### Hepatitis C prevalence in England remains low and varies by ethnicity: an updated evidence synthesis

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Background: Previous evidence synthesis estimates of Hepatitis C Virus (HCV) in England did not consider excess HCV risk in ethnic minority populations. We incorporate new information on HCV risk among non-injectors by ethnic group, and additional information on injecting prevalence in order to generate new and updated estimates of HCV prevalence risk in England for 2005. Methods: Bayesian evidence synthesis was used to combine multiple sources of data that directly or indirectly provide information on the populations at risk, or prevalence of HCV infection. HCV data were modelled by region, age group and sex as well as ethnicity for never-injectors and by injecting status (ex and current). Results: Overall HCV antibody prevalence in England was estimated at 0.67% [95% credible interval (95% CrI): 0.54–0.81] for those aged 15–59 years, or 203 000 (153 000, 260 000) individuals. HCV prevalence in never-injectors remains low, even after accounting for ethnicity, with a prevalence of 0.56% (95% CrI 0.42–0.72) in those of white/other ethnicity and 0.68% (0.59–0.78) in black/other ethnicity and 1.76% (1.32–2.28) in South Asians. Estimates are similar to 2003, although patterns of injecting drug use are different, with an older population of current injecting drug users and lower estimated numbers of ex-injectors, but higher HCV prevalence. Conclusions: Incorporating updated information, including data on ethnicity and improved data on injecting status, gave similar overall estimates of HCV prevalence in England. Further information on HCV in South Asians and natural history of injecting are required to reduce uncertainty of estimates. This method may be applied to other countries and settings.

### Introduction

Multiple parameter evidence synthesis (MPES) explicitly links (through a series of parameters and equations) all available information in order to derive evidence-based estimates; and provides an opportunity to test the consistency of information between different sources.¹ The approach is particularly appropriate when there is uncertainty and complexity in the evidence base. Estimating the prevalence of individuals with antibodies to hepatitis C virus (HCV; henceforward HCV prevalence) is complex as hepatitis C infection is asymptomatic for most of its long incubation time;² injecting drug users (IDUs), who are at greatest risk of infection, are difficult to study and monitor due to the illicit nature of drug injection;³,⁴ and there are no representative population surveys available that can provide unbiased estimates of HCV prevalence. The magnitude of the HCV burden has previously been the subject of debate, with estimates for England ranging from 1 million individuals with antibodies to HCV.⁵,⁶ Sweeting and De Angelis⁷,⁸ used an MPES approach that combined available information on risk group sizes and HCV prevalence, estimating an overall HCV prevalence of 0.60% (95% CrI 0.39–0.97) in England and Wales in 2003. The population was divided into current, ex- and never-injector groups, with approximately 72 000 HCV-infected current IDUs, 89 000 ex-IDUs (not injected in the last year) and 28 000 never-injectors. Further debate, however, has centred on whether these estimates adequately account for the potential excess risk in people who have migrated from higher prevalence countries who were not detected in routine laboratory surveillance.⁹

There are over two million people of Indian, Pakistani and Bangladeshi descent living in England today,¹⁰ many of whom have migrated from areas with relatively high HCV prevalence. In 1999, WHO estimates of HCV prevalence in India, Bangladesh and Pakistan were 1.8, 2.4 and 2.4%, respectively,¹¹ and those born in the UK may retain close contact with migrants or travel frequently to such areas. It is, therefore, postulated that there may be a substantial HCV burden among those of South Asian descent, similar to the high prevalence of hepatitis B in migrants from endemic countries,⁶,¹³ although there is little published evidence to support this.¹⁴

To plan treatment services and targeting of diagnostic efforts, up-to-date estimates of HCV prevalence in England are required with a focus on these ethnic groups. In this article, we update and extend the previous evidence synthesis in two important ways. First, we incorporate new information on the prevalence of injecting drug use (for all regions in England). Second, two sources of information on the HCV prevalence among Indian, Pakistani and Bangladeshi ethnic groups are included: prevalence by ethnic group among blood donors, and from a community-based screening study among South Asians.

### Methods

Data sources provide information on risk group sizes (i.e. prevalence of current/ex-IDUs) or HCV prevalence within risk groups. Briefly, prevalence of current IDUs is estimated from a capture-recapture (CRC) study (described below) and prevalence of current and ex-IDUs from household surveys.¹⁵–¹⁹ Data on population size in England in 2005 by region, age, gender and ethnicity were obtained from the Office for National Statistics (ONS).¹⁰,²⁰ Data sources on HCV prevalence include unlinked anonymous testing of IDUs in contact with specialist services;¹⁰ those attending sexually transmitted infection (STI) clinics and antenatal/neonatal clinics,²²–²⁴ blood donors and a community screening survey in those of South Asian origin.²⁵ The community screening study has detailed information on ethnicity and time of arrival in the UK (if born overseas), and the blood donor data have information on ethnicity but no length of stay information. No other studies provided
information on ethnicity. Updated data sources are described in Web Appendix S1 of Supplementary Data and new data are described below.

CRC methods are used to estimate the size of an unknown population by analysing the level of overlap of different lists; and interactions between these data sources and other covariates may be included to improve the estimates. In this case, four sources were used to assess the size of the IDU population with data on those in contact with: (i) probation service; (ii) Drug Intervention Programme (DIP) in prisons; (iii) drug treatment services; and (iv) DIP in the community. More detailed descriptions are available in Hay et al. These data have been more recently analysed by King et al., using methods previously applied to Scottish data. These updated analyses included covariates for age and sex, fully explored interactions between covariates and data sources, and incorporated model uncertainty into the estimates. Therefore, these results have been used to provide information on the number of current IDUs in England.

Data on population size for ethnic groups were by age and gender, and region and gender. Estimates of ethnic group sizes by UK born/time of arrival in the UK were provided on request by the ONS, based on the Annual Population Survey. These sources were combined to obtain group sizes by region, age, sex, ethnicity and UK born/time of arrival in the UK.

Data from a community-based screening study carried out in five areas (East London, West London, Walsall, Sandwell and Bradford) during 2007/2008 were used to estimate HCV prevalence in South Asians. Recruitment was through community and religious centres, selected because of their large South Asian communities who have migrated from India, Pakistan and Bangladesh. The authors of the study hypothesized that HCV prevalence was likely to be lower in people who volunteered for testing; making information from this study potentially biased.

**Evidence synthesis**

The English population was grouped by region (London, the North West and rest of England), sex and age (15–24, 25–34, 35–44, 45–59 years). Prevalence in those aged >60 was estimated for South Asians via the community screening study, and a small study in the general population. The number of current IDUs was informed directly by the CRC estimates, with the household surveys providing additional information on the age distribution (the CRC estimates having a combined 25–59 group). The number of ex-IDUs was informed by the household studies. The rest of the English population form the never-injector groups, which were subdivided by ethnicity (Indian, Pakistani, Bangladeshi and white/other) and by length of stay (UK born, >15, 5–15, <5 years). Data on HCV prevalence were combined with group sizes to estimate the number of HCV-infected individuals within each group. Information from Micallef et al. on the proportion of those with HCV antibodies that spontaneously resolve HCV infection was incorporated to estimate the number of chronically infected individuals.

The basic method is complicated by data that only provide information indirectly, due to potential bias, consisting of a mixture of groups or via inter-relationships with other data. Technical details are available from Web Appendix S2 of Supplementary Data, and previous evidence synthesis.

**Modelling HCV prevalence in never-injectors by ethnic group**

HCV data for never-injectors were modelled via the following logistic model:

-logit(\[\hat{p}_{l,\text{age},a}\]) = \beta_0 + \beta_1 l + \beta_2 e + \beta_3 r + \beta_4 a + \beta_5 s

where \(l\) is region, \(e\) is ethnicity, \(r\) is age group and \(s\) is sex. These were determined by the levels of each covariate \(l\), \(e\), \(r\), \(a\) and \(s\), these being assumed to have no interaction due to insufficient data to estimate such effects.

Blood donor data were assumed to represent a population less likely to be HCV positive. However, the interpretation of data on South Asian blood donors is uncertain, potentially being subject to the same bias as non-South Asian, differential bias or none. There is also uncertainty regarding the community screening study, hypothesized to under-represent HCV-infected individuals, and it is possible that these data should be modelled as biased. As there were only two data sources with ethnicity information, only one bias may be estimated and we therefore investigated two scenarios. In Model 1, data on South Asian blood donors were assumed to have the same bias as non-South Asians and the community screening was assumed to be biased. This bias is not constrained to be positive or negative, so the study is allowed to over-estimate or under-estimate prevalence. In Model 2, data on South Asian blood donors were assumed to have a different bias to other donors and the community screening data was assumed to be unbiased. The main results use Model 2, as the community screening study has more information than the blood donor data, which does not have length of UK stay.

**Bayesian modelling**

Evidence synthesis involves the formulation of a complex model accommodating multiple sources of data. This may be naturally achieved in a Bayesian framework, which combines sample information with prior information to produce posterior distributions of the quantities of interest. In our case, non-informative priors were used where possible; for instance, Gaussian N(0, 10^3) for regression parameters, and Uniform(0,1) distributions for proportions where data informed a mixture of risk groups (Web Appendix S2 in Supplementary Data).

Our model was implemented in WinBUGS, which derives posterior distributions via Markov chain Monte Carlo (MCMC) simulation (full-model code is available in Web Appendix S3 of Supplementary Data). Medians of the posterior distributions and 2.5 and 97.5% percentiles were taken as point estimates and 95% credible intervals (95% CrIs), respectively. Results were on the basis of 25 000 samples from two chains running in parallel, following a 5000 iteration "burn in" period. Convergence was assessed using the Gelman-Rubin diagnostic.

**Results**

**Risk group sizes**

Table 1 summarizes results on the estimated proportion of current IDUs and ex-IDUs in the English population. The proportion of ex-IDUs is higher than current IDUs; and the proportion of both current and ex-IDUs is higher in London and the North West, in males, and the 25–34 age group. From these estimates, and using the 2005 population data, the estimated number of current and ex-IDUs was 198 000 (95% CrI: 178 000–218 000) and 292 000 (130 000–558 000), respectively (table 1).

**HCV prevalence**

Table 2 presents results on HCV antibody prevalence. Overall, HCV prevalence in England was estimated to be 0.67% (0.50–0.94) for those aged 15–59 years. Including those >60 years, overall prevalence was estimated at 0.54% (0.40–0.75), although there were very little data on the >60s and results should be interpreted with caution. Current IDUs had the highest prevalence at 45% (41–49), with higher prevalence in London and the North West, and increasing with age. HCV prevalence in ex-IDUs was 30% (25–35), and followed a similar pattern to current IDUs. For both current and ex-IDUs, males and females had a similar prevalence [posterior probability that HCV higher in females [Pr (F > M)] : 0.270 and 0.488 for current and ex-IDUs, respectively].

HCV antibody prevalence was 0.05% (0.03–0.10) in white/other ethnicity never-injectors, with higher prevalence in London and older age groups, although the 35–44 and 45–59 groups were similar. Unlike IDUs, males had a higher risk than females [Pr (F > M) < 0.001]. For South Asian never-injectors, prevalence was 0.76% (0.48–1.23) and highest in the North West. Prevalence increased with age in the 15–24,
25–34 and 35–44 groups, but was lower in those aged 45–59 years. Males had a higher risk than females \( \Pr (F > M) < 0.001 \).

HCV antibody prevalence estimates combined with population sizes give a total of 203 000 (153 000–286 000) individuals with HCV antibodies aged 15–59 years in England. Of these, using information from Micallef et al.,30 150 000 (113 000–226 000) were estimated to have chronic HCV infection in 2005 in England, with 44% attributable to current IDUs, 43% to ex-IDUs, 7.3% to white/other ethnicity never-injectors and 5.6% to South Asian never-injectors. Figure 1 displays the posterior distribution of the number of chronic infections stratified by risk group, portraying the uncertainty associated with the estimation.

HCV in the South Asian population

Prevalence of HCV antibodies was highest in Pakistanis at 1.91% (1.24–3.10) and low in Indians and Bangladeshis [0.27% (0.06–0.78) and 0.32 (0.09–0.86), respectively]. Those migrating recently had a 5-fold increased risk of HCV infection compared with UK born, resulting in a significant proportion of the estimated cases attributable to recent migrants. Detailed results by individual ethnicity and length of UK stay/UK born are available in Web Appendix S4 of Supplementary Data.

Estimation of HCV antibody prevalence in the South Asian population was dependent on model assumptions. When the community screening data were assumed to be unbiased (Model 2), the number of HCV-infected South Asians aged 15–59 years was estimated to be 11 400 (7300–18 700) (table 3). Conversely, if the community screening data were assumed biased and blood donor data were assumed to be subject to equal bias for South Asian and non-South Asians (Model 1), the estimate was more than halved at 5300 (2300–10 200).

Discussion

Key findings

In this article, we provide updated evidence synthesis estimates of the number of HCV-infected individuals in England in 2005, which specifically address HCV risk among different ethnic groups, incorporate comprehensive estimates of the numbers of IDUs, and update and extend earlier estimates from 2003.8 We estimate that the total number of people
aged 15–59 years who had been infected with HCV in 2005 was 203,000 (153,000–286,000).

The South Asian population increased annually by 3–4% between 2001 and 2007, and constitute ≈5% of the English population. Despite relatively low numbers, we estimate that South Asians comprise nearly half of HCV infections among never-injectors (table 3). However, accounting for higher prevalence in South Asians has not resulted in increased estimates of HCV prevalence in never-injectors compared with previous analyses, despite speculation among collaborators that not accounting for a population with potentially high prevalence may have underestimated HCV prevalence. The higher HCV prevalence in South Asians has been balanced out to some extent by a lower estimate of HCV in other never-injectors: HCV prevalence has decreased over time in blood donors and STI clinic attendees, although to a lesser extent in antenatal screening (Harris R.J. et al., manuscript in preparation).

The risk of HCV among Indians and Bangladeshis was low compared with Pakistanis. In the community screening study, a large proportion of HCV-infected individuals were migrant Pakistanis; and therefore the results reflect this with the bulk of the HCV prevalence attributed to these groups. The authors noted that in the population studied, the prevalence of antibodies to HCV and Hepatitis B in those migrating from India was far lower than that in the country of origin, a phenomenon not in accordance with similar studies of Hepatitis B in the USA and France.

Overall, estimated prevalence of HCV in those aged 15–59 years in England was similar to results for England and Wales in 2003; although patterns of prevalence by risk group are different. The new CRC estimates provide information on the IDU prevalence outside of London, previously informed by the household surveys, and indicate a higher average age of current IDUs than previously estimated. This is of course compatible with an ageing injecting population, which has been age-corrected by sex and age group.
observed. As older IDUs tend to have injected for longer, increased age is associated with higher HCV prevalence; therefore, overall HCV prevalence in IDUs is higher in the current analysis, with 45% (41–49) in current IDUs and 30% (25–35) in ex-IDUs [previously 33% (29–37) and 20% (17–23), respectively]. However, estimated HCV prevalence in IDUs is generally higher than before, mainly driven by recent increases in HCV prevalence in the unlinked anonymous data, which persists even after accounting for age. The proportion of the population that are HCV infected from those that have never injected drugs is low, but 10-fold higher in the South Asian population compared with those of white/other ethnicity. Overall prevalence is ~0.67%, but an older population of current IDUs with higher HCV prevalence was observed in this analysis compared to 2003.

These estimates may be used to assess whether case finding among South Asian populations would be cost effective. Increased levels of treatment are required for older IDUs that are HCV infected and at higher risk of end stage liver disease.

Strengths and limitations

Information on the number of ex-IDUs is uncertain, and this propagates to the overall population estimates of HCV prevalence. This is a key limitation of the estimates, and more empirical data are required on the natural history of injecting as the number of ex-IDUs is highly dependent on injecting duration data. Data on >60 s is also sparse; however, most infections in IDUs occur in those aged 20–30 years, and there will be relatively few infected during the surge in injecting drug use in the 1980s that will fall into the >60 age group. Other limitations in this study include the lack of information to test the consistency of some data sources; in particular, results for South Asians are highly influenced by assumptions of likely bias. The community screening study was thought to potentially underestimate HCV prevalence in South Asians; but if a bias term is incorporated, the study in fact appears to overestimate prevalence. However, this is on the assumption that there is no differential bias for the South Asian blood donors, which may be unreasonable as risk factors for exclusion in blood donors (IDU, men who have sex with men) may be different in reality. It is likely that estimates of HCV prevalence from both studies are biased in some way; however, without a third data source, possible biases cannot be investigated in both simultaneously. Finally, the CRC estimates of current IDUs were obtained independently of the evidence synthesis model, whereas it would be more appropriate to incorporate CRC estimation within the evidence synthesis. This will be investigated in future updates when data become available.

The methods used here provide a robust picture of HCV prevalence in England, based on all available data. Other attempts to estimate HCV prevalence have used data from population based studies, which may not accurately capture the IDU population. In England, HCV data are based on opportunistic testing, which may under- or over-represent IDUs depending on the characteristics of the group being studied. We therefore advocate an evidence synthesis approach, which simultaneously estimates risk group sizes and HCV prevalence and correctly accounts for uncertainty in the evidence base.

Conclusions

We incorporated new information on HCV among the South Asian population to address concerns of policymakers and advocates, as well as extending and updating information on the injecting population. Overall our estimate of the total number of people with HCV was similar to previous estimates, although with a different pattern: higher HCV prevalence in current and ex-IDUs than that found previously with a smaller, older injecting population. We found very low prevalence in never-injectors of white/other ethnicity but a higher prevalence in South Asians. These estimates may be used to assess whether case finding among South Asian populations would be cost effective. However, information on ex-IDUs, and HCV among South Asian ethnic group, is sparse and needs to be improved. Further information could also be incorporated in the future if it is considered important and becomes available, e.g. on HCV among men who have sex with men. The methodology may also be used to address other areas where information on public health problems is incomplete or based on partial or potentially biased data, especially if there is controversy over the size of the problem; for instance, Hepatitis B.

Supplementary data

Supplementary data are available at EURPUB online.

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Conflicts of interest: None declared.

Key points

- HCV prevalence in those that have never injected drugs is low, but 10-fold higher in the South Asian population compared with those of white/other ethnicity. Overall prevalence is ~0.67%, but an older population of current IDUs with higher HCV prevalence was observed in this analysis compared to 2003.
- These estimates may be used to assess whether case finding among South Asian populations would be cost effective. Increased levels of treatment are required for older IDUs that are HCV infected and at higher risk of end stage liver disease.

References

Knowledge, attitudes and practices of voluntary HIV counselling and testing among rural migrants in central China: a cross-sectional study

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Objective: To document knowledge, attitudes and practices of voluntary HIV counselling and testing (VCT) among rural migrants in central China. Methods: A cross-sectional study with face-to-face anonymous questionnaire interviews was conducted using a structured questionnaire. Results: Among 1280 participants, 87.9% reported having had sexual intercourse during their lifetime, with 69% of singles having had sexual intercourse and 49.1% having had sex in the past month. Only 21% always used condoms, 84.4% knew HIV infection was a serious health problem, and 40.7% had heard of VCT. Conclusions: The results of this study indicated that much greater efforts are needed to improve HIV/AIDS and VCT knowledge, to promote safer sex and to improve VCT acceptance among rural migrants in central China, particularly those engaging in risky behaviours.