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Smolarchuk, C., Mohammed, H., Furegato, M. et al. (2019) Just Google it! Impact of media coverage of an outbreak of high-level azithromycin-resistant *Neisseria gonorrhoeae* on online searches, and attendances, testing and diagnoses at sexual health clinics in England between 2015 and 2016: an interrupted time series analysis using surveillance data. *Sexually Transmitted Infections*, 95 (8). pp. 594-601. ISSN: 1368-4973

<https://doi.org/10.1136/sextrans-2019-053986>

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1 **Just google it! Impact of media coverage of an outbreak of high-**
2 **level azithromycin resistant *Neisseria gonorrhoeae* on online**
3 **searches, and attendances, testing and diagnoses at sexual health**
4 **clinics in England between 2015 and 2016: an interrupted time**
5 **series analysis using surveillance data**

6
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30
31 **Word Count:** 3,219

32
33 **Keywords:** outbreak; digital health; sexually transmitted infections; STI; interrupted
34 time series; high-level azithromycin resistant gonorrhoea outbreak; HL-AziR
35

46 **ABSTRACT**

47

48 **Objectives** To determine if media coverage of an outbreak of high-level
49 azithromycin resistant *Neisseria gonorrhoeae* (HL-AziR) impacted online search
50 interest or was temporally associated with health-seeking behaviours in several
51 English cities.

52

53 **Methods** A descriptive analysis of outbreak-related online media articles and relative
54 search interest (RSI) using Google, and an interrupted time series analysis using
55 routine surveillance data from sexual health clinics (SHCs) in England (GUMCAD
56 STI surveillance system). The main outcomes were adjusted incidence rate ratios
57 (IRR) of weekly attendances, gonorrhoea tests, and diagnoses of gonorrhoea or 'any
58 STI' in selected cities after media coverage of the outbreak in 2015 and 2016

59

60 **Results** RSI for outbreak-related terms peaked during media coverage in September
61 2015 with smaller peaks coinciding with subsequent coverage. The greatest increase
62 in RSI was in Leeds, which coincided with a 63% rise (n=1932; IRR 1.26, 95% CI
63 1.12 to 1.43) in SHC attendances by women. There was only a 7% (n=1358; IRR
64 1.01, 95% CI 0.91 to 1.11) increase in attendances by men. Modest increases in
65 outcomes occurred in four other cities with a high RSI. There was no evidence of
66 increases in outcomes in cities, other than Leeds, after subsequent media coverage
67 of the outbreak.

68

69 **Conclusions** National and local media coverage of the HL-AziR outbreak coincided
70 with peak RSI for related terms, and a transient increase in attendances, gonorrhoea

71 tests, and diagnoses of gonorrhoea or 'any STI' in some cities with a high RSI. Our
72 analysis demonstrates the potential for media coverage to influence health-seeking
73 behaviours during high profile STI outbreaks.

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96 **Key Messages**

97 • After media coverage of the HL-AziR outbreak, the number of attendances at
98 SHCs increased in some English cities with a high RSI for ‘gonorrhoea’,
99 particularly among women in Leeds, where the outbreak was first detected,
100 and in cities near Leeds.

101

102 • Short periods of media coverage of high-profile STI outbreaks can impact
103 health-seeking behaviours and highlights opportunities to improve targeting of
104 health promotion information following online searches.

105

106 • There is a need for further research to optimise targeting and rapid delivery of
107 health promotion information to those most at risk of infection.

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121 **INTRODUCTION**

122 The ongoing emergence of resistance to antimicrobials used to treat gonorrhoea is a
123 global public health concern [1]. Gonorrhoea is the second most commonly
124 diagnosed bacterial sexually transmitted infection (STI) in England, and diagnoses
125 have doubled in the past 10 years [2]. At the time of the outbreak, many countries,
126 including the United Kingdom (UK), and the World Health Organization (WHO)
127 recommended treatment using first-line dual therapy of ceftriaxone with azithromycin
128 [3–6]. Resistance to azithromycin is increasing globally [1], which threatens the
129 efficacy of dual therapy and could lead to the emergence of untreatable gonorrhoea
130 [7].

131

132 An outbreak of sustained transmission of high-level azithromycin resistant *Neisseria*
133 *gonorrhoeae* (HL-AziR; minimum inhibitory concentration (MIC) \geq 256 mg/L) was
134 identified in England in 2015 [8–11], stimulating widespread media interest. In
135 England, isolates of HL-AziR were previously detected only sporadically or in small
136 clusters [12]. The outbreak was first identified among heterosexuals in Leeds, a large
137 city in the North of England, but then spread to other parts of the country. Initially, the
138 outbreak was relatively localized; there were 15 cases in Leeds, four in other parts of
139 the North, and one in the South of England [8,9]. Widespread local and national
140 media coverage started 17th September 2015 and dubbed it ‘super gonorrhoea’. The
141 media first reported cases in Leeds, Scunthorpe (near Leeds and Sheffield),
142 Macclesfield and Oldham (near Manchester). Coverage of the outbreak appeared on
143 television, in print, online, and made the front page of popular newspapers. A
144 surveillance report released 15th April 2016 fuelled further media attention when it
145 reported increased cases (n=34) nationally, including among men who have sex with

146 men (MSM)[9]. Media reported cases detected in the West Midlands (including
147 Birmingham), London, and the South of England. There were growing concerns that
148 HL-AziR could rapidly disseminate into wider sexual networks and become endemic.
149 However, a subsequent surveillance report on 9th September 2016 [8] reported little
150 change in the progression of the outbreak (n=48) and no evidence of rapid
151 dissemination.

152

153 Previous research indicated that prolonged or intensive public health campaigns and
154 media activity around health-related topics could influence health-seeking
155 behaviours [13–19]. In this analysis, we used relative search interest (RSI) and
156 interrupted time-series analysis to explore temporal associations between the effect
157 of media coverage of the outbreak on online searches and health-seeking behaviour
158 among people attending sexual health clinics (SHCs) in England. Online search
159 engine data is increasingly utilized for understanding population health and health-
160 related queries [20], including forecasting diseases and outbreak detection [21–23].

161

162 **METHODS**

163 **Study design and setting**

164 We used the Google search engine to quantify online media interest in the HL-AziR
165 outbreak, and Google Trends (Alphabet Inc, Mountain View, California, USA) to
166 determine RSI for outbreak-related search terms related. RSI is defined as the total
167 number of people searching for a specified term divided by the total number of
168 searches, providing a measure of the relative popularity (out of 100) of the term
169 during a selected date range [24].

170

171 We used the GUMCAD STI surveillance system to investigate associations between
172 online searches of the HL-AziR outbreak in England and health-seeking behaviour
173 as a result of media coverage. GUMCAD is a mandatory, pseudonymised, electronic
174 dataset covering all attendances and services provided at all SHCs in England and
175 includes basic patient characteristics and demographics [25]. In the UK, SHCs are
176 free, confidential, open-access services offering STI testing and treatment with many
177 people attending [26]. This analysis was designed to detect exceedances in
178 outcomes associated with defined periods of media coverage of the HL-AziR
179 outbreak (described below), similar to previous studies [17,27].

180

181 **Online media coverage of the HL-AziR outbreak**

182 The study population was news outlets who published online articles in the UK on
183 'super gonorrhoea'. Online news articles were identified by performing an online
184 search for the terms 'super gonorrh*' and 'super-gonorrh*' during defined periods of
185 media interest (described below). The articles were counted (no duplicates identified)
186 and categorised as related or unrelated to the outbreak to estimate media interest in
187 the outbreak.

188

189 **Online search interest for the HL-AziR outbreak**

190 The study population was people in England searching for outbreak-related search
191 terms. Separate analyses for RSI were conducted for 'gonorrhoea'/'super
192 gonorrhoea' (British English) and 'gonorrhea'/'super gonorrhea' (American English)
193 between 2014 and 2016 using Google Trends (wild card searches were not
194 possible). Data reported are for the American English terms due to low search
195 volumes for the British English terms. Google Trends generated a list of cities with

196 the highest RSI, and a list and percent increase in search frequency of other
197 common search-terms that users who searched for 'gonorrhoea' also searched for.

198

199 **Associations between media coverage of the outbreak of HL-AziR and** 200 **exceedances in sexual health outcomes**

201 The study population included men and women attending SHCs in the six cities with
202 the highest RSI between 2014 and 2016: Leeds (number of SHCs [n]=7), Sheffield
203 (n=2), Manchester (n=9), Birmingham (n=3), London (n=94), and Liverpool (n=5).
204 Attendances by people with an unspecified gender (0.02%; n=694) and prisoners
205 (0.1%, n=2774) were excluded.

206

207 The outcomes were: new attendances, gonorrhoea tests, and diagnoses of
208 gonorrhoea or 'any STI' at SHCs in selected cities. Attendance analyses excluded
209 follow-up attendances (9.9%, n=396728) and unspecified attendance type (10.1%,
210 n=406791). We defined 'any STI' using the Public Health England surveillance
211 definition for a new STI diagnosis [28]. Multiple records of gonorrhoea tests per
212 patient attendance were de-duplicated; all other tests were retained to allow for
213 repeat testers and tests-of-cure. A 42 day episode of care was used for gonorrhoea
214 and 'any STI' diagnoses to prevent over-counting due to discrepancies in dates
215 reported to GUMCAD [29]. 'Any STI' diagnoses were included as a proxy for those
216 who may have attended a SHC due to perceived risk of 'super gonorrhoea' but were
217 also at risk of other STIs.

218

219 **Period of exposure to media coverage**

220 The HL-AziR outbreak was covered by the media on three separate occasions. The
221 start date of each exposure period coincides with initial media coverage of the
222 outbreak. The periods of exposure were defined as successive six-week periods
223 directly before media coverage (pre-media: 2015 weeks 32-37; 2016 weeks 10-15;
224 2016 weeks 30 to 35), during and directly after media coverage (media: 2015 weeks
225 38-43; 2016 weeks 16-21; 2016 weeks 36 to 41), and a subsequent six-week period
226 after media exposure (post-media: 2015 weeks 44-49; 2016 weeks 22-27; 2016
227 weeks 42 to 47)(Figure 1). The six-week period accounted for increased RSI over
228 time, delays in making or obtaining SHC appointments, and was the same period
229 used to prevent over-counting of STI diagnoses (described above).

230

231 **Statistical analysis**

232 We calculated the percent change in each outcome in the media and post-media
233 period compared with the pre-media period as the baseline among men and women
234 in selected cities to give an indication of the relative change in attendances
235 compared to immediately prior to media coverage of the outbreak.

236

237 Next, we used interrupted time-series regression using a generalised linear model
238 with a negative binomial distribution of weekly counts of outcomes modelled
239 separately for men and women in each city. The hypothesis tested was that media
240 coverage of the outbreak led to increased outcomes in each city. We examined the
241 first two media exposure periods since they occurred in the absence of known
242 outbreak interventions. Models accounted for the underlying time trend (continuous
243 variable using weeks) and were adjusted for year to account for the increasing trend
244 in SHC attendances in England (categorical variable)[30], seasonality (calendar

245 quarter as a categorical variable), bank holidays and major clinic closures (indicator
246 variable). Time was divided into the previously defined exposure periods and
247 compared to the baseline trend between 2014 and 2016. A total of 157 weeks were
248 included in the analysis. Adjusted incidence rate ratios (IRRs) and 95% confidence
249 intervals (CI) are reported. Data cleaning and analysis were performed using Stata
250 v13.1 (StataCorp, College Station, TX, USA). P-values < 0.05 were considered
251 statistically significant. Statistically significant increases in IRR in both the media and
252 pre-media period were deemed to be unrelated to media coverage.

253

254 **RESULTS**

255 **Media and public interest in the HL-AziR outbreak**

256 The HL-AziR outbreak in England was covered in both 2015 and 2016 by many
257 popular news outlets [31–33] with a high readership among British adults (Figure 1A)
258 [34]. The RSI for the term ‘gonorrhoea’ peaked during initial media coverage in
259 September 2015 (RSI 100) with smaller peaks in December 2015 (RSI 46) and April
260 2016 (RSI 72) related to subsequent media coverage (Fig. 1A). Peaks in RSI for
261 ‘super gonorrhoea’ coincided with peak searches for ‘gonorrhoea’, although searches
262 were less common. Increases in RSI for ‘gonorrhoea’ were limited to two weeks
263 (weeks 38-39) in September 2015 and one week (week 16) in April 2016. There
264 were no peaks in RSI when the second surveillance report was published in
265 September 2016, which received less online media attention (Fig. 1A).

266

267 The cities with the highest RSI were Leeds (RSI 100), Sheffield (RSI 90),
268 Birmingham (RSI 88), Manchester (RSI 88), London (RSI 82), and Liverpool (RSI 74)
269 (Fig. 1B). Searches related to ‘gonorrhoea’ during this time-period were ‘super

270 gonorrhoea' (% increase in search frequency 2100%), 'Leeds gonorrhoea' (350%),
271 'super gonorrhoea symptoms' (250%), 'dean street express' (190%), and 'how is
272 gonorrhoea treated' (100%).

273

274 **Attendances at SHCs**

275 After initial media coverage of the HL-AziR outbreak in 2015, there was a significant
276 increase in attendances by women at SHCs in Leeds (Fig. 2, Tables 1A & 2), with no
277 change in attendances by men (Tables 1B & 2). This translated to a 63% increase
278 (n=1932; IRR 1.26, 95% confidence interval 1.12 to 1.43) in the media period,
279 followed by a 103% increase (n=2412; IRR 1.51, 95% CI 1.34 to 1.71) in the
280 subsequent post-media period compared to the pre-media period by women in
281 Leeds. A smaller increase (14%, n=2809, IRR 1.25, 95% CI 1.10 to 1.43) in
282 attendances by women at SHCs in Leeds occurred in 2016 during the media period,
283 but not in the post-media period. Smaller increases in attendances by men and
284 women at SHCs were detected in other cities in 2015. The second largest increase
285 in attendances at SHCs was in Sheffield by both women (32%, n=2257, IRR 1.21,
286 95% CI 1.04 to 1.44) and men (media: 33%, n=1269, IRR 1.19, 95% CI 1.04 to 1.36;
287 post-media: 31%, n=1254, IRR 1.15, 95% CI 1.01 to 1.32). In Manchester, there
288 were increased attendances by both women (media 15%, n=5213, IRR 1.19, 95% CI
289 1.08 to 1.31; post-media 13%, n=5132, IRR 1.22, 95% CI 1.10 to 1.35) and men
290 (media 17%, n=2835, IRR 1.13, 95% CI 1.04 to 1.24). In London, there was a 5%
291 increase in attendances by men in the post-media period (n=47008, IRR 1.10, 95%
292 CI 1.04 to 1.17). In Liverpool, there were increased attendances by men at SHCs
293 (media 17%, n=2186, IRR 1.14, 95% CI 1.07 to 1.23; post-media 18%, n=2213, IRR

294 1.16, 95% CI 1.08 to 1.23). Although Birmingham was ranked third for highest RSI,
295 there were no significant increases in attendances by men or women.

296

297

298

299 **Gonorrhoea testing**

300 Increases in the number of gonorrhoea tests, predominantly in 2015, were detected
301 after media coverage in some cities (Tables 1 & 2). There were increased in
302 gonorrhoea tests among women in Leeds and men in Sheffield, which coincided with
303 increased SHC attendances, but was only statistically significant among women
304 during the media (19%, n=1127, IRR 1.18, 95% CI 1.03 to 1.34) period in 2016 after
305 adjusting for the underlying time trend. In Manchester, the number of gonorrhoea
306 tests increased in the media (20%, n=2358, IRR 1.21, 95% CI 1.11 to 1.32) and
307 post-media (17%, n=2287, IRR 1.19, 95% CI 1.08 to 1.31) periods among women
308 and in the post-media period among men (10%, n=2107, IRR 1.13, 95% CI 1.04 to
309 1.23). In London, gonorrhoea tests increased by 4% in the post-media period among
310 men (n=37121, IRR 1.08, 95% CI 1.02 to 1.15). An increase in gonorrhoea tests in
311 the absence of a significant increase in SHC attendances occurred among women in
312 Liverpool and men in Birmingham. In Liverpool, gonorrhoea tests among women
313 increased in the media period (19%, n=2229, IRR 1.10, 95% CI 1.00 to 1.20) and
314 among men during both periods (media 17%, n=1532, IRR 1.13, 95% CI 1.05 to
315 1.23; post-media 19%, n=1551, IRR 1.15, 95% CI 1.06 to 1.25). In Birmingham,
316 gonorrhoea tests increased in both periods among men (media 8%, n=2319, IRR
317 1.11, 95% CI 1.02 to 1.22; post-media 15%, n=2480, IRR 1.15, 95% CI 1.06 to 1.25).

318 In Manchester, London, and Liverpool (men only), increased number of gonorrhoea
319 tests coincided with simultaneous increased SHC attendances.

320

321 **Diagnoses of gonorrhoea or any new STI**

322 There were increased STI and gonorrhoea diagnoses detected among women in
323 some cities in 2015 after media coverage (Tables 1 & 2). Diagnoses of 'any STI'
324 increased among women in Manchester (media 37%, n=378, IRR 1.25, 95% CI 1.09
325 to 1.43), but not gonorrhoea. There were small increases in diagnoses of 'any STI'
326 among women in London (media 6%, n=5099, IRR 1.09, 95% CI 1.03 to 1.16; post-
327 media 5%, n=5052, IRR 1.11, 95% CI 1.04 to 1.18) in the absence of increases in
328 gonorrhoea testing or SHC attendances. In Liverpool, diagnoses of 'any STI'
329 increased in both periods (media 17%, n=279; IRR 1.21, 95% CI 1.04 to 1.41; post-
330 media 27%, n=302; IRR 1.33, 95% CI 1.14 to 1.56), which coincided with increased
331 gonorrhoea diagnoses (post-media 108%, n=27, IRR 1.76, 95% CI 1.05 to 2.95) but
332 not SHC attendances. No increases in diagnoses were detected in any other cities.

333

334 **DISCUSSION**

335 Extensive local and national media coverage of an outbreak of HL-AziR was
336 temporally associated with a high RSI for outbreak-related search terms, and
337 increased attendances, gonorrhoea tests, and gonorrhoea or 'any STI' diagnoses at
338 SHCs in several English cities. After media coverage of the outbreak, people in the
339 initial outbreak city, Leeds, or nearby cities, were more likely to attend SHCs,
340 suggesting that they were modifying their health-seeking behaviour as a result.

341

342 We quantified online media coverage of the outbreak as a proxy for media interest.
343 However, we did not assess news articles in print, article placement (e.g. front page),
344 or differences in local media exposure between cities (e.g. dose-response), which
345 may have influenced outcomes. RSI for 'gonorrhoea' coincided with peak search
346 interest for 'super gonorrhoea' suggesting that both peaks were related to outbreak
347 media coverage. GUMCAD is a large, comprehensive surveillance dataset with
348 complete coverage of attendances, testing, and diagnoses of STIs at SHCs in
349 England. This provided a unique opportunity to quantify attendance-based changes
350 for multiple outcomes in different cities. We could not analyse reason for attendance,
351 the sequence of events (i.e. did a person attend a SHC because they searched
352 online, or vice versa) or associated risk factors because data were not available.
353 Since the interrupted time series analysis was ecological, we can only infer temporal
354 associations not causation, but there were no known national or local health
355 promotion campaigns which may have impacted this analysis. To our knowledge,
356 this is the first time associations between a relatively short-period of media interest of
357 a high-profile STI outbreak and changes in health-seeking behaviour were
358 demonstrated. Recent evidence suggests that media coverage could impact the
359 progression of epidemics [16], and impact health-seeking behaviour [14,17–
360 19,35,36].

361

362 Dean Street Express is a large SHC in central London providing asymptomatic STI
363 screening, so the increase in the search query could imply people were seeking SHC
364 appointments. Increased SHC attendances did not always coincide with increased
365 gonorrhoea tests or diagnoses, which may reflect an increase in attendances by low
366 risk individuals. However, media coverage may have encouraged clinicians to offer

367 tests to more patients or improved test uptake by patients, which could explain the
368 increased gonorrhoea tests in the absence of increased attendances in Birmingham.
369 Proximity to the initial outbreak area might influence risk perception among local
370 populations. Sheffield and Manchester and Birmingham had similar RSIs, but no
371 increased attendances occurred in Birmingham (located further from Leeds).
372 Major campaigns for AIDS in the UK were associated with a surge in HIV testing by
373 heterosexuals with no identified risk factors [37] and a decline in HIV positivity rates
374 [38]. In contrast, media campaigns aimed at increasing chlamydia screening
375 reported improved uptake by high risk individuals, but not total tests [15].

376

377

378 Other factors could have contributed to increased SHCs attendances by women in
379 Leeds. All known outbreak interventions were implemented after March 2016, so
380 were unlikely to have impacted outcomes in 2015 (described elsewhere) [10]. Leeds
381 SHCs increased their opening hours from July 2015 and began delivering an
382 integrated sexual health and reproductive health service from a new main hub with
383 satellite clinics from December 2015; however, there were no specific changes to the
384 service in mid-September 2015 when attendances peaked (Appendix Fig. 1). The
385 increase in opening hours at SHCs may have placed Leeds in a unique position to
386 accommodate more appointments after media coverage of the outbreak while other
387 SHCs may have already been operating at full capacity.

388

389 Our findings demonstrate that media stories can result in an increase in both online
390 searches and health-seeking behaviours. Public health agencies should make better
391 use of national and local media outlets to promote testing, treatment and healthier

392 behaviour. For example, the release of STI statistics or reports can often attract
393 media attention which can provide an important opportunity to reinforce key public
394 health messages on safer sexual and health-seeking behaviours. Public health
395 agencies need to have good internal coordination and strong communication
396 capacity (potentially supplemented by partnerships with media agencies) to be able
397 to respond rapidly and take full advantage of such media opportunities. When media
398 stories do occur, public health agencies should promote social media interventions
399 [39] and deliver major sexual health campaigns in order to reinforce key public health
400 message and disseminate accurate and evidence-based information.

401

402 This study also highlights that continued “click-bait” may desensitize people over
403 time. Most of the increases in our study were transient and limited to 2015, and
404 online RSI also declined over time. Awareness of people’s online search interest and
405 the impact it can have on health-seeking behaviour may aid in planning by health
406 professionals and identifying the optimal window for public health engagement and
407 education.

408

409 The HL-AziR outbreak in England persists and clinicians have reported difficulties in
410 getting partners of cases to attend SHCs for screening [39]. Therefore, more
411 research is needed to understand risk perceptions, health-seeking behaviours, and
412 barriers to accessing healthcare to improve infection control. Although this study
413 focused on a high-profile STI outbreak, understanding the relationship between
414 media health stories, the internet and social media, and subsequent health
415 behaviours is an area of increasing public health importance, especially for
416 controversial issues [40].

417

418 **CONCLUSION**

419 Our analysis demonstrates the potential for media coverage to have a beneficial
420 impact on health-seeking behaviour during high profile STI outbreaks. In England,
421 Google searches related to gonorrhoea direct people to the National Health Services
422 (NHS) Choices website; however, top results for 'super gonorrhoea' searches only
423 refer to media coverage of the outbreak. Opportunities to improve targeting of health
424 promotion information following online searches clearly exist, and further research is
425 needed to optimise targeting and rapid delivery of health promotion information to
426 those most at risk of infection. Partnerships between public health agencies and
427 media agencies, or the use of social media platforms could facilitate this process,
428 support infection control initiatives, and thereby achieve control of outbreaks.

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438

439 **Acknowledgements** We would to thank the clinical staff who routinely submit data
440 to the GUMCAD STI surveillance system; and André Charlett for providing statistical
441 advice.

442

443 **Author contributions:** CS, HF and GH conceived of the work. CS designed the
444 work and conducted the analysis with input from HM, MF and GH. CS prepared the
445 manuscript with significant input from HM and GH. All other authors contributed to
446 data interpretation and review of the final manuscript. All authors revised the work for
447 important intellectual content and gave their final approval for publication. CS acts as
448 guarantor and accepts full responsibility for the work. The corresponding author
449 attests that all listed authors meet authorship criteria and that no others meeting the
450 criteria have been omitted.

451

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458 [for-authors/licence-forms](http://group.bmj.com/products/journals/instructions-for-authors/licence-forms).

459

460

461 **Declaration of interests** All authors have completed the ICMJE uniform disclosure
462 form at www.icmje.org/coi_disclosure.pdf and declare: no support from any
463 organisation for the submitted work; no financial relationships with any organisations
464 that might have an interest in the submitted work in the previous three years; no
465 other relationships or activities that could appear to have influenced the submitted
466 work.

467

468 **Role of funding source** Undertaken as part of Public Health England-funded public
469 health surveillance

470

471 **Transparency statement** CS, as guarantor, affirms that the manuscript is an
472 honest, accurate, and transparent account of the study being reported; that no
473 important aspects of the study have been omitted; and that any discrepancies from
474 the study as originally planned have been explained.

475

476 **Patient consent and ethics statement**

477 As GUMCAD is a routine public health surveillance activity which collects de-
478 identified data, no specific consent was required from the patients whose data were
479 used in this analysis. In its role providing infectious disease surveillance, Public
480 Health England has permission to process data obtained by GUMCAD under
481 Regulation 3 of the Health Service (Control of Patient Information) Regulations 2002.
482 No patients were recruited for this study, or involved in the development of the
483 research question, outcome measures, or study design.

484

485 **Data sharing** Data from Google Trends are publicly available. GUMCAD STI
486 Surveillance System is the mandatory surveillance system for sexually transmitted
487 infections (STIs) in England. PHE collects pseudo-anonymised, electronic data on all
488 STI tests and diagnoses from all commissioned sexual health services in England.
489 Some data are publicly available, and the principles for accessing, storing, and
490 sharing data are given in PHE's HIV and STI data sharing policy found here:
491 <https://www.gov.uk/government/publications/hiv-and-sti-data-sharing-policy>

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Figures and Table Legends

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Figure 1 A) Relative search interest (RSI) for the search terms ‘gonorrhoea’ and
‘super gonorrhoea’ from Google Trends compared with the number of news articles
published online related to ‘super gonorrhoea’ during different exposure periods by
week, and B) cities with the highest RSI for the search term ‘gonorrhoea’ in England
from 2015 to 2016.

517
518 Footnote1: The periods of exposure were defined as successive six-week periods
519 directly before media coverage (pre-media: 2015 weeks 32-37; 2016 weeks 10-15;
520 2016 weeks 30 to 35), during and directly after media coverage (media: 2015 weeks
521 38-43; 2016 weeks 16-21; 2016 weeks 36 to 41), and a subsequent six-week period
522 after media exposure (post-media: 2015 weeks 44-49; 2016 weeks 22-27; 2016
523 weeks 42 to 47).

524 **Figure 2** Attendances at sexual health clinics by A) women and B) men in Leeds by
525 year, week and attendance type from 2014 to 2016. Incidence rate ratios (IRRs) and
526 95% confidence intervals for new attendances during the media and post-media
527 periods are displayed from interrupted time series regression using a negative
528 binomial regression after two periods of major media coverages of an outbreak of
529 high-level azithromycin resistant *Neisseria gonorrhoeae* in England. The vertical,
530 solid lines in 2015 and 2016 indicates the start of media coverage of the high-level
531 azithromycin resistant *N. gonorrhoeae* outbreak in England during that period, and
532 the dashed lines separate the pre-media, media and post-media periods.

533

534 Footnote1: The periods of exposure were defined as successive six-week periods
535 directly before media coverage (pre-media: 2015 weeks 32-37; 2016 weeks 10-15;
536 2016 weeks 30 to 35), during and directly after media coverage (media: 2015 weeks
537 38-43; 2016 weeks 16-21; 2016 weeks 36 to 41), and a subsequent six-week period
538 after media exposure (post-media: 2015 weeks 44-49; 2016 weeks 22-27; 2016
539 weeks 42 to 47).

540 Footnote2: Significance was defined as $p < 0.05$ and indicated by an asterisk.

541

542 **Table 1** Incidence rate ratios (IRRs) for A) women and B) men from interrupted time
543 series regression using a negative binomial distribution for sexual health clinic
544 attendances, gonorrhoea tests, and gonorrhoea or 'any STI' diagnoses after major
545 media coverage of the high-level azithromycin resistant *Neisseria gonorrhoeae*
546 outbreak in England for cities with the highest relative search interest (RSI) based on
547 Google Trends. Separate models were run stratified by city, and gender. Pre-media
548 (2015 weeks 32 to 37; 2016 weeks 10 to 15), media (2015 weeks 38 to 43; 2016
549 weeks 16 to 20) and post-media (2015 weeks 44 to 49; 2016 weeks 22 to 27)
550 periods were compared to the baseline trend from 2014 to 2016 after controlling for
551 year, seasonality, bank holidays, and clinic closures. Text highlighted in grey
552 represent statistically significant increases and text highlighted in black represent
553 statistically significant decreases in outcomes where no statistically significant
554 increase occurred in the pre-media period.

555

556 Footnote1: Significance was defined as $p < 0.05$ and indicated by an asterisk.

557

558 **Table 2** Percent change in number of sexual health clinic attendances, gonorrhoea
559 tests, and gonorrhoea or 'any STI' diagnoses among men or women after major
560 media coverage of an outbreak of high-level azithromycin resistant *Neisseria*
561 *gonorrhoeae* in England for cities with the highest relative search interest (RSI)
562 based on Google Trends. Percent changes in the media (2015 weeks 38 to 43; 2016
563 weeks 16 to 20) and post-media (2015 weeks 44 to 49; 2016 weeks 22 to 27)
564 periods were compared to the pre-media (2015 weeks 32 to 37; 2016 weeks 10 to
565 15) for each year. Text highlighted in grey represent statistically significant increases
566 and text highlighted in black represent statistically significant decreases in outcomes

567 where no statistically significant increases occurred in the pre-media period.
568 Statistical significance is based on separate analyses using interrupted time series
569 and is only highlighted in this figure for comparison purposes to Table 1.

Women

City	Outcome	2015			2016		
		pre-media	media	post-media	pre-media	media	post-media
		Incidence rate ratio (95% confidence interval)					
Leeds	Attendances	0.91 (0.80-1.03)	1.26 (1.12-1.43)*	1.51 (1.34-1.71)*	1.04 (0.92-1.17)	1.25 (1.10-1.43)*	1.11 (0.97-1.26)
	Gonorrhoea testing	0.87 (0.77-0.99)*	1.06 (0.95-1.20)	0.96 (0.85-1.08)	0.95 (0.84-1.08)	1.18 (1.03-1.34)*	1.08 (0.95-1.23)
	Gonorrhoea diagnoses	0.71 (0.42-1.19)	0.91 (0.59-1.41)	0.91 (0.58-1.43)	1.34 (0.89-2.03)	0.84 (0.51-1.40)	0.62 (0.35-1.11)
	'Any STI' diagnoses	0.75 (0.63-0.89)*	0.86 (0.74-1.00)*	0.87 (0.75-1.01)	0.94 (0.81-1.08)	1.14 (0.99-1.33)	0.93 (0.80-1.09)
Sheffield	Attendances	1.09 (0.92-1.29)	1.21 (1.04-1.44)*	1.11 (0.94-1.32)	0.71 (0.60-0.84)*	0.82 (0.68-0.99)*	0.87 (0.73-1.05)
	Gonorrhoea testing	0.64 (0.53-0.79)*	0.78 (0.65-0.95)*	0.69 (0.57-0.85)*	1.00 (0.82-1.22)	0.94 (0.76-1.16)	0.88 (0.72-1.09)
	Gonorrhoea diagnoses	0.86 (0.45-1.64)	0.91 (0.49-1.69)	0.62 (0.29-1.35)	0.64 (0.34-1.19)	0.34 (0.10-1.15)	0.52 (0.23-1.17)
	'Any STI' diagnoses	0.94 (0.76-1.17)	1.11 (0.91-1.34)	0.99 (0.81-1.22)	0.92 (0.75-1.15)	0.74 (0.58-0.96)*	0.86 (0.68-1.08)
Manchester	Attendances	1.06 (0.96-1.17)	1.19 (1.08-1.31)*	1.22 (1.10-1.35)*	1.16 (1.05-1.28)*	1.21 (1.09-1.35)*	1.10 (0.99-1.23)
	Gonorrhoea testing	1.07 (0.97-1.17)	1.21 (1.11-1.32)*	1.19 (1.09-1.31)*	1.02 (0.93-1.12)	1.07 (0.97-1.18)	0.98 (0.88-1.08)
	Gonorrhoea diagnoses	1.04 (0.61-1.77)	0.87 (0.49-1.55)	1.15 (0.66-1.99)	0.89 (0.53-1.52)	1.28 (0.76-2.17)	1.04 (0.61-1.79)
	'Any STI' diagnoses	0.98 (0.84-1.14)	1.25 (1.09-1.43)*	1.13 (0.98-1.31)	0.89 (0.76-1.03)	1.15 (0.98-1.34)	1.02 (0.87-1.19)
London	Attendances	1.07 (1.01-1.13)*	1.10 (1.04-1.17)*	1.13 (1.06-1.20)*	1.00 (0.94-1.06)	1.00 (0.94-1.07)	1.01 (0.95-1.07)
	Gonorrhoea testing	1.06 (1.00-1.13)*	1.09 (1.03-1.15)*	1.12 (1.05-1.19)*	0.99 (0.93-1.05)	1.00 (0.94-1.07)	1.01 (0.95-1.08)
	Gonorrhoea diagnoses	1.19 (1.04-1.35)*	1.27 (1.13-1.44)*	1.22 (1.08-1.39)*	0.81 (0.71-0.94)*	0.87 (0.75-1.01)	0.82 (0.71-0.95)*
	'Any STI' diagnoses	1.07 (1.00-1.14)	1.09 (1.03-1.16)*	1.11 (1.04-1.18)*	0.95 (0.89-1.01)	0.92 (0.86-0.99)*	0.91 (0.85-0.98)*
Liverpool	Attendances	0.97 (0.89-1.05)	1.00 (0.92-1.08)	0.97 (0.89-1.05)	1.04 (0.96-1.13)	1.01 (0.93-1.10)	0.93 (0.85-1.01)
	Gonorrhoea testing	1.00 (0.92-1.11)	1.10 (1.00-1.20)*	1.09 (0.99-1.20)	0.99 (0.90-1.09)	1.02 (0.92-1.13)	0.95 (0.86-1.05)
	Gonorrhoea diagnoses	0.93 (0.49-1.76)	1.36 (0.81-2.31)	1.76 (1.05-2.95)*	0.87 (0.51-1.49)	0.99 (0.56-1.77)	1.02 (0.59-1.77)
	'Any STI' diagnoses	1.08 (0.92-1.27)	1.21 (1.04-1.41)*	1.33 (1.14-1.56)*	0.81 (0.68-0.96)*	1.06 (0.89-1.26)	0.79 (0.66-0.95)*
Birmingham	Attendances	0.99 (0.87-1.13)	0.95 (0.84-1.08)	1.03 (0.91-1.17)	0.92 (0.81-1.04)	0.96 (0.84-1.10)	0.89 (0.77-1.01)
	Gonorrhoea testing	1.17 (1.06-1.30)*	1.17 (1.06-1.30)*	1.34 (1.20-1.48)*	0.94 (0.85-1.04)	0.98 (0.88-1.10)	0.90 (0.81-1.01)
	Gonorrhoea diagnoses	1.21 (0.90-1.63)	1.08 (0.79-1.46)	1.28 (0.94-1.75)	0.70 (0.52-0.95)*	0.51 (0.36-0.73)*	0.73 (0.54-1.00)*
	'Any STI' diagnoses	1.31 (1.16-1.47)*	1.21 (1.08-1.35)*	1.25 (1.11-1.41)*	0.87 (0.77-0.97)*	0.91 (0.80-1.03)	0.87 (0.77-0.99)*

		Men					
City	Outcome	2015			2016		
		pre-media	media	post-media	pre-media	media	post-media
Incidence rate ratio (95% confidence interval)							
Leeds	Attendances	1.03 (0.92-1.14)	1.01 (0.91-1.11)	0.94 (0.85-1.05)	0.87 (0.78-0.97)*	1.09 (0.97-1.22)	1.04 (0.93-1.17)
	Gonorrhoea testing	1.03 (0.93-1.15)	1.01 (0.91-1.12)	0.92 (0.82-1.03)	0.86 (0.77-0.97)*	1.10 (0.97-1.24)	1.02 (0.91-1.15)
	Gonorrhoea diagnoses	1.15 (0.80-1.66)	1.23 (0.87-1.74)	0.88 (0.59-1.31)	0.89 (0.59-1.34)	0.84 (0.55-1.31)	0.79 (0.51-1.23)
	'Any STI' diagnoses	1.00 (0.86-1.17)	0.87 (0.75-1.02)	0.88 (0.75-1.03)	0.88 (0.75-1.03)	1.12 (0.95-1.32)	0.97 (0.82-1.14)
Sheffield	Attendances	0.96 (0.83-1.09)	1.19 (1.04-1.36)*	1.15 (1.01-1.32)*	0.92 (0.80-1.06)	0.96 (0.82-1.11)	0.86 (0.75-1.00)
	Gonorrhoea testing	0.86 (0.75-0.99)*	1.05 (0.92-1.20)	1.02 (0.89-1.17)	0.97 (0.84-1.12)	0.91 (0.78-1.06)	0.81 (0.70-0.95)*
	Gonorrhoea diagnoses	0.60 (0.36-0.99)*	0.70 (0.46-1.05)	0.66 (0.44-1.00)	0.67 (0.37-1.21)	0.90 (0.51-1.58)	0.85 (0.50-1.46)
	'Any STI' diagnoses	0.83 (0.67-1.02)	1.05 (0.87-1.26)	1.10 (0.91-1.33)	0.80 (0.65-0.99)*	0.95 (0.77-1.18)	0.88 (0.71-1.09)
Manchester	Attendances	1.01 (0.92-1.10)	0.99 (0.91-1.08)	1.13 (1.04-1.24)*	1.09 (0.99-1.19)	1.05 (0.96-1.16)	1.02 (0.93-1.12)
	Gonorrhoea testing	1.07 (0.99-1.17)	1.06 (0.97-1.15)	1.13 (1.04-1.23)*	1.08 (1.00-1.18)	1.06 (0.97-1.16)	1.02 (0.94-1.12)
	Gonorrhoea diagnoses	1.24 (1.00-1.55)	1.17 (0.94-1.45)	1.00 (0.79-1.27)	1.08 (0.85-1.38)	0.78 (0.60-1.04)	0.81 (0.63-1.07)
	'Any STI' diagnoses	1.11 (0.97-1.26)	1.09 (0.96-1.24)	1.12 (0.98-1.28)	1.08 (0.94-1.23)	0.95 (0.82-1.10)	0.96 (0.83-1.10)
London	Attendances	1.04 (0.99-1.11)	1.04 (0.98-1.10)	1.10 (1.04-1.17)*	0.99 (0.94-1.05)	1.00 (0.93-1.06)	0.98 (0.93-1.06)
	Gonorrhoea testing	1.04 (0.98-1.10)	1.04 (0.98-1.10)	1.08 (1.02-1.15)*	0.99 (0.93-1.05)	0.99 (0.92-1.05)	0.98 (0.93-1.05)
	Gonorrhoea diagnoses	1.11 (1.01-1.22)*	0.95 (0.86-1.03)	0.94 (0.85-1.03)	0.95 (0.86-1.05)	0.82 (0.74-0.91)*	0.87 (0.78-0.97)*
	'Any STI' diagnoses	1.04 (0.98-1.12)	1.00 (0.94-1.07)	1.04 (0.97-1.11)	0.97 (0.91-1.04)	0.94 (0.88-1.01)	0.95 (0.88-1.02)
Liverpool	Attendances	1.04 (0.96-1.11)	1.14 (1.07-1.23)*	1.16 (1.08-1.23)*	1.05 (0.98-1.13)	1.05 (0.97-1.13)	1.01 (0.94-1.10)
	Gonorrhoea testing	1.03 (0.94-1.12)	1.13 (1.05-1.23)*	1.15 (1.06-1.25)*	1.04 (0.96-1.13)	1.06 (0.97-1.16)	1.05 (0.96-1.15)
	Gonorrhoea diagnoses	1.02 (0.73-1.44)	0.98 (0.71-1.36)	0.92 (0.66-1.30)	1.08 (0.75-1.55)	1.14 (0.79-1.65)	1.08 (0.75-1.56)
	'Any STI' diagnoses	0.97 (0.85-1.11)	1.09 (0.96-1.24)	1.07 (0.94-1.22)	1.15 (1.01-1.32)*	1.24 (1.08-1.43)*	1.09 (0.95-1.26)
Birmingham	Attendances	1.10 (0.99-1.23)	1.08 (0.98-1.19)	1.10 (0.99-1.22)	0.89 (0.81-0.99)	0.93 (0.83-1.04)	0.98 (0.88-1.09)
	Gonorrhoea testing	1.09 (1.00-1.20)	1.11 (1.02-1.22)*	1.15 (1.05-1.26)*	0.94 (0.86-1.02)	0.94 (0.85-1.03)	0.94 (0.86-1.04)
	Gonorrhoea diagnoses	1.09 (0.86-1.39)	0.99 (0.79-1.26)	0.81 (0.63-1.06)	0.69 (0.53-0.90)*	0.70 (0.53-0.91)*	0.59 (0.44-0.78)*
	'Any STI' diagnoses	1.13 (1.01-1.27)*	1.19 (1.07-1.32)*	1.10 (0.98-1.23)	0.93 (0.83-1.04)	0.89 (0.78-1.00)*	0.80 (0.71-0.91)*

City	Outcome	Women						Men					
		2015			2016			2015			2016		
		pre-media	media	post-media	pre-media	media	post-media	pre-media	media	post-media	pre-media	media	post-media
		(n)	% increase		(n)	% increase		(n)	% increase		(n)	% increase	
Leeds	Attendances	1,187	63%	103%	2,458	14%	0%	1,271	7%	1%	1,155	25%	17%
	Gonorrhoea testing	823	35%	24%	946	19%	5%	1,079	6%	-5%	820	26%	14%
	Gonorrhoea diagnoses	19	47%	53%	36	-31%	-58%	54	6%	-24%	38	-3%	-5%
	'Any STI' diagnoses	191	31%	39%	297	19%	-4%	323	-7%	-6%	293	28%	8%
Sheffield	Attendances	1,711	32%	29%	1,647	7%	11%	954	33%	31%	1,139	2%	-9%
	Gonorrhoea testing	807	32%	20%	808	4%	-1%	877	29%	29%	1,034	2%	-9%
	Gonorrhoea diagnoses	13	8%	-38%	13	-77%	-38%	20	55%	65%	14	29%	43%
	'Any STI' diagnoses	160	29%	21%	158	-23%	-11%	181	30%	40%	166	19%	13%
Manchester	Attendances	4,544	15%	13%	4,759	5%	-10%	2,431	3%	17%	2,689	1%	-4%
	Gonorrhoea testing	1,957	20%	17%	2,118	4%	-9%	1,918	3%	10%	2,117	2%	-4%
	Gonorrhoea diagnoses	20	-25%	-5%	20	40%	20%	128	-3%	-16%	104	-21%	-16%
	'Any STI' diagnoses	276	37%	24%	288	24%	7%	577	4%	6%	592	-6%	-7%
London	Attendances	53,009	5%	5%	51,506	5%	4%	44,763	1%	5%	41,604	6%	4%
	Gonorrhoea testing	35,992	5%	5%	34,426	5%	5%	35,713	1%	4%	33,020	5%	4%
	Gonorrhoea diagnoses	369	19%	16%	288	10%	1%	2,415	-15%	-19%	1,556	-5%	-2%
	'Any STI' diagnoses	4,790	6%	5%	4,456	1%	-3%	9,236	-4%	-4%	7,591	3%	2%
Liverpool	Attendances	5,268	9%	6%	5,478	2%	-8%	1,869	17%	18%	1,965	2%	-3%
	Gonorrhoea testing	1,874	19%	18%	2,036	4%	-7%	1,305	17%	19%	1,401	3%	0%
	Gonorrhoea diagnoses	13	62%	108%	19	11%	21%	49	10%	6%	43	23%	16%
	'Any STI' diagnoses	238	17%	27%	207	30%	-7%	345	24%	23%	378	10%	-5%
Birmingham	Attendances	3,911	8%	26%	4,635	5%	-3%	2,497	5%	11%	2,698	4%	9%
	Gonorrhoea testing	2,870	9%	29%	3,557	3%	-5%	2,148	8%	15%	2,410	1%	1%
	Gonorrhoea diagnoses	64	-16%	-8%	59	-20%	5%	103	-1%	-19%	77	18%	-6%

'Any STI' diagnoses	626	-2%	4%	601	7%	1%	581	11%	4%	584	1%	-11%
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