estimates for HBV and HCV, respectively, and presented separately in the tables below.

HBV prevalence ranges per country for the general population, pregnant women and first-time blood donors are shown in Table 8, the ranges of HCV prevalence per country are shown in Table 9. Prevalence of HBV in EU/EEA countries ranged from 0.0 to 7.5% in the general population and from 0.1 to 5.3% in pregnant women. Prevalence of HBV among first-time blood donors was estimated to be approximately 0.2% in the EU/EEA. Prevalence of HCV in EU/EEA countries ranged from 0.0 to 27.6% in the general population and from 0.1 to 1.7% in pregnant women; it was 0.1% in first-time blood donors for the whole EU/EEA. No incidence data were available for any of the three groups.

More detailed information on studies from the systematic literature search can be found in Appendices 5-8.

Table 8. HBV prevalence estimates for the general population, pregnant women and first-time blood donors, per EU/EEA country

	General population[a]		Pregnant women			First-time blood donors	
	N[b]	Estimate/range (%)	N[b]	Estimate/range (%)	Ref	2010-2013[c]	2014[d]
Austria						0.058	0.084
Belgium	3	0.6-0.7				0.094	0.076
Bulgaria			1	2.3	[34]	1.511	
Croatia	2	0.7-2.3				0.106	
Cyprus						0.049	
Czech Republic	1	0.6				0.038	0.042
Denmark			2	0.3	[19]	0.029	0.014
Estonia						0.109	
Finland						0.004	0.007
France	2	0.7-2.2	2	0.2-0.8	[19]	0.054	0.074
Germany	3	0.3-0.7	2	0.5-0.8	[19]	0.112	0.090
Greece	2	3.3-7.5	6	0.0-5.3	[19]		0.531
Hungary	1	0.4				0.200	0.134
Ireland	2	0.1	1	0.2	[19]	0.011	
Italy	10	0.5-5.8	3	0.8-0.9	[19,35]	0.181	0.161
Latvia						0.558	0.376
Lithuania						0.540	
Luxembourg						0.000	
Malta						0.081	0.326
Netherlands	2	0.2-0.7	1	0.4	[19]	0.04[e]	0.031
Norway			1	0.1	[19]	0.037[e]	0.000
Poland	2	0.9-1.1			[19]	0.436	0.218
Portugal						0.135	0.097
Romania	2	4.4-6.2				3.060	
Slovakia	1	1.1	2	2.1-2.3	[19]	0.074	0.056
Slovenia						0.101	
Spain	4	0.0-0.7	3	0.1-0.9	[19]	0.183	0.143
Sweden						0.033[e]	0.039
UK	1	1.7	4	0.3-1.4	[19,36]	0.039	0.032
EU/EEA	38	0.0-7.5	28	0.1-5.3		0.228	

[a] Extracted from ECDC systematic review on hepatitis B and C prevalence in the EU/EEA [19]
[b] Number of included estimates
[c] Adapted from Lieshout-Krikke et al., 2016 [21]
[d] Adapted from Table 7.2, Council of Europe report, 2014 [22]
[e] Prevalence in newly registered blood donors, pre-donation

Table 9. HCV prevalence per country for the general population, pregnant women and first-time blood donors, per EU/EEA country

	General population[a]		Pregnant women			First-time blood donors	
	N[b]	Estimate/range (%)	N[b]	Estimate/range (%)	Ref	2010-2013[c]	2014[d]
Austria			1	1.7	[19]	0.029	0.011
Belgium	1	0.1				0.039	0.027
Bulgaria						0.253	
Croatia	2	0.0-0.9				0.065	
Cyprus						0.024	
Czech Republic						0.070	0.193
Denmark						0.012	0.009
Estonia						0.505	
Finland						0.034	0.021
France	2	0.8-0.9				0.026	0.036
Germany	3	0.3-1.0				0.050	0.052
Greece	1	2.2	1	1.3	[19]		0.124
Hungary	1	0.5				0.212	0.134
Ireland	1	0.1	2	0.7-0.9	[19]	0.004	
Italy	14	0.6-27.6	3	0.4-0.9	[19]	0.090	0.077
Latvia	1	2.4				1.670	1.321

	General population[a]		Pregnant women			First-time blood donors	
	N[b]	Estimate/range (%)	N[b]	Estimate/range (%)	Ref	2010-2013[c]	2014[d]
Lithuania	1	2.9				1.425	
Luxembourg						0.078	
Malta						0.046	0.109
Netherlands	3	0.1-1.1	1	0.3	[19]	0.014[e]	0.024
Norway			1	0.9	[19]	0.043[e]	0.025
Poland	3	0.9-2.9	1	0.8	[27]	0.314	0.231
Portugal						0.161	0.058
Romania	1	3.2				0.557	
Slovakia	1	2				0.043	0.006
Slovenia			2	0.1	[19,37]	0.025	
Spain	4	0.4-1.5	1	0.2	[19]	0.102	0.075
Sweden						0.042[e]	0.029
UK	2	0.4-1.2	3	0.1-0.5	[36,38,39]	0.034	0.019
EU/EEA	41	0.0-27.6	16	0.1-1.7		0.128	

[a] *Extracted from ECDC systematic review on hepatitis B and C prevalence in the EU/EEA [19]*
[b] *Number of included estimates*
[c] *Adapted from Lieshout-Krikke et al., 2016 [21]*
[d] *Adapted from Table 7.2, Council of Europe report, 2014 [22]*
[e] *Prevalence in newly registered blood donors, pre-donation*

Birth cohorts

Three articles reporting on the prevalence of HCV in birth cohorts were identified by ECDC and the project team (i.e. not part of the systematic search). One article reported the prevalence of HCV in the Czech Republic for four age categories (between 18 and 60+ years); prevalence ranged between 0.23% (in the age group 60+ years) and 3.58% (in the 30–44-year age group). HCV prevalence was <1% for the following age groups: 45–59 and 60+ years, between 1 and 2% for the age group 18–29 years, and >2% for the age group 30–44 years [25].

An article from Poland reported the prevalence of HCV in seven age groups ranging between 15 and 64 years of age. Prevalence ranged between 1.2% (for the age group 25–34 years) and 2.9% (45–54 years of age). HCV prevalence was between 1 and 2% for the following age groups: 15–24, 25–34 and 35–44 years of age. The age groups 45–54 and 55–64 years had a prevalence of >2% [27].

A third article reported on prevalence of HCV in Spain in fourteen different age categories. Prevalence was lowest in people born after 1990 (0.9%) and highest in people born between 1961 and 1965 (14.5%). HCV prevalence was <1% for people born after 1990; prevalence was between 1 and 2% for people born between 1986 and 1990, and >2% for people born before 1930, and in each five-year cohort between 1930 and 1986 [26]. See also Table 10.

No articles were identified reporting prevalence of HBV by birth cohorts or reporting incidence of either HCV or HBV by birth cohorts.

More detailed information on each study from which estimates have been extracted can be found in the summary tables, Appendices 5-8.

Table 10. Age groups/birth cohorts by HCV prevalence range and country

Country, reference	HCV prevalence Age group (years)/birth cohort		
	<1%	1%-2%	>2%
Czech Republic [25]	45-59 60+	18-29	30-40
Poland [27]		15-24 25-34 35-44	45-54 55-64
Spain [26]	After 1990	1986-1990	Before 1930 1931-1935 1936-1940 1941-1945 1946-1950 1951-1955 1956-1960 1961-1965 1966-1970 1971-1975 1976-1980 1981-1985

Population groups characterised by common HBV/HCV transmission routes

Transmission via percutaneous injuries and iatrogenic transmission

People who inject drugs

Estimates of HBV and HCV prevalence among PWID were obtained from the EMCDDA website [23] for a total of 39 HBV prevalence estimates from 17 EU/EEA countries and 67 HCV prevalence estimates from 22 countries. In addition, 36 prevalence or incidence estimates among PWID were identified in the systematic literature search.

Four HBV prevalence estimates and 18 HCV prevalence estimates among PWID who belong to multiple-risk groups were retrieved in the literature search; these included PWID living with HIV (three for HBV, eight for HCV), PWID in prison (one for HBV, five for HCV), homeless PWID (three for HCV), MSM PWID (one for HCV) and PWID sex workers (one for HCV). Prevalence estimates of HBV and HCV among PWID are presented by country and by risk category in Tables 11 and 12, respectively. Prevalence of HBV ranged from 0.0 to 12.5% among PWID across the EU/EEA: prevalence in PWID living with HIV ranged from 7.5 to 20.6%, while it was 1.4% in a study on PWID in prison. Prevalence of HCV was between 7 and 95.4% in PWID, and between 38.3 and 98% in PWID living with HIV. PWID in prison had a prevalence range from 22.5 to 86%. A study on PWID MSM reported a prevalence of 22.1%. Other prevalence data came from homeless PWID (34.7–69.9%) and PWID sex workers (84.4%).

Fourteen HCV incidence estimates were retrieved by the systematic literature search; 11 in PWID, one in PWID living with HIV and two in PWID in prison. HCV incidence estimates for PWID are presented in Table 13. Incidence of HCV ranged from 2 to 52.9 cases per 100 person-years in PWID; it was 7.2 cases per 100 person-years in PWID living with HIV, and 6.7 cases per 100 person-years in PWID in prison. Only one estimate on HBV incidence was retrieved: 3.36 cases per 100 person-years in PWID in Sweden [40].

For more information on included studies, please refer to Appendices 5-8.

Table 11. HBV prevalence among PWID, by EU/EEA country and risk category

	PWID[a]		PWID living with HIV			PWID in prison		
Belgium	2	1.9-5.6						
Bulgaria	2	3.58-9.84	1	20.6	[41]			
Croatia	1	0						
Czech Republic								
Denmark								
Estonia	2	4-5.7						
France	1	0.81	1	7.5	[42]			
Germany	2	0.3-1.52						
Greece	14	0-6.61						
Hungary	4	0-2.24				1	1.4	[29]
Ireland	1	0.5						
Italy								
Lithuania	1	10.5						
Netherlands	2	6.7-12.5						
Norway	1	0.88						
Poland	2	2.5-3.77						
Portugal	1	7						
Romania	1	10.53						
Slovenia								
Spain	1	11	1	7.8	[43]			
Sweden	1	1.38						
UK								
EU/EEA	39	0-12.5	3	7.5-20.6		1	1.4	

[a] *Source: EMCDDA website [23]*
[b] *Number of included estimates*

Table 12. HCV prevalence among PWID, by EU/EEA country and risk category

	PWID[a]		PWID living with HIV			PWID in prison			PWID MSM			Homeless PWID			PWID Sex workers		
	N[b]	Estimate/range (%)	N[b]	Estimate/range (%)	Ref	N[b]	Estimate/range (%)	Ref	N[b]	Estimate/range (%)	Ref	N[b]	Estimate/range (%)	Ref	N[b]	Estimate/range (%)	Ref
Belgium	2	7-75.2															
Bulgaria	2	61.6-78.57	1	87.4	[41]												
Croatia	2	27.1-38.31															

	PWID[a]		PWID living with HIV			PWID in prison			PWID MSM			Homeless PWID			PWID Sex workers		
	N[b]	Estimate/range (%)	N[b]	Estimate/range (%)	Ref	N[b]	Estimate/range (%)	Ref	N[b]	Estimate/range (%)	Ref	N[b]	Estimate/range (%)	Ref	N[b]	Estimate/range (%)	Ref
Czech Republic	1	15.74															
Denmark	1	52.5															
Estonia	2	61.3-90.18															
France	1	63.83	1	92.8	[42]												
Germany	8	36.92-73.02															
Greece	14	30-90.32															
Hungary	7	11.49-55.3				1	22.5	[29]									
Ireland	1	41.5															
Italy	4	54.1-70.97				1	74.7	[44]									
Lithuania	2	27.59-77															
Netherlands	2	55-67.44															
Norway	2	60.16-78.85				1	86	[45]									
Poland	2	44.3-72.38	1	97.7	[46]												
Portugal	1	83.5															
Romania	1	75.67															
Slovenia	1	42.7															
Spain	1	66.6	2	89.5-91.4	[43,47]	1	84.9	[48]				1	69.9	[48]	1	84.4	[48]
Sweden	2	55.7-95.4	1	98	[49]												
UK	8	22.31-64.05	2	38.3-83.7	[50,51]	1	49.3	[52]	1	22.1	[50]	2	34.7-67	[52,53]			
EU/EEA	67	7-95.4	8	38.3-98		5	22.5-86		1	22.1		3	34.7-69.9		1	84.4	

[a] Source: EMCDDA website [23]
[b] Number of included estimates

Table 13. HCV incidence among PWID, by EU/EEA country and risk category, cases per 100 person-years

	PWID			PWID living with HIV			PWID in prison		
	N*	Estimate/range	Ref	N*	Estimate/range	Ref	N*	Estimate/range	Ref
Ireland	1	24.5	[54]						
Italy				1	7.2	[55]			
Netherlands	1	2	[56]						
Spain	2	25.1-52.9	[48,57]				1	6.7	[58]
Sweden	1	38.3	[40]						
UK	6[a]	4-47	[52,53,59-62]				1[b]		[63]
EU/EEA	11	2-52.9		1	7.2		2	6.7	

[a] A study from the UK provided an incidence estimate of 3.0% per year [60]
[b] A study from the UK provided an incidence estimate of 2.0–2.9% [63]
** Number of included estimates*

Population groups at risk of nosocomial and iatrogenic transmission

The systematic literature search returned a total of 70 estimates of prevalence or incidence in subgroups potentially at risk of nosocomial and iatrogenic transmission of HBV/HCV. These included dialysis/haemodialysis patients (seven estimates on HBV, 21 on HCV), healthcare workers (four on HBV, 12 on HCV), diabetes mellitus patients (three on HBV, eight on HCV), recipients of SoHO (four on HBV, eight on HCV) and recipients of (unspecified) medical/dental procedures (four on HCV). HBV and HCV estimates were available from seven and twelve EU/EEA countries, respectively.

Data on HBV and HCV prevalence (17 estimates of HBV prevalence and 44 estimates of HCV prevalence) are presented in Tables 14 and 15, respectively. Prevalence of HBV ranged from 1.88 to 11.7% among dialysis/haemodialysis patients, from 2 to 9.8% among recipients of SoHO, from 0.4 to 1.63% among diabetes patients, and from 0.6 to 2.2% among healthcare workers. Prevalence of HCV ranged from 3.3 to 39.3% among dialysis/haemodialysis patients, from 8.9 to 11.3% among recipients of medical/dental procedures, from 2 to 95.4% among recipients of SoHO, from 0.7 to 9.2% among diabetes patients, and from 0.8 to 6.4% among healthcare workers.

Data on HCV incidence (nine estimates) are presented in Table 16. Incidence of HCV ranged from 2.4 to 6.2 cases per 100 person-years and between 0 and 2.6% per year among haemodialysis patients, 0 cases per 100 person-years among medical/dental procedure recipients, and 0 cases per 100 person-years in healthcare workers. Only one study presented an estimate of HBV incidence in one of these groups; in the UK, HBV incidence was reportedly 0% in haemodialysis patients [64].

More detailed information on each included study can be found in the summary tables below, Appendices 5-8.

Table 14. HBV prevalence in population groups at risk for nosocomial and iatrogenic transmission by EU/EEA country

	Haemodialysis patients			Recipients of SoHO				Diabetes patients			Healthcare workers	
France				1[b]	5.9	[42]	1	0.7	[65]			
Greece	1	5.5	[66]	1[c]	2	[67]						
Italy	1	1.88	[68]	1[d]	4	[69]	1	1.63	[70]			
Lithuania	1	11.7	[71]									
Poland				1	9.8	[72]				3[e]	0.6-1.2	[73-75]
Romania	2	7.91-9.5	[76]							1	2.2	[77]
Spain	1[a]	7.8	[43]				1	0.4	[78]			
EU/EEA	6	1.88-11.7		4	2-9.8		3	0.4-1.63		4	0.6-2.2	

[a] *HIV+ haemodialysis patients*
[b] *HIV+ haemophiliacs*
[c] *Cardiac surgery patients who received blood units*
[d] *Patients with inherited bleeding disorders treated before 1986*
[e] *Includes one study in which sample includes administrative workers (prevalence 0.6%)*
** Number of included estimates*

Table 15. HCV prevalence in population groups at risk of nosocomial and iatrogenic transmission by EU/EEA country

	Haemodialysis recipients			Recipients of medical/dental procedures			Recipients of SoHO			Diabetes patients			Healthcare workers		
	N*	Estimate/range (%)	Ref	N*	Estimate/range (%)	Ref	N*	Estimate/range (%)	Ref	N*	Estimate/range (%)	Ref	N*	Estimate/range (%)	Ref
France	2	7.7-16.3	[79,80]	1[a]	9.2	[65]	2[d]	8.2-47.1	[42,65]	3[g]	2.1-9.2	[65]			
Germany	2	3.6-5.2	[81,82]	1[b]	11.3	[83]									
Greece	2	24-29	[66,84]				2[e]	2-54.2	[67,85]						
Italy	2	15.1-18.8	[68,86]	1[c]	8.9	[87]	4[f]	35.5-95.4	[69,88]	1	5.9	[70]	2[h]	3-6.4	[89,90]
Netherlands													1[i]	1.4	[91]
Poland													7[j]	0.8-1.7	[73-75,92-94]
Lithuania	1	12.5	[71]												
Romania	2	27.3-39.3	[76,77]							2	4.5-7.7	[95]	1	1.07	[77]
Spain	2	5.7-6.2	[96]							1	3.4	[78]			
Sweden										1	0.7	[97]			
UK	1	3.3	[98]												
EU/EEA	14	3.3-39.3		3	8.9-11.3		8	2-95.4		8	0.7-9.2		11	0.8-6.4	

[a] *Diabetes patients who had surgery, endoscopy or other invasive procedures*
[b] *Persons who received cardiac surgery as infants before 1991*
[c] *Family members of HCV+ persons who had dental procedures*
[d] *Includes one study in diabetes patients who had blood transfusions (prevalence: 8.7%) and one study in HIV+ recipients of blood transfusions (prevalence: 47.1%)*
[e] *Includes one study in cardiac surgery patients who received blood units (prevalence: 2%)*
[f] *Includes one study in patients with inherited bleeding disorders treated before 1986 (prevalence: 95.4%)*
[g] *Includes one study in diabetes patients who had blood transfusions (prevalence: 8.2%) and one study in diabetes patients who had medical procedures (prevalence: 9.2%)*
[h] *Includes one study on healthcare workers with high risk of exposure (prevalence: 3%)*
[i] *EPP-performing healthcare workers*
[j] *Includes one study in which the sample includes administrative personnel (prevalence: 1.7%)*
** Number of included estimates*

Table 16. HCV incidence in population groups at risk of nosocomial and iatrogenic transmission by EU/EEA country, cases per 100 person-years

	Haemodialysis recipients			Recipients of medical/dental procedures			Healthcare workers		
	N*	Estimate/range	Ref	N*	Estimate/range	Ref	N*	Estimate/range	Ref
France	2[a]		[79,99]						
Germany	1[b]		[82]						
Greece	1	6.2	[84]						
Italy	1	2.5	[86]	1[d]	0	[100]	1	0	[89]
UK	2[c]		[64,98]						
EU/EEA	7	2.4-6.2		1	0		1	0	

[a] *Two studies reported incidence of 0% per year and 0.4% per year [79,99]*
[b] *One study reported incidence of 0% per year [82]*

[c] Two studies reported incidence in haemodialysis patients who travelled of 0% and 2.6% [64,98]
[d] Endoscopy patients
** Number of included estimates*

Other groups with exposure to percutaneous injuries

Other groups with potential exposure to contaminated needles or other sharp objects for which estimates were retrieved by the systematic literature search included waste collection workers (four estimates for HBV, two for HCV), persons with tattoos/piercings (one HBV, one HCV) and anabolic steroid users (one for HCV). Data on HBV and HCV were available for three and four EU/EEA countries, respectively.

Data on HBV and HCV prevalence (five HBV estimates and five HCV estimates) are summarised in Tables 17 and 18, respectively. Prevalence of HBV was 0.7% among people with tattoos/piercings; among waste collection workers, prevalence ranged from 2% to 11.3%. Prevalence of HCV in EU/EEA countries was 0.2% among people with tattoos/piercings, between 2% and 2.4% among waste collection workers, and 2% among anabolic steroid users. No studies reporting data on incidence were identified.

More detailed information on each included study can be found in the summary tables (Appendices 5–8).

Table 17. HBV prevalence in population groups at risk of transmission via contaminated needles or other sharp objects, by EU/EEA country and category

	People with tattoos/piercings			Waste collection workers		
	N*	Estimate/range (%)	Ref	N*	Estimate/range (%)	Ref
Greece				3	2-11.3	[101-103]
Italy				1	3.98	[104]
Netherlands	1	0.7	[105]			
EU/EEA	1	0.7		4	2-11.3	

** Number of included estimates*

Table 18. HCV prevalence in population groups at risk of transmission via contaminated needles, by EU/EEA country and category

	People with tattoos/piercings			Waste collection workers			Anabolic steroid users		
	N*	Estimate/range (%)	Ref	N*	Estimate/range (%)	Ref	N*	Estimate/range (%)	Ref
Greece				1	2	[103]			
Italy				1	2.4	[104]			
Netherlands	1	0.2	[105]						
UK							1	2	[106]
EU/EEA	1	0.2		2	2-2.4		1	2	

** Number of included estimates*

Sexual transmission

Men who have sex with men

Seventeen estimates from seven countries on HBV/HCV prevalence in MSM were extracted from the previous systematic review on hepatitis B and C prevalence in the EU/EEA [19] and updated with the present systematic review to include prevalence data from 2015 onwards, incidence data and data in MSM who belong to multiple-risk groups. Thirty-eight estimates were retrieved from the systematic literature search, providing data on HBV from eight EU/EEA countries and data on HCV from 11 countries.

Twelve estimates were retrieved on HBV prevalence, including seven estimates on MSM and five on MSM living with HIV. HBV prevalence per country is presented in Table 19. Prevalence of HBV ranged from 0.0% to 1.4% among MSM, and from 1.7 to 17.2% among MSM living with HIV. Twenty-eight estimates were retrieved on HCV prevalence, including 11 on MSM, 16 on MSM living with HIV, and one on PWID MSM. HCV prevalence per country is presented in table 20. Prevalence of HCV among MSM ranged from 0.0 to 4.7%; prevalence was between 0.88 and 25% among MSM living with HIV and 22.1% in one study among PWID MSM.

Four estimates were retrieved on HBV incidence, one on MSM, and three on MSM living with HIV. Thirteen estimates of HCV incidence were found, including two on MSM and eleven on MSM living with HIV. Incidence estimates for HBV and HCV in MSM are presented in Tables 21 and 22, respectively. Incidence of HBV was 0.047% per year in one study in MSM, and ranged from 1.1 to 2.5 cases per 100 person-years among MSM living with HIV. HCV incidence ranged from 0.1 to 0.2 cases per 100 person-years among MSM and from 0.7 to 2.4 cases per 100 person-years among MSM living with HIV.

More detailed information on each included study can be found in Appendices 5–8.

Table 19. HBV prevalence among MSM, by EU/EEA country and risk category

	MSM			MSM living with HIV		
	N*	Estimate/range (%)	Ref	N*	Estimate/range (%)	Ref
Bulgaria				1	8.4	[41]
Croatia	1	0.6	[19]			
Denmark	1	1.4	[107]			
Estonia	2	0.0-1.0	[19]			
France	1	1.4	[19]	1	9.2	[42]
Germany				1	1.7	[108]
Greece				1	17.2	[109]
Spain				1	5.8	[43]
UK	2	0.0-1.0	[19]			
EU/EEA	7	0.0-1.4		5	1.7-17.2	

** Number of included estimates*

Table 20. HCV prevalence among MSM, by EU/EEA country and risk category

	MSM			MSM living with HIV			PWID MSM		
Bulgaria				1	3	[41]			
Croatia	2	2.5-2.9	[19]						
Denmark				1	4	[110]			
Estonia	2	1.8-4.7	[19]						
France	1	1	[19]	1	3.1	[42]			
Germany				1	8.2	[108]			
Greece				1	8.6	[109]			
Italy	1	0	[19]						
Netherlands	2	0.7-1.3	[19]	5[a]	6.4-25	[111-114]			
Spain				2	3.5-4.3	[43,47]			
Sweden	1	0.6	[19]	1	3.7	[49]			
UK	2	1.6-2.1	[19]	3	0.88-7.2	[28,51,115]	1[b]	22.1	[50]
EU/EEA	11	0.0-4.7		16	0.88-25		1	22.1	

[a] Including one study on MSM sex workers living with HIV (prevalence: 13%) and one study on MSM with chlamydia living with HIV (prevalence: 25%)
[b] Homosexual male PWID
** Number of included estimates*

Table 21. Incidence of HBV in MSM per country, cases per 100 person-years

	MSM			MSM living with HIV		
	N*	Estimate/range	Ref	N*	Estimate/range	Ref
Germany				1	2.5	[108]
Italy				1	1.7	[116]
Netherlands	1[a]		[117]	1	1.1	[118]
EU/EEA	1			3	1.1-2.5	

[a] A study from the Netherlands provided an estimate of 0.047% per year [117]
** Number of included estimates*

Table 22. Incidence of HCV in MSM per country, cases per 100 person-years

	MSM			MSM living with HIV		
	N*	Estimate/range	Ref	N*	Estimate/range	Ref
Belgium				1[a]	1.4	[119]
Denmark				1[b]		[120]
France				1[c]		[121]
Germany				1	1.5	[108]
Italy				1	0.7	[55]
Netherlands	2	0.1-0.2	[122,123]	2	1.1-2.4	[112,114]
Spain				1	0.8	[124]
UK				3	0.9-1.1	[125-127]
EU/EEA	2	0.1-0.2		11	0.7-2.4	

[a] *An addition study from Belgium provided an estimate of 2.3–2.9% per year [128]*
[b] *A study from Denmark provided an estimate of 0.4% per year [120]*
[c] *A study from France provided an estimate of 0.4% per year [121]*
** Number of included estimates*

Other groups at risk of sexual transmission

Alongside MSM, other groups at risk of sexual transmission for which studies were identified in the systematic literature search included sex workers, persons engaging in high-risk sexual behaviour and STI-infected persons. In total, eleven estimates were retrieved for these groups; five on sex workers, four on high-risk sexual behaviour (which included studies in people with multiple sexual partners, commercial sex workers and their clients and people in prison who had unprotected sex) and two on STI-infected persons. HCV prevalence estimates from five EU/EEA countries and HBV estimates from two EU/EEA countries were included.

Two HBV prevalence estimates were available, both on sex workers, ranging from 0 to 2.5% [107,129]. Nine HCV prevalence estimates were available, including three on sex workers, four on people engaging in high-risk sexual behaviour, and two on STI-infected people. These data are presented in Table 23. The prevalence of HCV ranged from 0 to 13% among sex workers, from 8.5 to 25% among STI-infected individuals, and from 4 to 43.2% among people with high-risk sexual behaviour. No incidence data were retrieved.

More detailed information on each included study can be found in the summary tables, Appendices 5-8.

Table 23. HCV prevalence among population groups at risk of sexual transmission by EU/EEA country and category

	Sex workers			STI-infected individuals			People with high-risk sexual behaviours		
Croatia				1	8.5	[130]	2[c]	4-6.3	[130]
Estonia	1	7.9	[131]						
Hungary							1[d]	4.2	[29]
Italy	1	0	[129]				1[d]	43.2	[44]
Netherlands	1[a]	13	[114]	1[b]	25	[132]			
EU/EEA	3	0-13		2	8.5-25		4	4-43.2	

[a] *MSM sex workers living with HIV*
[b] *MSM with chlamydia living with HIV*
[c] *Includes one study on people with multiple sexual partners (6.3%) and one study on commercial sex workers and their clients (4%)*
[d] *People in prison who had unprotected sex*
** Number of included estimates*

Intranasal transmission

Intranasal drug users

The literature search retrieved four estimates on intranasal drug users. Only one study from France reported an estimate of HBV prevalence of 1.4% [133]. Two estimates, one from Spain and one from France were available on HCV prevalence: 0.9% and 5%, respectively [134,135].

An HCV incidence of three cases per 100 person-years was reported in Spain [136]. No estimates were retrieved for HBV incidence.

More detailed information on each included study can be found in Appendices 5–8.

Vulnerable populations and mixed transmission groups

People living with HIV

The systematic literature search yielded a total of 97 estimates on PLHIV, with and without multiple risks. These provided data on HBV from nine EU/EEA countries and data on HCV from 14 countries. Twenty-four HBV prevalence estimates were retrieved, 11 of which reported on a broad group of PLHIV, five on MSM living with HIV, three on PWID living with HIV, three on PLHIV in prison, one on migrants living with HIV, and one on haemophiliacs living with HIV. These data are presented in Table 24. Prevalence of HBV ranged from 2.9 to 43.4% in broad PLHIV groups, from 1.7 to 17.2% among MSM living with HIV, from 7.5 to 20.6% among PWID living with HIV, from 6.8 to 16.9% among PLHIV in prison; HBV prevalence was estimated at 5.4% among migrants living with HIV and at 5.9% in haemophiliacs living with HIV. Forty-seven prevalence estimates were retrieved, 17 of which were based on a broad group of PLHIV, 16 on MSM living with HIV, eight on PWID living with HIV, four on PLHIV in prison, one on haemophiliacs living with HIV, and one on migrants living with HIV. These data are presented in Table 25. Prevalence of HCV ranged from 1.8 to 71.1% among broad PLHIV groups, from 0.88 to 25% among MSM living with HIV, from 38.3 to 98% among PWID living with HIV, and from 55.9 to 93.5% among PLHIV in prison. HCV prevalence was estimated at 7.7% among migrants living with HIV and 47.1% in haemophiliacs living with HIV.

Eight HBV incidence estimates were retrieved, including four on a broad group of PLHIV, three on MSM living with HIV, and one on STI-infected PLHIV. These data are presented in Table 26. HBV incidence ranged from 0.0 to 2.5 cases per 100 person-years among broad groups of PLHIV, from 1.1 to 2.5 per 100 person-years among MSM living with HIV; among STI-infected PLHIV it was 1.3 per 100 person-years. Eighteen HCV incidence estimates were retrieved, including five on a broad group of PLHIV, twelve on MSM living with HIV and one on PWID living with HIV. This data is presented in table 27. HCV incidence ranged from 0.3 to 0.9 cases per 100 person-years among PLHIV, from 0.7 to 2.4 per person years and 0.4 to 2.9% per year among MSM living with HIV and was 7.2 per 100 person-years among PWID living with HIV.

More detailed information on each included study can be found in Appendices 5-8.

Table 24. HBV prevalence among PLHIV, by EU/EEA country and risk category

	PLHIV			MSM living with HIV			PWID living with HIV			PLHIV in prison			Migrants living with HIV			Haemophiliacs living with HIV	
	N*	Estimate/ range (%)	Ref	N*	Estimate/ range (%)	Ref	N*	Estimate/ range (%)	Ref	N*	Estimate/ range (%)	Ref	N*	Estimate/ range (%)	Ref	N*	Estimate/ range (%)	Ref
Bulgaria	1	10.4	[41]	1	8.4	[41]	1	20.6	[41]	1	16.9	[41]						
Denmark	1	3	[110]															
France	1	7	[42]	1	9.2	[42]	1	7.5	[42]							1	5.9	[42]
Germany				1	1.7	[108]												
Greece	1	12.1	[109]	1	17.2	[109]												
Italy	1	3.7	[137]							2	6.8-8.8	[138,139]						
Netherlands	1	5	[140]															
Romania	1	43.4	[141]															
Spain	3	2.9-5.8	[43,47,142]	1	5.8	[43]	1	7.8	[43]				1	5.4	[143]			
UK	1	5.1	[144]															
EU/EEA	11	2.9-43.4		5	1.7-17.2		3	7.5-20.6		3	6.8-16.9		1	5.4		1	5.9	

** Number of included estimates*

Table 25. HCV prevalence among PLHIV, by EU/EEA country and risk category

	PLHIV			MSM living with HIV			PWID living with HIV			PLHIV in prison			Migrants living with HIV			Haemophiliacs living with HIV	
	N*	Estimate/ range (%)	Ref	N*	Estimate/ range (%)	Ref	N*	Estimate/ range (%)	Ref	N*	Estimate/ range (%)	Ref	N*	Estimate/ range (%)	Ref	N*	Estimate/ range (%)	Ref
Bulgaria	1	25.6	[41]	1	3	[41]	1	87.4	[41]	1	82	[41]						
Denmark	1	7	[110]	1	4	[110]												
France	2	5.7-24.3	[42,145]	1	3.1	[42]	1	92.8	[42]							1	47.1	[42]
Germany				1	8.2	[108]												
Greece	1	8.2	[109]	1	8.6	[109]												
Ireland	1	26	[146]															
Italy	1	40.7	[137]							2	55.9-78.3	[41,138,139]						
Netherlands	1	3.7	[140]	5[a]	10.3-25	[113,114]												
Poland	1	71.1	[140]				1	97.7	[46]	1	93.5	[46]						
Romania	1	1.8	[141]															
Slovenia	1	7.6	[147]															
Spain	4	20.5-61	[43,47, 142,148]	2	3.5-4.3	[43,47]	2	89.5-91.4	[43,47]				1	7.7	[143]			
Sweden	1	14	[49]	1	3.7	[49]	1	98	[49]									

	PLHIV			MSM living with HIV			PWID living with HIV			PLHIV in prison			Migrants living with HIV			Haemophiliacs living with HIV	
	N*	Estimate/range (%)	Ref	N*	Estimate/range (%)	Ref	N*	Estimate/range (%)	Ref	N*	Estimate/range (%)	Ref	N*	Estimate/range (%)	Ref	N*	Estimate/range (%)	Ref
UK	1	8.9	[51]	3	0.88-7.2	[28,51,115]	2	38.3-83.7	[50,51]									
EU/EEA	17	1.8-71.1		16	0.88-25		8	38.3-98		4	55.9-93.5		1	7.7		1	47.1	

[a] *Including one study in MSM with chlamydia living with HIV (prevalence: 25%) and one study in MSM sex workers living with HIV (prevalence: 13%)*
** Number of included estimates*

Table 26. HBV incidence among PLHIV, by EU/EEA country and risk category, cases per 100 person-years

	PLHIV			MSM living with HIV			STI infected PLHIV		
	N*	Estimate/range	Ref	N*	Estimate/range	Ref	N*	Estimate/range	Ref
Denmark	1	0.0	[110]						
Germany				1	2.5	[108]			
Italy	1	1.2	[116]	1	1.7	[116]	1	1.3	[116]
Netherlands				1	1.1	[118]			
Romania	1	2.5	[141]						
UK	1	1.7	[144]						
EU/EEA	4	0.0-2.5		3	1.1-2.5		1	1.3	

** Number of included estimates*

Table 27. HCV incidence among PLHIV, by EU/EEA country and risk category, cases per 100 person-years

	PLHIV			MSM living with HIV			PWID living with HIV		
	N*	Estimate/range	Ref	N*	Estimate/range	Ref	N*	Estimate/range	Ref
Belgium				2[b]	1.4	[119,128]			
Denmark	1	0.3	[110]	1[c]		[120]			
France	1	0.4	[145]	1[d]		[121]			
Germany				1	1.5	[108]			
Italy	1	0.6	[55]	1	0.7	[55]	1	7.2	[55]
Netherlands				2	1.1-2.4	[112,114]			
Spain	1	0.9	[124]	1	0.8	[124]			
UK				3	0.9-1.1	[125,127,149]			
EU/EEA	5[a]	0.3-0.9	[150]	12	0.7-2.4		1	7.2	

[a] *An additional study gives an estimate for an EU/EEA-wide 12-year cumulative incidence of 4.4% [150]*
[b] *An additional study from Belgium provided an estimate of 2.3–2.9% per year [128]*
[c] *A study from Denmark provided an estimate of 0.4% per year [120]*
[d] *A study from France provided an estimate of 0.4% per year [121]*

** Number of included estimates*

People in prison

Fifty-eight estimates on people in prison were extracted from the previous ECDC systematic review on risk groups [19]; 15 on HBV prevalence from 12 EU/EEA countries and 43 on HCV prevalence from 12 EU/EEA countries. These were updated with the present systematic literature search to include prevalence estimates from 2015 onwards; also included were prevalence and incidence estimates among people in prison with multiple risks from 2005 onwards. Twenty-eight estimates were retrieved in the current systematic literature search, including eight on HBV (from four EU/EEA countries) and twenty on HCV (from eight EU/EEA countries).

Twenty-three HBV prevalence estimates were retrieved in total; 16 on a broad group of people in prison, three on PLHIV in prison, one on PWID in prison, two on people in prison with tattoos, and one on people in prison who had unprotected sex. HBV prevalence per country is presented in Table 28. HBV prevalence ranged from 0.0 to 25.2% among people in prison, from 6.8 to 16.9% among PLHIV in prison, from 1.4 to 2.3% among people in prison with tattoos. HBV prevalence was 1.4% among PWID in prison and 1.4% among people in prison who had unprotected sex. Fifty-nine estimates were retrieved on HCV prevalence, including 44 on a broad group of people in prison, five on PWID in prison, four on PLHIV in prison, three on people in prison with tattoos, two on people in prison who had unprotected sex, and one on people in prison who had blood transfusions. HCV prevalence per country is presented in Table 29. HCV prevalence ranged from 1.3 to 86.3% among people in prison, from 55.9 to 93.5% among PLHIV in prison, from 22.5 to 86% among PWID in prison, from 4.5 to 51.2% among people in prison with tattoos, from 4.2 to 43.2% among people in prison who had unprotected sex. HCV prevalence was 48.7% among people in prison who had transfusions.

Four incidence estimates were retrieved, all of which were on HCV. In Spain, the reported incidence was 1.2 cases per 100 person-years in people in prison [58] and 6.7 cases per 100 person-years in people in prison with a history of intravenous drug use [58]. In the UK, the reported incidence was one case per 100 person-years among people in prison [63] and 2.0 to 2.9 cases per 100 person-years among people in prison who inject drugs in prison [63].

More detailed information on each included study can be found in Appendices 5–8.

Table 28. HBV prevalence among people in prison, by EU/EEA country and risk category

	People in prison			PLHIV in prison			PWID in prison			People in prison with tattoos			People in prison who had unprotected sex		
	N*	Estimate/range (%)	Ref	N*	Estimate/range (%)	Ref	N*	Estimate/range (%)	Ref	N*	Estimate/range (%)	Ref	N*	Estimate/range (%)	Ref
Bulgaria	1	25.2	[19]	1	16.9	[41]									
Croatia	3	1.3-1.4	[19]												
Finland	1	0.5	[19]												
France	2	0.6	[19,151]												
Hungary	1	1.5	[19]				1	1.4	[29]	2	1.4-2.3	[29]	1	1.4	[29]
Ireland	1	0.3	[19]												
Italy	1	6.7	[19]	2	6.8-8.8	[138,139]									
Luxembourg	1	7.0	[19]												
Portugal	1	10.8	[19]												
Romania	1	10.7	[19]												
Spain	1	2.6	[19]												
UK	2	0.0-2.0	[19]												
EU/EEA	16	0.0-25.2		3	6.8-16.9		1	1.4		2	1.4-2.3		1	1.4	

** Number of included estimates*

Table 29. HCV prevalence among people in prison by EU/EEA country and risk category

	People in prison			PLHIV in prison			PWID in prison			People in prison with tattoos			People in prison who had unprotected sex			People in prison who had transfusions		
	N*	Estimate /range (%)	Ref	N*	Estimate /range (%)	Ref	N*	Estimate /range (%)	Ref	N*	Estimate /range (%)	Ref	N*	Estimate /range (%)	Ref	N*	Estimate /range (%)	Ref
Bulgaria	3	20.5-28.6	[19]	1	82	[41]												
Croatia	3	4.3-14.2	[19]															
Finland	1	45.8	[19]															
France	8	3.8-6.8	[19,151]															
Germany	4	8.6-84.9	[19]															
Hungary	1	4.9	[19]				1	22.5	[29]	2	4.5-4.6	[29]	1	4.2	[29]			
Ireland	1	12.9	[19]															
Italy	2	37.4-38	[19]	2	55.9-78.3	[139]	1	74.7	[44]	1	51.2	[44]	1	43.2	[44]	1	48.7	[44]
Luxembourg	1	86.3	[19]															
Norway							1	86	[45]									
Poland				1	93.5	[46]												
Portugal	2	10.8-34.4	[19]															
Spain	13	14.7-44.9	[19]				1	84.9										
UK	5	1.3-19.2	[19]				1	49.3	[63]									
EU/EEA	44	1.3-86.3		4	55.9-93.5		5	22.5-86		3	4.5-51.2		2	4.2-43.2		1	48.7	

** Number of included estimates*

Migrants

A total of 210 estimates on prevalence in migrants were extracted from the previous ECDC epidemiological assessment on hepatitis B and C among migrants (110 on HBV prevalence, 100 on HCV prevalence). These were updated in this systematic literature search to include prevalence data from 2015 onwards, incidence data and data in migrants subgroups with multiple risks. Twenty-five estimates were retrieved in the current literature search, all of which were on HBV.

A total of 132 estimates on HBV prevalence in migrants from a range of different countries were retrieved (Table 30). Among first-generation migrants, the prevalence of HBV ranged from 0 to 5.6% among migrants from the east Mediterranean region, from 0 to 5.0% among migrants from south Asia, from 0.3 to 20.0% among migrants from south-east Asia, from 0 to 11.7% among east European migrants, from 0 to 5.6% among Latin American migrants, and from 0 to 22.2% among migrants from sub-Saharan Africa. The prevalence of HBV among second-generation migrants ranged from 0 to 1.0% among migrants from the east Mediterranean region, from 0 to 0.7% among south Asian migrants, from 0 to 6.7% among south-east Asian migrants; it was 1.6% among migrants from sub-Saharan Africa. Among refugees, the prevalence of HBV ranged from 0 to 8.6% among refugees from the east Mediterranean region; it ranged from 1.6 to 53.1% among east European refugees, from 0 to 15% among Latin American refugees, and from 3.3 to 26.7% among refugees from sub-Saharan Africa; it was 0.0% among south Asian refugees and 57.7% among south-east Asian refugees. The prevalence of HBV in pregnant migrants ranged from 0.5 to 0.8% among migrants from south Asia, from 4.3 to 8.19% among migrants from

south-east Asia, from 0.7 to 7.25% among east European migrants, and from 2.9 to 6.1% among migrants from sub-Saharan Africa.

All retrieved HCV prevalence estimates were from the previous review on migrants (Table 31). Prevalence of HCV in first-generation migrants ranged from 0 to 3.0% among migrants from the east Mediterranean region, from 0 to 9.6% among south Asian migrants, from 0.6 to 1.6% among south-east Asian migrants, from 3.1 to 9.3% among east European migrants, from 0 to 10% among Latin American migrants, and from 0 to 19.2% among migrants from sub-Saharan Africa. In second-generation migrants, the prevalence of HCV was 0.0% among migrants from the east Mediterranean region and 0.0% among Latin American migrants. In refugees, the prevalence of HCV among refugees from the east Mediterranean region ranged from 0 to 0.2%, from 0 to 9.1% among south Asian refugees, from 0.2 to 1.3% among east European refugees, and from 0 to 26.7% among refugees from sub-Saharan Africa. In pregnant migrants, the prevalence of HCV ranged from 0 to 0.5% (migrants from the east Mediterranean region); among pregnant migrants from Latin America, HCV prevalence was 0.0%.

Three estimates were retrieved on HBV incidence in migrants. Incidence ranged between 0.004 and 0.0047% per year [152] among first-generation Turkish, Ghanaian and Moroccan migrants residing in Amsterdam, the Netherlands.

More detailed information on each included study can be found in Appendices 5-8.

Table 30. HBV prevalence among migrants, by country of origin and category

	First generation migrants			Second generation migrants			Refugees			Pregnant migrants		
Country of origin	N*	Estimate/range (%)	Ref	N*	Estimate/range (%)	Ref	N*	Estimate/range (%)	Ref	N*	Estimate/range (%)	Ref
East Mediterranean region	**13**	**0-5.6**		**2**	**0-1.0**		**5**	**0-8.6**				
Egypt	2	1.1-2.1	[20,153]									
Iraq	1	0.7	[20]				2	1.4-2.5	[20]			
Iran	1	0.7	[20]									
Morocco	4	0-5.6	[20,153]	1	0	[20]						
Turkey	5[a]	0-4.9	[20]	1	1	[20]	2	3.3-8.6	[20]			
Syria							1	0	[154]			
South Asia	**15**	**0-5.0**		**4**	**0-0.7**		**2**	**0.0-0.0**		**3**	**0.5-0.8**	
Afghanistan	1	2.1	[20]				1	0	[20]			
Bangladesh	4	1.5-5.0	[20]	1	0.2	[20]						
India	3	0-0.1	[20]	1	0	[20]	1	0	[20]	1	0.5	[155]
Pakistan	7	0-4.1	[20,153]	2	0-0.7	[20]				2	0.5-0.8	[20,155]
South-east Asia	**10**	**0.3-20.0**		**2**	**0-6.7**		**1**	**57.7**		**2**	**4.3-8.19**	
China	5[b]	0.3-11.4	[20,153,156]	2	0-6.7	[20]	1	57.7	[20]	2	4.3-8.19	[20,35]
Hong Kong	1	7.8	[20]									
Philippines	1	3.3	[20]									
Vietnam	3	9.5-20.0	[20]									
Eastern Europe	**10**	**0-11.7**					**8**	**1.6-53.1**		**7**	**0.7-7.25**	
Albania	1	11.7	[20]				5	8.8-53.1	[20]	3	5.4-7.71	[20,35]
Former USSR	3	0-5.3	[20]									
Kazakhstan	1	7	[20]									
Macedonia										1	2.11	[35]
Moldova	1	10.7	[153]									
Kosovo							2	1.6-5.8	[20]			
Romania	1	3.7	[153]				1	30.7	[20]	1	1.94	[35]
Russia	2	0-10.3	[20]									
Poland	1	0	[20]							1	0.7	[155]
Ukraine										1	7.25	[35]
Latin America	**14**	**0-5.6**					**3**	**0-15**				
Argentina	1	5.6	[20]									
Bolivia	1	0	[20]									
Brazil	2	0.0-3.3	[20,153]				1	15	[20]			
Chile	1	0	[20]									
Colombia	2	0.0-0.0	[20]				1	0	[20]			
Dominican Republic	1	0	[20]									
Dutch Antilles	1	2.6	[20]									
Ecuador	1	0	[20]									
Haiti	1	0	[20]									
Paraguay	1	0	[20]									
Peru	1	0	[20]				1	0	[20]			
Suriname	1	0	[20]									

	First generation migrants			Second generation migrants			Refugees			Pregnant migrants		
Country of origin	N*	Estimate/range (%)	Ref	N*	Estimate/range (%)	Ref	N*	Estimate/range (%)	Ref	N*	Estimate/range (%)	Ref
Sub-Saharan Africa	**12**	**0-22.2**		**1**	**1.6**		**15**	**3.3-26.7**		**2**	**2.9-6.1**	
Burkina Faso							1	15.8	[20]			
Cape Verde	1	0	[20]									
Equatorial Guinea	1	7.9	[20]									
Eritrea							3	3.3-6.3	[20]			
Ethiopia	1	0	[20]				1	13.2	[20]			
Ghana	1	16.3	[20]				1	26.7	[20]			
Ivory Coast							1	11.8	[20]			
Liberia							2	18.1-26.3	[20]			
Mali							1	13.3	[20]			
Nigeria	1	1.7	[153]				1	8.5	[20]			
Senegal	2	13-22.2	[20,153]							1	6.1	[35]
Sierra Leone	1	15.8	[20]									
Somalia	4[c]	3.6-7.6	[20]	1	1.6	[20]	3	4.2-15.8	[20]	1	2.9	[155]
Sudan							1	22.7	[20]			

[a] Includes one study where FGM status was not reported
[b] Includes one study where FGM status was not reported and one study where first and second generation were mixed
[c] Includes three studies where first- and second-generation migrants were a mixed group
** Number of included estimates*

Table 31. HCV prevalence among migrants, by country of origin and category

	First generation migrants			Second generation migrants			Refugees			Pregnant migrants		
Country of origin	N*	Estimate/range (%)	Ref[c]	N*	Estimate/range (%)	Ref[c]	N*	Estimate/range (%)	Ref[c]	N*	Estimate/range (%)	Ref[c]
East Mediterranean region	**14**	**0-3.0**		**6**	**0.0-0.0**		**2**	**0-0.2**		**4**	**0-0.5**	
Egypt	1	2.4	[20]									
Iraq	1	0.3	[20]				1	0.2	[20]			
Iran	1	0.7	[20]									
Morocco	5	0-3.0	[20]	2	0.0-0.0	[20]				2	0.0-0.0	[20]
Turkey	6	0-0.8	[20]	4	0.0-0.0	[20]	1	0		2	0-0.5	[20]
South Asia	**13**	**0-9.6**		**1**	**0.7**		**2**	**0-9.1**				
Afghanistan	1	1	[20]				1	9.1	[20]			
Bangladesh	3	0-0.6	[20]									
India	3	0-2.9	[20]									
Pakistan	6[a]	0-9.6	[20]	1	0.7	[20]	1	0	[20]			
South-east Asia	**2**	**0.6-1.6**										
Philippines	1	0.6	[20]									
Vietnam	1	1.6	[20]									
Eastern Europe	**4**	**3.1-9.3**					**3**	**0.2-1.3**				
Albania							2	0.2-1.3	[20]			
Former USSR	1	3.1	[20]									
Kazakhstan	1	9.3	[20]									
Kosovo							1	0.6	[20]			
Poland	1	7.1	[20]									
Russia	1	6.9	[20]									
Latin America	**15**	**0-10**		**2**	**0.0-0.0**					**2**	**0.0-0.0**	
Argentina	1	0	[20]									
Bolivia	1	0	[20]									
Brazil	1	0	[20]									
Colombia	1	1.5	[20]									
Cuba	1	10	[20]									
Chile	1	0	[20]									
Dominican Republic	1	0	[20]									
Dutch Antilles	1	2.6	[20]									
Ecuador	1	1.2	[20]									
Paraguay	1	0	[20]									
Peru	1	0	[20]									
Suriname	4	0.0-3.0	[20]	2	0.0-0.0	[20]				2[b]	0.0-0.0	[20]
Sub-Saharan Africa	**4**	**0-19.2**					**8**	**0-26.7**				
Burkina Faso							1	10.5	[20]			
Cameroon	1	4.1	[20]									
Cape Verde	1	0	[20]									

	First generation migrants			Second generation migrants			Refugees			Pregnant migrants		
Country of origin	N*	Estimate/range (%)	Ref[c]	N*	Estimate/range (%)	Ref[c]	N*	Estimate/range (%)	Ref[c]	N*	Estimate/range (%)	Ref[c]
Equatorial Guinea	2	9.8-19.2	[20]									
Eritrea							1	3.3	[20]			
Ghana							1	3.3	[20]			
Ivory Coast							1	5.9	[20]			
Mali							1	26.7	[20]			
Nigeria							1	6.1	[20]			
Somalia							2	0-0.2	[20]			

[a] *Includes one study where first- and second-generation migrants were a mixed group*
[b] *Includes one study where pregnant women were second-generation migrants*
[c] *Source: [20]*
** Number of included estimates*

Family, household and sexual partners

Twenty estimates on family, household or sexual partners of HBV/HCV infected family members were retrieved in the systematic literature search; two on HBV prevalence (from two different EU/EEA countries) and 18 on HCV prevalence (from five different EU/EEA countries). No incidence estimates were retrieved.

Both HBV prevalence estimates were based on family members of persons chronically infected with HBV (HBsAg+); prevalence was reported at 5.7% in a study from the Czech Republic and at 15.8% in a study from Greece [157,158]. For HCV prevalence, twelve estimates were retrieved on infants of mothers with chronic hepatitis C, five estimates were on family members of people with chronic hepatitis C, and one estimate was on sexual partners of infected persons (Table 32). The prevalence of HCV ranged from 2.4 to 10.9% among infants of mothers with chronic hepatitis C, including three studies on infants of HIV/HCV-coinfected mothers (range: 3.2–10.9%), two studies on infants of mothers with chronic hepatitis C who also injected drugs (range: 5.9–6.3%). HCV prevalence ranged from 2.1 to 9.8% in family members of people with chronic hepatitis C. In one study on sexual partners of people with chronic hepatitis C, HCV prevalence was 13.8%.

More detailed information can be found in Appendices 5–8.

Table 32. HCV prevalence in family/household/sexual partners of HCV-positive persons, by EU/EEA country

	Infants of HCV+ mothers			Family members of HCV+ persons			Sexual partners of HCV+ persons		
	N*	Estimate/range (%)	Ref	N*	Estimate/range (%)	Ref	N*	Estimate/range (%)	Ref
France	3[a]	5.6-10.9	[159]						
Ireland	1	4.1	[160]						
Italy	1	7.3	[161]	5[d]	2.1-9.8	[87,162]	1	13.8	[162]
Portugal	1	2.7	[163]						
Spain	3[b]	2.4-3.2	[164,165]						
EU/EEA	12[c]	2.4-10.9		5	2.1-9.8		1	13.8	

[a] *Includes one study on infants of HCV+/HIV+ mothers (prevalence: 10.9%) and one study on HCV+ PWID mothers (prevalence: 5.9%)*
[b] *Includes one study on infants of HCV+/HIV+ mothers (prevalence: 3.2%)*
[c] *In addition, three studies provided estimates for the entire EU/EEA: one on infants of HCV+ mothers (prevalence: 6.2%) [166], one study on infants of HCV+/HIV+ mothers (prevalence: 8.7%) [166] and one study on HCV+ PWID mothers (prevalence: 6.3%) [166]*
[d] *Includes the following: family members who have travelled abroad (prevalence: 9.8%), family members who had had dental procedures (prevalence: 8.9%), family members (prevalence: 6%), offspring (prevalence: 2.3%) and parents and siblings (prevalence: 2.1%)*
** Number of included estimates*

Other vulnerable populations/mixed exposure groups

Other groups for which estimates were retrieved in the literature search include transgender (two estimates), homeless (four estimates), travellers (one estimate) and public safety workers (six estimates).

Three HBV prevalence estimates were retrieved for public safety workers, and one was retrieved for transgender people and travellers each. These data are summarised in Table 33. Prevalence of HBV ranged from 0 to 2.9% among public safety workers, was 4.5% among transgender people and 5.86% among travellers. Three HCV prevalence estimates were retrieved for public safety workers, four for homeless people and one for transgender people (Table 34). Prevalence of HCV ranged from 10.1 to 69.9% among homeless people; three of which were among homeless PWID and ranged from 34.7% to 69.9% and from 0 to 0.5% among public safety workers; HCV prevalence in transgender people was 4.5%.

No studies with incidence data for HBV or HCV were identified.

More detailed information on each included study can be found in Appendices 5-8.

Table 33. HBV prevalence among other risk groups, by EU/EEA country

	Transgender			Travellers			Public safety workers		
	N*	Estimate/range (%)	Ref	N*	Estimate/range (%)	Ref	N*	Estimate/range (%)	Ref
Croatia							2[a]	0-2.9	[167]
France				1	5.86	[168]			
Hungary							1[a]	0.4	[29]
Italy	1	4.5	[169]						
EU/EEA	1	4.5		1	5.86		3	0-2.9	

[a] *Prison staff*
** Number of included estimates*

Table 34. HCV prevalence among other risk groups, by EU/EEA country

	Transgender			Homeless			Public safety workers		
	N*	Estimate/range (%)	Ref	N*	Estimate/range (%)	Ref	N*	Estimate/range (%)	Ref
Croatia							2[b]	0-0	[167]
France				1	10.1	[170]			
Hungary							1[b]	0.5	[29]
Italy	1	4.5	[169]						
Spain				1[a]	69.9	[48]			
UK				2[a]	34.7-67	[52,53]			
EU/EEA	1	4.5		4	10.1-69.9		3	0-0.5	

[a] *Homeless PWID*
[b] *Prison staff*
** Number of included estimates*

3.4 Undiagnosed fraction

In total, 26 estimates of the undiagnosed fraction were retrieved from the systematic literature search (18 estimates) and an ECDC survey that was included as part of the grey literature (eight estimates). Fourteen estimates were retrieved for the undiagnosed fraction of HBV cases, providing estimates for eight EU/EEA countries; twelve estimates were retrieved for the undiagnosed fraction of HCV cases, providing estimates for eight EU/EEA countries.

Ten estimates on HBV included the general population or a proxy. Proxy populations included people who had blood sampled and tested prior to orthopaedic interventions or during an emergency room visit. The proportion of cases unaware of their infection ranged between 40% and 85% (Table 35). Four other estimates were on migrants. Three estimates were on Chinese, British Chinese and British Asian people, all living in the UK. The proportion of cases unaware of their infection ranged from 70 to 100%. The fourth estimate was on pregnant migrants from countries with intermediate/high-HBV prevalence living in Italy, with an undiagnosed fraction of 56.7%.

Eleven estimates on HCV included the general population or a proxy. The proportion of HCV cases unaware of their infection ranged between 20 and 91.2% (Table 35). One other study from the UK provided an estimate for the undiagnosed proportion of PWID of 59%. One study from the UK did not find any HCV-positive cases among Chinese migrants and could therefore not provide an estimate of the undiagnosed proportion.

The estimates were retrieved from a diverse range of sources, including screening surveys (16 estimates), modelling studies (eight estimates) and expert opinions (three estimates).

More detailed information on each included study can be found in Appendices 9 and 10.

Table 35. Undiagnosed proportion of HBV and HCV cases in the general population or proxy populations, by EU/EEA country

	HBV	HCV
Denmark	50% [Expert opinion, 2013] [16] 67% [Modelling, 2007] [171]	20% [Expert opinion, 2013] [16] 46% [Modelling, 2012] [172]
France	55% [Screening, 2004] [33]	43% [Screening, 2004] [33]
Germany	85% [Screening, 2013] [173]	65% [Screening, 2013] [173] 22% [Screening, 2010] [174]
Greece	50% [Modelling, 2012] [175] 83% [Screening, 2006] [176]	81% [Modelling, 2012] [175] 91.2% [Screening, 2006] [176]

	HBV	HCV
Italy	40% [Screening, 2009] [177]	
Ireland		50-67% [Expert opinion, 2014] [16]
Netherlands	80% [Screening, 2007] [178]	
Poland		78% [Screening, 2015] [16] 89% [Modelling, 2016] [179]
Scotland	45% [Modelling, 2014] [16]	43% [Modelling, 2014] [16]

4 Discussion

Two systematic reviews were undertaken to collect, assess and collate prevalence and incidence data on HBV and HCV in selected population groups. Data were also collected on the proportion of infected people who are unaware of their infection. In addition, a review and comparative analysis of existing national and supranational viral hepatitis testing guidelines, guidance documents and other relevant policy documents was undertaken to identify population subgroups that may be at risk of HBV/HCV or have a high burden of viral hepatitis.

For the first review, 148 studies on HBV/HCV prevalence and incidence were retrieved from searches in bibliographic databases and additional sources; various grey literature sources provided additional estimates. For the second review, 14 studies and one survey with data on the undiagnosed fraction were retrieved. The retrieved estimates were analysed by country and by population group, including general population, proxy populations and population at risk of HBV/HCV transmission and/or at high burden of disease. Prevalence ranges across the EU/EEA were obtained for each population group, with the aim to provide public health experts in the Member States with strategic information to guide the identification of target groups for HBV and HCV testing initiatives.

General population, proxy populations and birth cohorts

Despite the call for elimination of viral hepatitis by 2030 and a target for the reduction of undiagnosed chronic HCV and HBV cases [14], robust epidemiological data to support monitoring progress in this plan are lacking for many EU/EEA countries. This is particularly relevant with respect to HBV and HCV prevalence estimates in the general population. A previous ECDC systematic review produced a range of estimates for EU/EEA countries, despite the heterogeneity of the source data [18]. This review confirms the previous considerations on low/lower prevalence among proxy populations such as blood donors and pregnant women, with the exception of pregnant women with a migration background, who may be at increased risk of infection, depending on the underlying prevalence in the country of origin, and pregnant women from risk groups (e.g. PWID). Antenatal screening, at least for HBV, may be of great relevance among these groups, as suggested in a recent ECDC guidance [180].

This review retrieved very limited data on the HCV burden experienced by certain birth cohorts. For example, prevalence by age group or birth cohort was explored in three countries; findings were indicative of a higher prevalence of HCV infection in certain age groups, but with variability across countries. Further investigation of the extent of this phenomenon and its relevance in each EU/EEA country may be warranted to inform subsequent HCV testing interventions, following the example of the US [181].

Expanding testing opportunities among the general population may be needed to reduce the undiagnosed fraction in the EU/EEA. Despite the limited number of studies, the findings from this review point towards a substantial proportion of undiagnosed chronically infected people in the EU/EEA, albeit with large variability between countries. The estimated undiagnosed fraction of HBV cases in the general population or proxy populations ranged from 40% in Italy to 85% in Germany. The estimated undiagnosed fraction among Chinese, British Chinese, British Asian migrants and pregnant migrants ranged between 57 and 100%. The estimated fraction of HCV cases that are undiagnosed in the general or proxy populations ranged between 20% in Denmark and 91.2% in Greece. In PWID, one study estimated the undiagnosed fraction at 59% of cases. The methods for estimating the undiagnosed fraction varied widely; some estimates were based on expert opinion, others on modelling studies and others on screening studies. Selection bias may have a large impact on the accuracy of the estimate in screening studies. For example, community-based testing offers are likely to target people unaware of their infection and will likely overestimate the undiagnosed fraction. In general, the findings of this report are in line with a modelling study by Razavi et al. [182] that estimated the overall proportion of undiagnosed HCV cases in the EU/EEA at 64%.

Population groups likely to be at higher risk or with a high burden of disease across the EU/EEA

A recently released WHO testing guidance for hepatitis B and C proposes a 2% threshold for intermediate HBV/HCV prevalence, above which testing scale-up is recommended. This systematic review identified the following population groups as having HBV prevalence estimates above the 2% threshold across all studies (excluding outliers): dialysis/haemodialysis patients, PLHIV and PLHIV with multiple risks (MSM living with HIV, PWID living with HIV, and PLHIV in prison). These groups are likely to be at a high risk of HBV and/or have a high burden of disease throughout the EU/EEA and may benefit from expanded testing opportunities.

For HCV, the following population groups were above the 2% threshold (excluding outliers) with regard to HCV prevalence estimates retrieved in this review: PWID, PWID with multiple risks (PWID in prison, PWID living with HIV, and homeless PWID), dialysis/haemodialysis patients, recipients of SoHO, diabetics, people in prison, people in prison with multiple risks (PWID in prison, PLHIV in prison), PLHIV, PLHIV with multiple risks (PWID living with

HIV, MSM living with HIV, PLHIV in prison), infants of mothers with chronic hepatitis C, and family members of people with chronic hepatitis C. These groups are likely to be at a high risk of HCV and/or have a high burden of disease throughout the EU/EEA and may benefit from expanded testing opportunities.

More groups likely to be at high risk were identified for HCV than HBV. This is partly due to the fact that for many groups, few HBsAg prevalence studies were retrieved. In certain groups, this may be due to wide vaccination coverage, e.g. in healthcare workers. In addition, the data for HBV prevalence are more heterogeneous for some key groups which were identified as likely HCV risk groups, indicating that the group may be only at risk in certain regions or under certain conditions (e.g. groups with multiple risks).

According to the findings of this review, two of the groups most commonly targeted for HBV testing in the retrieved guidelines, PWID and MSM (see Appendix 11), were not characterised by an intermediate prevalence of chronic HBV infection. People in these groups may be at higher risk of acquiring HBV infection, but have a small chance of developing chronic infection if they acquire the infection at an older age. On the contrary, PLHIV and haemodialysis recipients were identified as a target group for HBV testing by less than a third of the included guidelines. For HCV, there is more concurrence between the target groups commonly identified by retrieved testing guidelines and the findings of this review. However, less than half of guidelines indicated that haemodialysis patients, PLHIV, or family members of people with chronic hepatitis C were at risk; diabetes patients were not mentioned at all.

Population groups with heterogenous patterns of risk and/or burden of disease across the EU/EEA

Population groups for which HBV prevalence data were more heterogeneous and varied from country to country or between studies conducted in the same country include PWID, MSM and people in prison. For PWID, 39 prevalence estimates were available, ranging from 0 to 12.5% throughout the EU/EEA. Several studies reported prevalence estimates for PWID that were in line with estimates of general population prevalence in that country, however, many studies (from Belgium, Bulgaria, Estonia, Germany, Greece, Hungary, Lithuania, the Netherlands, Poland, Portugal, Romania, Spain and Sweden) reported prevalence figures that were higher. Differences in prevalence reported between studies may be partly due to differences in the composition of the study population, e.g. the proportion of PWID who have ever been imprisoned or who are infected with HIV, whether former injecting drug users were included, or vaccination policies in different countries were taken into account. Three studies conducted in PWID living with HIV reported high prevalence, indicating that certain populations of particularly vulnerable PWID may be at high risk. There is a marked difference in the prevalence of HBsAg and anti-HCV reported in this group. This could be explained by vaccination or the fact that the risk of developing chronic HBV is relatively low compared with developing HCV through injecting drug use [183], as the risk of developing chronic HBV is highly age dependent. However, the markers are not equivalent because HBsAg is a marker of current HBV infection and anti-HCV is a marker of ever having been infected. Seven studies reported HBsAg prevalence data in MSM; in all cases this was lower than 2%. However, two studies reported prevalence at 1.4% which is likely to be higher than the prevalence in the general population for those countries, i.e. Denmark and France. The relatively few studies in this group could indicate that MSM are less researched as an HBV risk group. Much higher prevalence figures were reported in studies on MSM living with HIV; these ranged from 1.7 to 17.2%. For people in prison, 16 prevalence estimates were available, ranging between 0 and 25.2% (entire EU/EEA). Although many studies reported rather high prevalence figures for Bulgaria, Italy, Luxembourg, Portugal and Romania, five estimates were in line with the prevalence in the general population for any given country. Differences in prevalence estimates between studies may be due to variations in the demographic composition of the study populations, for example the proportion of PWID, PLHIV or prisoners born in foreign countries. HBV vaccination policies in different countries or prisons may also influence prevalence figures. There may be a lot of variation in prevalence between prisons: several studies reported regional data or received data only from one detention centre. Of the guidelines retrieved in the comparative analysis, 35% listed people in prison as a target group for testing.

Population groups for which anti-HCV prevalence data were heterogeneous and varied between countries or studies include MSM and healthcare workers. For MSM, eleven studies reported prevalence figures ranging from 0 to 4.7% across the EU/EEA. Most studies reported prevalence figures which were higher than the expected prevalence in the general population; however, three studies reported prevalence figures which are probably more in line with the expected prevalence in the general population. In general, the reported prevalence figures were higher than those reported for HBsAg. The reported prevalence figures in MSM infected with HIV were much higher than in MSM, so variation in reported prevalence in total MSM populations may be partly due to differences in the proportion of HIV+ MSM in MSM study populations. MSM were described as a target group for testing by 13% of the retrieved guidelines. For healthcare workers, 11 studies reported anti-HCV prevalence ranging between 0.8 and 6.4%. Although a few of the studies reported prevalence figures which appeared to be higher than what would be expected in the general population, study populations in these studies may not have been representative. For example, the highest HCV prevalence reported (6.4%) was measured in Naples, an area of Italy known to be endemic for HCV [184]; a study reporting a prevalence of 1.3% in the Netherlands was conducted in healthcare

workers performing exposure-prone procedures. Healthcare workers were listed as a target group for HCV testing in 29% of the retrieved guidelines.

Another group with a wide variety of reported HBsAg and anti-HCV prevalence is migrants [19]. As expected, prevalence estimates were generally higher for first-generation migrants and refugees than second-generation migrants. Second generation migrants generally showed low prevalence figures which may be in line with the prevalence in the general population in their country of residence. Prevalence reported in first-generation migrants, refugees and pregnant migrants were generally higher in migrants from south-east Asian, east European and sub-Saharan African countries, more heterogeneous in migrants from the east Mediterranean region and Latin America, and generally lower in south Asian migrants. Similarly, anti-HCV prevalence was low in all studies in second-generation migrants, and heterogeneous in first-generation migrants, refugees and pregnant migrants, with migrants from east European and sub-Saharan African countries having the highest reported prevalence.

Population groups for which limited or no evidence was found

For some population groups, few prevalence estimates were retrieved (i.e. less than five), making it difficult to assess whether they are likely to be at risk or have a high burden of disease. The groups for which fewer than five studies were available with prevalence data for HBV and/or HCV are: anabolic steroid users, recipients of tattoos/piercings, recipients of medical/dental interventions, waste collection workers, sex workers, people with STI, people engaging in high-risk sexual behaviour, people who are already are infected with HBV or HCV, transgender people, homeless people, travellers, and public safety workers.

In some cases, the few studies that were performed for a group indicated that a high prevalence may indeed be present within certain groups – for example two of the three studies performed in sex workers reported high prevalence of anti-HCV [114,131], but more data are needed to determine the actual risk status.

For certain population groups from Table 1 no evidence was retrieved. These include: tattoo or piercing artists, recipients of acupuncture or mesotherapy, sexual partners of PWID, sexual assault victims, people in care homes or institutionalised people, and intellectually disabled people. A lack of studies in this area may suggest that these groups are not widely considered to be important risk groups (in general or specifically in the EU/EEA), but this may also be due to other factors such as the relative size of the group in the population (i.e. niche groups) or the ethical and practical challenges in conducting studies in certain hard-to-reach population groups (e.g. sex workers).

Fewer than 25% of the retrieved guidelines defined these groups as a target for testing, except for recipients of tattoos or piercings: 38% of guidelines saw this groups as a priority group for HCV testing; incidentally, half of the guidelines also specified tattoos or piercings received in unregulated or unhygienic settings as a reason for testing.

Limitations

The comparability of data was limited by the large degree of heterogeneity between studies and population groups. For example, PWID populations differed widely among studies in whether the population included former injectors, or whether they were recruited from the streets, from needle exchange programmes or specialist addiction treatment facilities. For nosocomial risk groups, study populations differed in the proportion treated before measures to prevent exposure to blood-borne virus became routine practise. For HBV prevalence studies, the vaccinated proportion of a population varied between studies and was often not mentioned. Another source of variation were the testing methods such as laboratory test type and whether the result was confirmed by a second test. Differences between studies with regard to HBV/HCV prevalence or incidence can at least partly be explained by these factors. A direct comparison between studies is therefore not possible. For this reason, grouped data in synoptic tables were presented as ranges and no weighted or pooled average was calculated.

Due to the design of the included studies, it was not possible to do a formal quality assessment. All studies were of observational design and could be divided in prospective and retrospective studies, cross-sectional studies and surveillance studies. No internationally agreed tool for measuring the quality of these types of studies is available [185]. It was therefore not possible to assign an overall quality score per study. Instead, a list of quality criteria was compiled. The evidence tables list which criteria were not satisfied per study. Although studies were not excluded based on the list of criteria, four studies were excluded because the methodology was too unclear or limited to allow for accurate data extraction. The most common quality issues with the included studies were the following: samples were not always representative for the population under study, serology methods were not always reported, and selection of the participants was not always clearly described. Based on this assessment, high-quality prevalence estimates from representative study populations are not available for many target populations and countries. Many estimates were based on local, rather than national data. For these reasons, all retrieved studies reporting on a given population group were included in the analysis and no analytical algorithm was defined.

For the first research question, a pre-defined list of populations potentially at high risk of HBV/HCV or with high burden of diseases was used. The list was based on a comparative guideline analysis, as well as input from ECDC and the project team. It is possible that certain population groups at risk were missed using this approach. Similarly, some population groups may have overlapping risks beyond the mixed risk categories that were defined for the purpose of the analysis (e.g. sex workers have a high rate of injecting drug use), resulting in over-estimation of the disease prevalence. Two bibliographic databases were chosen which would yield the vast majority of relevant original data articles on this topic. During a sensitivity analysis, the search strings did retrieve key articles from a WHO guideline on testing [11]. Furthermore, the reference lists of systematic reviews retrieved during the search were checked for possibly relevant articles missed by the search. This was the case for only two of the 148 included articles. Three articles on birth cohorts were identified by ECDC or the project team as they were not retrieved by the search, indicating that for this group the search string was not sufficiently sensitive. For the systematic review on the undiagnosed fraction it was hard to construct a search string to find data on undiagnosed fraction, because these results are often not listed in the abstract, but instead are reported in the results section of the article. It was not possible to perform a sensitivity analysis of the search strings for this review. To overcome this challenge, during the data extraction for the first review, attention was paid to whether data on undiagnosed fraction was provided. Furthermore, ECDC and members of the project team added articles with data on undiagnosed fraction. There were a few instances where it was not possible to obtain the full text of a number of articles selected on the basis of title and abstract, even after contacting authors. Therefore, some potentially relevant data may have been missed.

For some population groups, stricter exclusion criteria were enforced and an algorithm for study inclusion was applied. A large number of studies were available on PLHIV, including a number of large, multicentre studies. These studies were considered more likely to give an accurate estimate of national prevalence in this risk group, only these multicentre studies were included. When no representative studies existed for a country, all studies were included. For studies on haemodialysis patients, only multicentre studies were included because prevalence estimates from single centres can be strongly influenced by local outbreaks and hygiene practices in individual centres. For multiple risk groups, inclusion was limited to studies with a sample size of more than 50 subjects because many studies on single-risk groups, e.g. PLHIV, also reported prevalence for all relevant subgroups, e.g. PWID living with HIV or diabetics living with HIV. While this might have resulted in loss of data, the included estimates were considered more likely to be representative of the study populations. An exception was made, however, for multiple-risk groups which were considered relevant and may be relatively rare in generally populations, e.g. transgender people and sex workers.

Grey literature or other data sources were used to retrieve data for certain groups such as the general population, PWID or blood donors, for whom reliable data were already available, allowing the search to be focused on other potential risk groups. Estimates for the prevalence in the general population were taken from a previous systematic review on prevalence [19]. For data on prevalence in first-time blood donors, two sources were used [21,22]. Both studies report as a limitation the lack of data on how confirmatory testing was performed across the EU/EEA. The methodology of the two studies differs in the covered time period (four-year average prevalence vs. one-year prevalence) [21,22] and the number and type of the included reporting institutions. They also report prevalence differently, either by first time donations [21] or by first-time donors [22]. Lieshout-Krikke et al. combined data from national competent authorities and blood establishments while Rautmann et al. present data from blood establishments reporting directly to the Council of Europe. Differences between the two sources of blood donor data can partially explain the variation in reported prevalence; some variation, however, can be due to trends. Poland, for example, reported a decrease in HBV prevalence between 2010 and 2013 [21] that appears to continue in 2014. Another factor responsible for differences between the two studies is the very low absolute number of positive donors for some countries, e.g. Malta. Data on prevalence in PWID was collected from the EMCDDA website [23]. The website lists the main limitations of EMCDDA's data collection approach: variation in the sampling approach (e.g. participants from drug treatment, low-threshold, prisons, etc.), which may lead to variations in the target group; and defining PWID as 'ever injectors' or 'current injectors'. A survey on hepatitis testing in the EU/EEA was referred to for data on the undiagnosed fraction [16]. The survey had a number of limitations which may have affected the validity of the results: respondents reported that the survey was challenging to complete, it was only available in English, and more than a third of EU/EEA countries did not respond.

Although data on HBV DNA and HCV RNA prevalence were also extracted, this was reported by few studies and was therefore not analysed in this report. Incidence data were only found for a few groups, and comparability between studies was limited by the use of different units to express incidence. No incidence data were available for the general population which made it impossible to compare incidence rates in risk groups. Therefore, incidence data were not considered during data analysis.

5 Conclusions

The scope of this project was to identify the population groups at increased risk and/or with a high burden of hepatitis B and C within the framework of developing an evidence-based public health guidance on testing for viral hepatitis in the EU/EEA. These population groups may need to be targeted and/or prioritised for HBV/HCV testing.

A systematic review of the literature was performed to identify, collate, and assess available evidence on HBV and HCV incidence and prevalence in selected population groups. A qualitative approach was applied to compare the prevalence data gathered for each population group with the prevalence reported for the general population and/or proxy populations in that country, and against the intermediate HBV/HCV prevalence threshold of 2% as suggested by the latest WHO guidance [2].

For HBV, the following populations were deemed likely to be at higher risk of disease or have a high disease burden across the EU/EEA: dialysis/haemodialysis patients, PLHIV and PLHIV with multiple risks (MSM living with HIV, PWID living with HIV, PLHIV in prison). For HCV, these populations were: PWID, people in prison, PLHIV and PLHIV with multiple risks (PWID in prison, PWID living with HIV, homeless PWID, PLHIV in prison, MSM living with HIV), dialysis/haemodialysis patients, recipients of SoHO, diabetics, infants of mothers with chronic hepatitis C and other family members of people with chronic HCV. Populations that were identified as possibly at risk of HBV in certain regions or under certain circumstances are: PWID, MSM, people in prison and migrants. For HCV, these populations were: MSM, healthcare workers and migrants. For other population groups, data were insufficient to identify risk groups. Incidence data were very sparse and limited to certain population subgroups, such as MSM and PLHIV, and largely focused on HCV. The available evidence indicates transmission among MSM, PLHIV and people in prison, while HCV incidence among dialysis/haemodialysis patients at significant levels was reported only in older studies.

The literature search for estimates of the undiagnosed fraction yielded very limited findings. The undiagnosed proportion of people infected with HBV and HBV was generally high among the general population in countries throughout the EU/EEA, suggesting widespread underdiagnosis. Based on these findings, it is advisable to scale up testing coverage, at least for population groups at higher risk or with a higher burden of HBV or HCV in order to achieve the WHO global goal of eliminating viral hepatitis. The European regional targets calls for diagnosing 50% of all people with chronic HBV/HCV by 2020 and 90% by 2030 [14].

The findings presented in this report will be integrated into a European guidance for HBV and HCV testing. This guidance is intended to support EU/EEA countries in the development of national guidelines and in the design and scale-up of testing interventions.

6 Next steps

The results and conclusions of this review will be incorporated into an evidence-based public health guidance on testing for viral hepatitis in the EU/EEA, intended to support EU/EEA Member States in their efforts to scale up hepatitis testing programmes.

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