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Public health management of invasive meningococcal disease outbreaks: worldwide 1973–2018, a systematic review

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Abstract

Background Infectious disease outbreaks are an ongoing public health concern, requiring extensive resources to prevent and manage. Invasive Meningococcal Disease (IMD) is a severe outcome of infection with *Neisseria meningitidis* bacteria, which can be carried and transmitted asymptomatically. IMD is not completely vaccine-preventable, presenting an ongoing risk of outbreak development. This review provides a retrospective assessment of public health management of IMD outbreaks.

Methods A systematic search was performed in PubMed and EMBASE. English-language studies reporting on IMD outbreaks and associated public health response were considered eligible. Reporting on key characteristics including outbreak size, duration, location, and public health response were assessed against Strengthening the Reporting of Observational studies in Epidemiology guidelines. A summary of lessons learned and author recommendations for each article were also discussed.

Results 39 eligible studies were identified, describing 35 outbreaks in seven regions. Responses to outbreaks were mostly reactive, involving whole communities over prioritising those at highest risk of transmission. Recent responses identified a need for more proactive and targeted controls. Reporting was inconsistent, with key characteristics such as outbreak size, duration, or response absent or incompletely described.

Conclusion There is a need for clear, comprehensive reporting on IMD outbreaks and their public health response to inform policy and practice for subsequent outbreaks of IMD and other infectious diseases.

Keywords Meningococcal infections, Meningitis, Meningococcal, Meningococcal vaccines, Disease outbreaks, Communicable disease control, Mass vaccination, Mass drug administration, Public health

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Introduction

Invasive Meningococcal Disease (IMD) is a severe and often life-threatening condition caused by infection with *Neisseria meningitidis* (*N. meningitidis*) bacteria. The most common clinical presentations of IMD are sepsis and meningitis [1]. IMD cases require prompt recognition and treatment to reduce the risk of complications or death [1]. *N. meningitidis* is carried in the human pharynx and may be transmitted between individuals. Transmission requires close, sustained contact, or direct exposure to nose and/or throat secretions. Asymptomatic carriage is possible, lasting up to several months, with factors such as age, gender, smoker status, size and density of social networks and living space impacting the risk of carriage [2, 3].

There are 12 identified serogroups of *N. meningitidis*, with six responsible for the majority of IMD worldwide (A, B, C, W, X and Y) [4]. Sero-specific vaccines are available to protect against ABCWY, but there is currently no single vaccine that protects against all disease-causing serogroups. Vaccines differ in their effectiveness and long-term immunogenicity, with polysaccharide vaccines offering a limited duration of protection and no booster effects [5]. Conjugate vaccines offer more long-term protection and herd immunity benefits compared with polysaccharide vaccines [5]. Regardless of vaccination practices, the swift course of the disease and ongoing risk of carriage and transmission within the general population necessitates robust disease surveillance and notification systems to quickly identify and respond to cases of IMD.

If the transmission of *N. meningitidis* is not successfully prevented, subsequent cases of IMD can indicate the beginning of an outbreak. In jurisdictions with a low overall incidence of IMD, an outbreak is typically defined as 'two or more cases of the same serogroup within a shared community or organisational setting, occurring less than four weeks apart' [6, 7]. Jurisdictions with higher incidence of IMD often have minimum thresholds of cases per 100,000 population which are used to identify and define outbreaks [8]. The World Health Organization (WHO) recommends an alert threshold (indication to intensify preparedness) as 3–9 cases per 100,000 per week and an epidemic threshold (indication to initiate widespread treatment and vaccination) as >10 cases per 100,000 per week [9]. Outbreaks require a much more involved and costly response when compared to a single isolated case [10]. They can develop within mass gatherings, community (e.g. social network, village or region), or organisational settings (e.g. workplaces, dorm accommodation, army barracks, childcare, or schools) [7].

Public health management of IMD outbreaks is focussed on early identification and interruption of the chain of transmission, preventing further cases [7]. To accomplish this, public health staff are responsible for identifying the population most at risk of transmission and offering interventions to prevent disease. These interventions can include increasing awareness of IMD within health professionals, enhancing their capacity to detect additional IMD cases, community vaccination to prevent IMD within an at-risk population, or antibiotic treatment (chemoprophylaxis) to clear *N. meningitidis* from potential carriers [11]. Outbreak responses are tailored to the population at risk, with characteristics such as causative serogroup, setting, source of exposure, timing, and availability of public health staff and resources all influencing the chosen response. Reporting on the impact of outbreak characteristics on the public health response is scarce, and it is currently unclear how they may affect outbreak management.

Infectious disease outbreak management is an iterative process, with public health guidance evolving over time in response to new evidence [12, 13]. Strategies for the public health management of IMD outbreaks have been developed over time and practice responding to the changing epidemiology of the disease.

Aims

The purpose of this research is to describe the public health management of IMD outbreaks by:

- Identifying and describing similarities and differences between jurisdictions in outbreak characteristics;
- Identifying and assessing any potential similarities and differences in public health response by outbreak setting; and.
- Summarising the change in response strategies over time.

Methods

This review was registered with PROSPERO (Record ID: CRD42020221472). PubMed and Embase were searched using terms relating to meningococcal disease, outbreaks, and outbreak management. This search was not time limited and was initially conducted in December of 2020 then repeated in September 2021.

English-language studies were considered eligible for inclusion if they reported on outbreak with at least one clinically or laboratory confirmed case of IMD, detailed the region, month, and year of the outbreak, and included a detailed description of the subsequent public health response. Studies discussing or investigating sporadic IMD cases with no epidemiological link beyond immediate household settings were excluded as they are not commonly considered outbreaks until transmission occurs outside of the household affected, along

with narrative reviews, incidence/prevalence studies (in absence of an outbreak), vaccination studies (in absence of an outbreak), general carriage studies, cost-effectiveness studies and animal studies.

Reference lists of included articles were hand-searched for additional studies eligible for inclusion. All screening, reference management and data extraction was conducted through Covidence systematic review software [14].

In total, 1,309 studies were identified by the search criteria and imported into Covidence. After removal of duplicates ($n=206$) the remaining 1,103 studies were screened by title and abstract for relevance. From those, 186 full-text articles were assessed for eligibility against inclusion criteria. An additional seven eligible articles were identified from hand-searching reference lists of included articles ($n=2$) or repeat database search in September 2021 ($n=5$). Outbreaks with more than one study describing outbreak characteristics and response were grouped together for data extraction ($n=4$ papers detailing two separate outbreaks). In summary, 39 articles were included, detailing 35 outbreaks and their associated response (see Fig. 1). All screening was carried out by BM, in consultation with AM, HM and LG. Any cases where article eligibility was unclear went to a consensus vote with all authors.

Data extraction

Data extraction was carried out by BM, with cross-checking conducted by AM. Included articles were grouped by decade of publication (1970-79, 1980-89, 1990-99, 2000–2009, and 2010-19). One paper from each decade was randomly selected and cross-checked by AM ($n=5$). Data extracted fell into three main categories: **Contextual** – information regarding the setting of the outbreak, specifically the date, type of study, region and author details; **Outbreak details** – information on the size and impact of the outbreak as measured by number of cases, outbreak duration (defined as number of days between first and last notified case), attack rate (cases per 100,000 population), case fatality rate (presented as a percentage), IMD complications; and **Outbreak response** – information on the public health management strategies including existing management guidelines, vaccine availability (whether there was a vaccine at the time of the outbreak that protected against the given strain), mass vaccination/chemoprophylaxis campaigns, lessons learnt and future recommendations summarized by authors.

Data analysis

Two main measures were used for outbreak size – total number of cases and attack rate (i.e. total number of cases per 100,000 population over the entire duration of the outbreak). Published attack rates were used whenever possible; when not provided, attack rates were calculated using the study-reported population size or publicly available official population estimates (e.g. university enrolment reports) as the denominator. A summary of calculations and population sizes is included in Additional file 1. Exact 95% confidence intervals (95% CI) for the attack rates were calculated using the Clopper-Pearson method. All calculations were conducted in Stata version 15 [15].

Quality appraisal

Included articles were assessed for quality in four domains: introduction, methods, results, and discussion. Each domain had key criteria or information that were expected, based on the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) Statement [16]. A single qualitative comment was added for each domain where criteria were absent or missing details. Key criteria included outbreak duration (clear start and finish dates), summary of investigation, case summaries (time, person, place), clear summary of findings and clearly identified author recommendations. A summary of comments is included in Additional File 1. Quality appraisal was carried out by BM, in consultation with AM, HM and LG.

Results

In total, 35 outbreaks in six regions from around the world were included. A summary of outbreaks and average number of cases by region is presented in Table 1. The earliest outbreak occurred in Finland in 1973, and the most recently reported outbreaks occurred in early 2018. Average duration (time between first and last reported case) was 221 days, or just over 31 weeks (range=4 days – 4.5 years). Of the 28 outbreaks that reported on seasonality, the most common seasons were spring/summer ($n=13$) and the equatorial dry season ($n=9$). Seven major settings were identified: Community: urban/metro ($n=11$ outbreaks), Community: rural/remote ($n=9$), Childcare and Educational ($n=7$), Events ($n=3$), Refugee camps ($n=2$), Army barracks ($n=2$), and Organisational ($n=1$).

Relative size (by attack rate) and location of outbreaks can be seen in Fig. 2. All outbreaks identified causative serogroup, which was either A, B, C or W. The predominant serogroup changed over time, from A or B outbreaks in 1970–1980 to A or C in 1990-early 2000s, then B or C in the mid-2000s with a recent increase in serogroup W outbreaks since 2016. Earlier outbreaks had a longer duration, often occurring over months or years. More recent outbreaks have lasted less than six months on average.

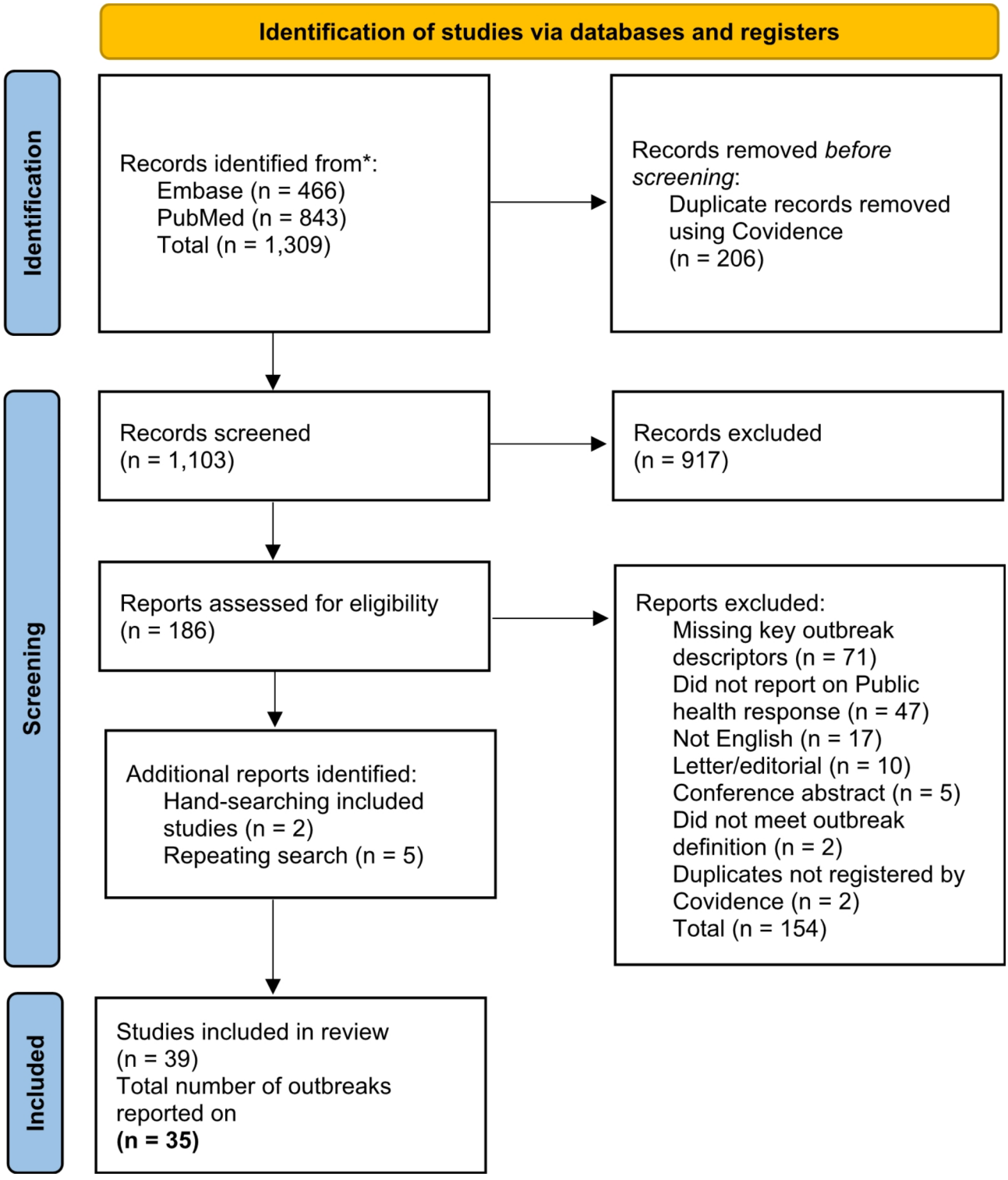

Fig. 1 PRISMA diagram of literature search and screening process. *From*: Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ 2021;372:n71. doi: https://doi.org/10.1136/bmj.n71. For more information, visit: http://www.prisma-statement.org/

Table 1 Summary of outbreaks by region

Region	No. outbreaks	Serogroups	Mean no. cases (range)	Median no. cases (1st – 3rd quartile)
Europe	13	A, B, C, W	124 (2 – 1,527)	7.5 (4.25-14)
Africa	10	A, C, W	12,956 (9-109,580)	291 (88 – 7,881)
North America	6	B, C	10 (3–19)	9.5 (5.5–15)
Asia	3	A, B, W	11 (5–17)	6 (5.5–11.5)
Oceania	2	W	13 (2–24)	13 (7.5–18.5)
South America	1	C	16 (NA)	NA

Outbreaks by setting

A summary of outbreak characteristics by setting can be seen in Table 2, below is a narrative summary of outbreak characteristics by setting.

Community (Urban/Metro)

Of the 11 outbreaks that occurred in urban or metropolitan community settings, eight occurred in Europe, and three occurred in North America. The European outbreaks occurred in France ($n=3$), the UK ($n=2$), Czechia ($n=1$), Belgium ($n=1$), and Finland ($n=1$). The Finnish outbreak had the longest recorded duration, from 1973 to 1976 (1,460 days) [17]. Average number of cases was 1479, with a median of 13.5 (Interquartile range, IQR = 8.75–30.5, range = 4–1,527) and seasonality was varied, the more recent the outbreak, the shorter the duration.

The typical response for this setting differed over time, as the earliest outbreaks occurred prior to vaccine availability. In the absence of vaccination, control measures such as mass-chemoprophylaxis and heightened disease surveillance were relied on. More recent outbreaks had more targeted responses, with an emphasis on identifying and managing only the community at risk. Author recommendations varied over time, but increasingly focussed on the importance of restricting clearance antibiotic use to contacts at the highest risk of transmission, and, with the exception of an outbreak in Tijuana, Mexico [18] relying on mass vaccination in preference to chemoprophylaxis when responding to the whole community.

Community (Rural/Remote)

There were nine outbreaks that occurred in a rural or remote community setting. Two occurred in remote Australian First Nations communities, and seven occurred in Sub-Saharan Africa. All outbreaks were associated with extended periods of hot, dry weather in the form of an arid Australian spring/summer or the Sub-Saharan dry season spanning December-June. Another commonality among these outbreaks was endemicity within the affected population, and occurrence over large geographic areas. As presented in Table 2, these outbreaks reported the highest average number of cases at 15,770 (median = 1,995, IQR = 24–9,367, range = 2–109,580).

Fig. 2 Map of reported outbreak locations ($n=32$) showing relative cumulative attack rates (number of cases per 100,000 population) as reported in Table 2, color-coded by serogroup

Table 2 Summary of outbreak characteristics, arranged by setting

Study	Outbreak location	Year and duration (days)	Serogroup	No. cases	Cumulative attack rate (cases per 100,000 population), 95% CI	Case fatality ratio (%)
Community Settings – Urban/Metro						
Cartwright 1986 [34]	Gloucestershire, England	1981 1,612	B	65	21.6 (16.6–27.5)	3.00%
Chacon-Cruz 2014 [18]	Tijuana, Mexico	2013 59	C	19	1.07 (0.0664–0.167)	36.8%
Delisle 2010 [42]	Dax City, Departement Landes, Aquitaine region, France	2008 274	B	11	8.90 (4.44–15.9)	9.09%
DeSchrijver 2003 [39]	Antwerp province, Belgium	2001 334	C	74	4.50 (7.70–10.7)	9.46%
Jacobson 1977 [37]	Mobile County, Alabama, USA	1974 396	B	16	20.0 (11.4–32.5)	31.3%
Krause 2002 [43]	Putnam County, Florida, USA	1998 395	C	12	36.4 (18.8–63.5)	16.7%
Kriz 1995 [41]	Olomuc and Bruntal, Czechia	1993 Olomouc: 240 Bruntal: 531	C	Olomouc: 9 Bruntal: 15	Olomouc 17.0 (7.77–32.3) Bruntal 23.4 (12.5–40.0)	UKN[a]
Peltola 1978 [17, 44]	Finland, Europe	1973 1,460	A	1,527	32.5 (30.9–34.1)	UKN
Perrett 2000 [38]	Rotherham, South Yorkshire, England	1988 7	C	8	UKN	25.0%
Pivette 2020 [32]	Departement Cotes-d'Armor, Brittany Region, France	2016 121	B	5	6.40 (2.08–14.9)	NA[b]
Thabuis 2018 [33]	Beaujolais province, Auvergne-Rhone-Alpes Region, France	2016 19	B	4	22.5 (6.13–57.6)	NA
Community Settings – Rural/Remote						
Chow 2016 [23]	Kebbi, Niger and Sokoto states, Nigeria	2015 118	C	6394	282 (275.14-288.99)	5.02%
Flood 2021 [45]	Ceduna Region, South Australia, Australia	2016 62	W	2	54.0 (6.54–195)	NA
Mohammed 2000 [21]	Nigeria	1996 182	A	109,580	UKN	10.7%
Mounkoro 2019 [22]	Kara Region, Togo, Africa (initial)	2016 176	W	1995	78.8 (75.4–82.3)	6.40%
Nnadi 2017 [30]	Zurmi Local Government Area, Zamfara State, Nigeria	2016 184	C	14,518	UKN	8.00%
Rude 2019 [46]	Foya District, Lofa County, Liberia	2017 30	W	9	679 (311-1,285)	44.4%
Sanogo 2019 [24]	Ouélessébougou district, Koulikoro Region, Mali	2010 58	C	39	18.07 (0.128–0.247)	15.4%
Sidikou 2016 [47]	Niger, Africa	2015 180	C	9,367	50.6 (49.57–51.62)	5.90%
Sudbury 2020 [20]	Alice Springs, Northern Territory, Australia	2017 153	W	24	10.9 (6.98–16.2)	NA
Childcare and Educational Settings						
Bassi 2017 [48]	Paris, Hauts-De-France, France	2017 89	W	2	200 (24.2–721)	50.0%
Capitano 2019 [49]	Eugene, Oregon, United States	2015 120	B	7	30.5 (12.3–62.8)	14.3%
Centers for Disease Control 2012 [50]	Rogers County, Oklahoma, United States	2010 21	C	5	270 (87.8–630)	40.0%

Table 2 (continued)

Study	Outbreak location	Year and duration (days)	Serogroup	No. cases	Cumulative attack rate (cases per 100,000 population), 95% CI	Case fatality ratio (%)
Ritscher 2019 [51]	University of Wisconsin-Madison, Madison, Wisconsin State, United States	2016 23	B	3	10.2 (2.10–29.7)	NA
Round 2001 [26]	University of Wales, Cardiff, Wales	1996 47	C	7	800 (294-1,734)	28.6%
Sekiya 2021 [25]	South-West Japan	2011 11	B	5	1,100 (358-2,546)	20.0%
Stewart 2013 [52]	West Midlands, England	2010 28	B	2	1,705 (353-4,900)	NA
Events						
Doedeh 2017 [53, 54]	Greenville, Sinoe county, Liberia	2017 9	C	27	26.4 (17.4–38.4)	37.0%
Kanai 2017 [55, 56]	Japan hosted WSJ, cases occurred in Sweden & Scotland	2015 4	W	6 (2 Scotland, 4 Sweden)	19.5 (7.16–42.4)	NA
Reintjes 2002 [40]	Belgium	1997 229	C	5	385 (125–895)	40.0%
Refugee Camps						
Haelterman 1996 [19]	Kibumba and Katale camps, Goma Region, Zaire	1994 62	A	Kibumba: 162 Katale: 137	Kibumba: 94.2 (81.0-109) Katale: 134 (117–152)	Kibumba: 8.00% Katale: 3.00%
Santaniello-Newton 2000 [57]	East Moyo sub-district, Moyo District, Uganda	1994 372	A	291	300 (267–336)	14.4%
Army Barracks						
Kushwaha 2010 [58]	Kashmir Region, India	2006 114	A	17	571 (333–913)	11.8%
Masterton 1988 [59]	Royal Air Force Base, Lincoln, England	1986 91	C	4	310 (84.4–791)	NA
Organizational Settings						
Iser 2012 [28]	Rio Verde, Goias State, Brazil	2008 147	C	16	12 (0.0686–0.195)	31.0%

[a]Not reported

[b]No deaths linked to this outbreak

The typical response included an outbreak response team of public health and clinical staff to the affected regions and a strong emphasis on community engagement and education. Febrile protocols were adopted as part of the clinical response [19, 20] – meaning the immediate provision of antibiotics to persons presenting with fever or other potential symptoms of IMD prior to laboratory confirmation. Mass vaccination was carried out in all instances. Specific to sub-Saharan Africa were mentions of resource limitations, underreporting of cases, and an inability to determine the causative pathogen for all clinically suspected IMD cases. Responses were often reliant on the WHO [21, 22] or non-governmental organisations (NGOs) such as Médecins Sans Frontiers [23] or the Bill and Melinda Gates Foundation [24] for assistance with surveillance, vaccine acquisition and distribution, resulting in decentralized and asynchronous responses. Recommendations included routine vaccination with long-lasting conjugate vaccines, stronger surveillance systems, and gradual scaling up of response capacity to reduce reliance on NGOs.

Childcare and Educational settings

Seven outbreaks occurred in educational or childcare settings. Four of these occurred in university student accommodation, two in childcare settings, and one in a high school dormitory. The university outbreaks either initiated in first-year cohorts or students returning from overseas travel. These outbreaks had some of the lowest case numbers presented in Table 2 (median=5, IQR=2.5–6), but also recorded some of the highest attack rates shown in Fig. 2, with a mean of 588 cases per 100,000 population (median=270, IQR=115–950 per 100,000, range=10.2–1,705 cases per 100,000).

These outbreaks were detected rapidly and responses were targeted to easily-identifiable social networks (residence halls, shared dining spaces, classroom). The typical response was mass-vaccination of the at-risk cohort in all cases except Sekiya et al. [25], as there was no meningococcal B vaccine licenced in Japan at the time of the outbreak. In that outbreak, chemoprophylaxis was limited to those in close contact with identified cases [25]. Recommendations included proactive vaccination of incoming residents to shared accommodation settings. Vaccination was described as preferable to mass-chemoprophylaxis where the population at risk was not easily identifiable as the duration of protection is much longer [26] and has no associated risk of encouraging microbial resistance. Authors also stressed the importance of appropriate, comprehensive information for the population at risk.

Events

There were two international youth events with associated IMD outbreaks, namely the 2015 World Scout Jamboree (WSJ) held in Japan, and a European youth soccer tournament held in Belgium in 1997. There was also one local event, a funeral in Sinoe County, Liberia. All three outbreaks were linked back to the respective events, with cases occurring among attendees and/or staff. The two international events were linked to small local outbreaks in attendees' home countries, indicating cases returning home were spreading IMD to individuals within their local communities.

The typical response to these outbreaks was increased surveillance, notification of event attendees and their contacts (with the added difficulty of cross-jurisdictional notification in the international events), and vaccination and chemoprophylaxis of at-risk contacts and communities. Responses and recommendations for case management differed depending on the case jurisdiction. Recommendations included facilitation of cross-jurisdictional notification of communicable disease and vaccination of incoming travellers to large international events.

The response described in the Liberian outbreak was made with no knowledge of the causal pathogen (later confirmed to be meningococcal C [27]). In this instance, an additional recommendation was made for increased testing capabilities and more comprehensive surveillance to allow quicker identification of causal pathogens.

Refugee camps

Two outbreaks occurring in refugee camps were included. Both camps were located in Sub-Saharan Africa, and outbreaks occurred in the dry season after large influxes of new residents. The overall health of residents was described as poor, with widespread malnutrition. Limited data was available on pre-existing vaccination coverage.

Responses included community education on good hygiene practices, immediate provision of antibiotics to any suspected cases, mass-vaccination campaigns, and active surveillance of cases and their contacts. Recommendations included improved vaccination coverage and screening of incoming residents, use of conjugate instead of polysaccharide vaccines for increased duration of protection, and more accommodation facilities to reduce overcrowding.

Army

Two outbreaks occurred in army barracks or training camps, one in the UK and one in the Kashmir region of India. These outbreaks were characterised by shared sleeping arrangements, largely transient populations and close living quarters. The Indian outbreak also occurred during a period of overcrowding within the training camp.

Response included enhanced surveillance, chemoprophylaxis of contacts at high risk of transmission (medical staff, those who shared barracks with cases) and vaccination in the case of the UK outbreak. Vaccination supply was not secured in time for the Indian outbreak, which was instead managed through isolation of cases, rearrangement of sleeping quarters to improve airflow, and strict contact-management protocols. Recommendations included routine vaccination of incoming recruits and better management of accommodation facilities to reduce the impact of overcrowding.

Organisational

One outbreak occurred in an organisational setting – a food preparation plant – before spreading to the wider community of Rio Verde, Brazil [28]. This outbreak recorded 16 cases, 14 of which were linked to the food processing plant, which was described as a humid, enclosed work environment.

The response to this outbreak was mass-vaccination of food plant workers as the population most at risk. After this vaccination campaign, there were no further cases identified among plant workers, but four additional cases were recorded in the wider community. The authors emphasise the possibility of asymptomatic spread within a community as an ongoing challenge to outbreak prevention and management [28].

Data quality

Few of the included articles reported on outbreaks and their response in a consistent manner. Key contextual information such as outbreak setting, size, and duration were missing from multiple studies. As summarized in Additional file 1, almost half ($n=15$) of the articles did not include an overall attack rate for the outbreak described, and three of these outbreaks additionally did not have

readily available population data. 16 articles either did not include or provided limited information regarding case demographics, number of contacts, outbreak duration or response size. Some public health responses were not clearly described, or required close reading to identify critical details.

Discussion

Over time, factors of geography and human behaviour have been identified as increasing the risk of development and spread of IMD outbreaks. Rural or remote regions were at a higher risk of community outbreaks of IMD, particularly during dry seasons or periods of reduced humidity [29]. These regions often spanned broad areas and when the response was not immediate, were the largest outbreaks by case numbers. A frequent point of discussion was resource limitations, in particular availability of testing, vaccine availability and vaccination facilities [21, 22, 30]. A common recommendation for people living in these areas was routine proactive vaccination with conjugate vaccines over reactive use of polysaccharide vaccines, which do not provide long-term immunity or herd immunity protections [5].

Shared accommodation settings also present an increased risk for outbreak development, in particular dormitories, barracks, or large refugee camps. Instances of overcrowding, paired with highly transient populations, are likely to lead to an increased risk of IMD given the introduction of a disease-causing strain [31]. This also extends to large events or gatherings, with several outbreaks associated with the Hajj and Umrah mass gatherings. Descriptions of these outbreaks were not eligible for inclusion in this analysis as they did not include any details on the associated public health response.

Some outbreaks did not have such an easily identifiable link to a high-risk setting, such as those occurring in urban or metropolitan communities. These outbreaks were either characterised by the emergence of a new, possibly hyper-virulent strain [32, 33] with rapid spread, or a steady increase in cases over several months or years [17, 34], and were more resource-intensive to manage. Without a clearly defined sub-population at risk, public health control measures were by necessity more expansive, applying to the entire region or community affected.

A gradual evolution in public health management of outbreaks can be seen over time, increased vaccine availability and strain coverage has allowed some jurisdictions to be more proactive in their outbreak prevention. Most developed nations include some form of meningococcal vaccine in their infant schedules. However, some countries, especially in Sub-Saharan Africa, are not necessarily able to afford a multi-strain vaccination program across their whole population [35]. These countries are not always equipped with public health systems able to mobilise and handle large-scale outbreaks of IMD [36], requiring the assistance of non-local resources to control outbreaks as they occur.

Outbreak reporting is used to inform future policy and practice, and good quality reporting is essential to inform effective, evidence-based practice [16]. Learnings for outbreak management happens retrospectively, with current practice based on the outcomes of past responses. Incomplete reporting of key contextual details such as outbreak size, setting, and duration alongside a comprehensive summary of response characteristics could influence future decision-making processes. There has been some consensus in recommendations over time (i.e. progression from chemoprophylaxis to vaccination), however reporting on outbreaks is non-standardised, and key measures of outbreak size and impact were often not reported in the studies considered here. This may have been unavoidable due to resource or other constraints, or lack of recognition that their reporting would be used to inform future management strategies, more widespread adoption of standard reporting guidelines for future reports should be considered.

Previous research has identified discrepancies in public health recommendations for management for close contacts to IMD cases [12, 13], however it is currently unclear what degree of international consensus there is in guidelines for management of IMD outbreaks. Without clear, comprehensive reporting, evidence on the effectiveness of different outbreak management strategies for IMD is difficult to ascertain. This evidence is often used alongside surveillance data, vaccine effectiveness studies, cost-effectiveness data, case reports and clinical trial data to inform the development of public health guidance for communicable disease management. Limited availability of this evidence may negatively impact the development of internationally consistent outbreak management strategies.

Conclusion

There are identifiable high-risk settings for outbreak development. Public health management of infectious disease outbreaks has historically been reactive, with a recent shift in focus to proactive measures. Reporting on outbreaks is inconsistent, and thus decisions around outbreak prevention and management are made without a full understanding of jurisdictional context.

High quality reporting is essential for effective, evidence-based policy and practice, in turn supporting the shift from reactive to proactive response measures. Consistent reporting, in line with the STROBE statement or similar reporting frameworks, would assist in optimising prevention and mitigation strategies for IMD outbreaks, and concurrently inform strategies to manage other infectious diseases.

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12889-024-19740-y.

Supplementary Material 1

Supplementary Material 2

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Author contributions
BM wrote the main manuscript text. AM provided assistance with article screening and data extraction. All authors (BM, AM, LG & HM) reviewed the manuscript and provided substantial feedback on research direction, manuscript preparation and final submission. All authors (BM, AM, LG, HM) provided edits following reviewer feedback.

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Data availability
The datasets used and analysed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and content to participate
Not applicable.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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