Online health information seeking for mpox in endemic and non-endemic countries: A Google Trends study.

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Abstract

Background: The recent global outbreak of Monkeypox has already been declared a Public Health Emergency of International Concern by the World Health Organisation. Given the health, social and economic impact of COVID-19, there is understandable concern and anxiety around the emergence of another infectious disease.

Objective: We aimed to explore online health information seeking for Monkeypox in endemic and non-endemic regions.

Methods: Google Trends search data was used as a surrogate measure of online health information seeking. Search data for the 178 day (between February 18th - August 18th, 2022|) were downloaded for non-endemic countries with the highest case count (USA, Spain, Germany, UK and France) and 5 endemic countries (Democratic Republic of Congo, Nigeria, Ghana, Central African Republic and Cameroon). Ioinpoint regression analysis measured change in searching trends following the announcement of the first in-human case.

Results: Online health information seeking significantly increased after the publication of the first case in all the non-endemic countries as illustrated by significant Joinpoint regression models. Whilst this was found in two endemic countries (Ghana and Nigeria) this was not found for Central African Republic, Democratic Republic of Congo or Cameroon.

Conclusions: Findings demonstrate a surge in heath information seeking relating to Monkeypox after the first in-country case was publicised. The increase in searching is characterised by a sharp, but short-lived period of searching before falling back to previous levels. Implications for the publication and provision of accurate relevant public health information during disease outbreaks – especially for diseases that are relatively unknown – are discussed. Clinical Trial: N/A

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Online health information seeking for mpox in endemic and non-endemic countries: A Google Trends study.

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Abstract

Introduction

The recent global outbreak of mpox has already been declared a Public Health Emergency of International Concern by the World Health Organisation. Given the health, social and economic impact of the COVID-19 pandemic, there is understandable concern and anxiety around the emergence of another infectious disease – especially one for which little is known. We used Google Trends to explore online health information seeking patterns for mpox in endemic and non-endemic countries and investigated the impact of the publication of the first in-country case on search volume.

Method

Google Trends is a publicly accessible and free data source that aggregates worldwide Google search data. Google search data was used as a surrogate measure of online health information seeking for the 178 days between February 18th - August 18th, 2022. Searching data were downloaded across this time period for non-endemic countries with the highest case count - United States of America (USA), Spain, Germany, United Kingdom (UK) and France and 5 endemic countries (Democratic Republic of Congo, Nigeria, Ghana, Central African Republic and Cameroon). Joinpoint regression analysis was utilised to measure changes in searching

trends for mpox preceding and following the announcement of the first in-human case.

Results

Online health information seeking significantly increased after the publication of the first case in all the non-endemic countries; USA, Spain, Germany, UK and France as illustrated by significant Joinpoint regression models. Joinpoint analysis revealed models with 3 significant joinpoints were the most appropriate fit for these data; where the 1st joinpoint represents the initial rise in mpox searching; the second joinpoint reflects the start of the decrease mpox searching trend and a 3rd joinpoint for where searching trends return to pre-first case announcement searching levels. Whilst this was also found in two endemic countries - Ghana and Nigeria - this was not found for Central African Republic, Democratic Republic of Congo or Cameroon.

Conclusions

Findings demonstrate a surge in online heath information seeking relating to mpox after the first in-country case was publicised in all the non-endemic countries and Ghana and Nigeria of the endemic counties. The observed increases in mpox searching are characterised by sharp, but short-lived periods of searching before steep declines back to levels observed prior to the publication of the first case. These findings emphasise the importance of the provision of accurate, relevant public health information online during disease outbreaks. However, online health information seeking behaviours only occur for a short time period, the provision of accurate information needs to be timely in relation to the publication of new case related information.

Introduction

Mpox is a viral zoonosis (transmitted to humans from animals) with symptoms similar to smallpox, although it is clinically less severe [1]. The current Monkeypox outbreak was declared a Public Health Emergency of International Concern (PHEIC) by the World Health Organisation July 23rd 2022. As of September 13th 2022 there have been approximately 57,995 confirmed cases globally, with 511 reported in countries where cases have occurred previously and 57,484 confirmed cases in countries that previously never reported Monkeypox infection [2]. The current outbreak of Monkeypox virus in humans suggests biological changes and or changes in human behaviour with these being precipitated by reduced smallpox immunity, relaxation of COVID-19

transmission prevention measures, recommencement of international travel and increased sexual interactions associated with large gatherings [3, 1]. Whilst human-human transmission was previously thought to be rare it is attributed to respiratory droplets or direct contact with mucocutaneous lesions of an infected individual [4]. Given the health, social and economic impact of the COVID-19 pandemic, there is understandable concern and anxiety around the emergence of another infectious disease [5].

The growth of global internet usage has made health related information more accessible [6]. Individuals increasingly use the internet to search online for health-related information. The data generated by this search traffic provides a rich dataset to monitor health information seeking behaviours [7] and can be used as a "surrogate" measure of disease awareness [8]. Using Google Trends (GT; Alphabet Inc, Mountain View CA, USA), a free and publicly accessible tool, it is possible to access such internet traffic data. GT analyses Google searches, generating data on the geographical and temporal search patterns according to specified keywords [9]. GT determines the proportion of searches for a user specified search term among all searches performed with Google. It uses this data to provide a relative search volume (RSV), which is the query share of a particular term for a given location and time period, normalised by the highest query share of that search term [7]. Utility of this data is still in its infancy but has been used successfully to predict outbreaks of influenza [10], norovirus [11] and COVID-19 [12]; the impact of disease awareness programmes [13,14] and the seasonality of searching for pain-related conditions [15]. With mpox being a rare disease and relatively unknown outside of endemic regions, we aimed to explore online health information seeking behaviour in both endemic and non-endemic regions using Google Trends. We hypothesised that RSV would be low for mpox until cases notifications were publicised in the media, which would precipitate an initial searching before a steep reduction in searching – replicating health information searching patterns seen in our previous work [13,14] and highlighting the increasing public awareness of this infection.

Method

Google Trends

Google Trends data comes from a sample of the total Google search data, which is categorized, connected to a topic, and anonymised. Searches with special characters, those with a very low search volume, and repeated

searches from the same individual over a short period are excluded. Each sampled data point is then scaled to the total number of searches done over the selected location and time period. This 'relative popularity' is given in the form of a Relative Search Volume (RSV) as a value between 0 and 100 (8). Google Trends data only reflects Google searches initiated by the user, not the subsequent online activity in response to the findings of the initial search.

Monkeypox case data

Monkeypox case data was recorded on August 18th 2022 and was accessed via The Centre for Disease Control (CDC) 2022 Monkeypox Outbreak Map [2]. The CDC global map displays case data per country where cases are confirmed by laboratory testing. The five non-endemic countries with highest cases numbers at the time of accessing the data were the USA (13,516), Spain (5792), Germany (3213), UK (3081) and France (2749). For endemic countries cases were highest for the Democratic Republic of Congo (163), Nigeria (157), Ghana (47), Central African Republic (8) and Cameroon (7). Ghana was included in the endemic country list, although not reporting confirmed cases until the 2022 outbreak, the country was identified as the source of a shipment that led to a 2003 outbreak [2]. Internet penetrance (as a percentage of the total population) for the countries in the study were as follows USA (91.2%), Spain (89.3%), Germany (93.3%), UK (96.6%), France (92.2%), Democratic Republic of Congo (7.3%), Nigeria (63.8%), Ghana (45.9%), Central African Republic (3.7%) and Cameroon (20.5%) [16].

Google Trends reporting

Users can manipulate aspects of Google Trends to tailor their search. To ensure transparency, reproducibility and quality of our methods, we followed the reporting guidelines recommended by Nuti et al 2014 [7].

Search input

The term [Monkeypox] was used to facilitate trend searching with 'topic' selected instead of 'search term' - searches and data downloads were completed before the WHO recommendation to use the term mpox (28th November 2022). Google describes a topic as "a group of terms that share the same concept in any language". The example they provide is that searching for "London" as a topic will yield results for searches including "capital of the UK" and "Londres", the Spanish name for London [17]. The topic feature encompasses

searches for relevant subthemes. For instance, our search input “Monkeypox” will have included Google Trends data for the search input “Monkeypox symptoms”. The topic feature encompasses linguistic variations of the search input. This is especially important as we analysed data from countries with differing official languages. Accommodating for linguistic variation enabled us to measure search inputs in other languages used within countries besides the official language, allowing for greater representation of searching behaviours across countries.

Search variables

Data was accessed from Google Trends on August 18th 2022. Daily RSV was downloaded for each country over a 6-month period to covering the start of the outbreak to the time of writing. Daily RSV was therefore downloaded for a period of 178 days between February 18th, 2022 to August 18th, 2022.

Analytic method

A time trend analysis was carried out on the RSV data as an indicator of health information seeking behaviour leading up to, and following, the announcement of the first in-human case. The joinpoint regression model was used to identify points where statistically significant changes in the linear slope of the trend had occurred. These best-fitting points, called ‘joinpoints’, mark a statistically significant increase or decrease in RSV. The Joinpoint Regression Programme (4.6.0.0 ed) was used to undertake the analysis [18]. This statistical software quantitatively identifies time points in which a temporal trend significantly changes and estimates the regression function with previously identified joinpoints [19]. In light of our previous GT work [13,14], the analysis was pre-set with criteria to find a minimum of 0 and maximum of 3 joinpoints. This was to capture an initial increase in RSV when initial mpox cases were discovered and publicised in country, a second for when searching would typically fall following this initial increase, and a third for when the downturn resumes back to levels seen prior to the first case. The model selection method was a permutation test, testing for an overall significance level at 0.05.

Results - (Figure 1 and 2 around here please)

Non-endemic regions

USA

RSV data are presented in Figure 1 (upper left). Analysis showed 3 significant joinpoints (*P*<.001). While there was a spike in searching around the date of the first case (May 18th 2022 or Day 89). This increase in RSV was the first joinpoint (*P* <.001) the most significant peak, and most appropriate joinpoint model was applied to the time that Monkeypox was declared a Public Health Emergency of International Concern (PHEIC) by the World Health Organisation (July 23rd 2022, or Day 155). This increase in RSV of approximately 800% represented the second joinpoint (*P*<.001). Searching peaked at day 167 – 14 days after the steep rise in searching began, the following reduction in searching represented the 3rd significant joinpoint (*P*<.001) back to pre-PHEIC announcement levels.

Spain

RSV data for Spain are presented in Figure 1 (upper middle). Analysis revealed 3 significant joinpoints (*P*<.001). The first mpox case in Spain was reported on May 18th 2022, or day 89. The first significant joinpoint (*P*=.027) was found on day 88 which led to a significant sharp rise in RSV of approximately 1000% in 4 days to the peak on day 92. Day 92 was also the location of the 2nd significant joinpoint (*P*=.002), which preceded a sharp decline in RSV for 9 days until joinpoint 3 (*P* <.001) at day 101, where RSV clustered around a level of 10.

Germany

RSV data for Germany is presented in Figure 1 (upper right). Analysis showed significant 3 joinpoints model (*P* <.001). The first significant joinpoint (day 88) lead to an approximate 1250% increase in searching the first case in Germany was reported (May 21st 2022 or day 91). RSV peaked at day 92 representing the second joinpoint (*P* =.026), with the steep decline in searching reaching the 3rd significant joinpoint (*P* <.0001) 9 days later. Despite the steep reduction in searching after the initial peak, RSV has remained higher than prior to the first case announcement.

UK

A significant 3 joinpoint model was found for UK RSV data (*P*<.001) and is presented in Figure 1 (lower left).

The first case was on the 6th of May 2022, or day 63, whilst this lead to an increase in RSV, the first significant joinpoint was found on day 87 (*P*<.001) reflecting an approximate 444% increase over 8 day period. The second significant joinpoint (*P*<.001) was the RSV peak (day 95), precipitating a steep fall over the next 5 days, where the third significant joinpoint is found (*P*<.001). RSV from this joinpoint onwards is only marginally higher than prior to the first case.

France

RSV data from France is presented in Figure 1 (lower right). Analysis revealed 3 significant joinpoints (*P*<.001). The first case was on May 19th 2022 or day 90. The first significant joinpoint is found on day 89 (*P* <.001), preceding the steep and immediate rise of approximately 2000% to peak RSV, 3 days later at day 92. Day 92 is also the second significant joinpojnt (*P*=.02). The following 8 days reflect a steep decline in RSV from the peak down to levels shown at joinpoint 1. Joinpoint 3 is reported at day 100 (*P*=.01), although there has since been a steady increase in RSV of approximately 100%.

Endemic countries

Democratic Republic of Congo

Mpox RSV data for the Democratic Republic of Congo (DRC) is presented in Figure 2 (upper left). No significant joinpoints were found during analysis (*P* =0.92). RSV levels range from 0-100, with a mean of 10.69, however as illustrated, RSV data points were widely spread.

Nigeria

Figure 2 (upper middle) displays RSV data for Nigeria. A significant 3 joinpoint model was found in the analysis (*P*<.001). Joinpoint 1 was found at day 89, before a 1000% increase in RSV to the peak at day 99. The second significant joinpoint is found earlier, at day 93 (*P*<.001) precipitating a less steep decline in RSV seen elsewhere. RSV post peak is much higher and varied after the 3rd significant joinpoint found at day 114 (*P*=.002) and shows searching gradually increasing towards day 178.

Ghana

RSV data for Ghana is presented in Figure 2 (upper right). A significant 3 joinpoint model is reported for RSV data in Ghana (*P* <.001). The first significant joinpoint (p=.03) was found on day 89, preceding the first case was reported in Ghana on June 8th 2022 or day 110. The second significant joinpoint is reported at day 94 (*P*=.003) at RSV of 50, 50% of the peak RSV found on day 97. The 3rd significant joinpoint (*P*<.001) is found on day 105 once RSV has declined. Post joinpoint 3, RSV gradually increases towards the end of the study period.

Central African Republic

RSV data for Central African Republic (CAR) is presented in Figure 2 (lower left). Analysis revealed no significant joinpoints in the data (*P*=0.43). RSV levels range from 0-100 with a mean of 19.87, however, there are no discernible trends observed in the RSV data.

Cameroon

RSV data for Cameroon is presented in Figure 2 (lower right). No significant joinpoints were found in the analysis (*P*=0.94). RSV levels range from 0-100 with a mean of 5.92. RSV remains relatively consistent throughout the study period, without observable trends.

Discussion

This study investigated online health information seeking behaviour for mpox in both endemic and non-endemic countries as a result of the 2022 global outbreak. We used Google Trends data as a surrogate for online health information seeking and joinpoint analysis software to analyse the data.

Data predominantly reflected the same pattern, whereby the first in-human case of mpox triggers a surge in online health information seeking. This pattern was observed for Spain, Germany, UK, France, Nigeria and Ghana. Whilst a significant 3 joinpoint model was found in the RSV data from the USA, the declaration of the mpox outbreak as a Public Health Emergency of International Concern (PHEIC) lead to a more significant peak compared to the publication of the first case. Furthermore, the 3 significant joinpoint pattern was not observed in CAR, DRC or Cameroon – despite DRC being the African country with the current highest

number of cases. However, our data suggested that whilst RSV for mpox was active in the country, the levels of searching were more sporadic and seemingly not following any discernible trend. Additionally, these 3 countries also had much lower internet penetrance (Democratic Republic of Congo, 7.3%; Central African Republic, 3.7% and Cameroon, 20.5%) compared to the other African countries (Nigeria, 63.8% and Ghana, 45.9%).

When a significant steep rise in online searching was reported (in both non-endemic and previously endemic countries), the trends all reflected the same type of pattern. A steep increase in searching behaviour that peaks quickly, a peak that is rarely sustained for more than a few days, before searching levels return to those seen prior to the initial surge. This is consistent with previous work exploring the impact of the disease specific awareness days on health-related information searching [13,14]. This observation can be attributed to several factors. Firstly, Google Trends data only accounts for one element of online health information searching, with other searching and subsequent learning taking place on other websites, or platforms, including social media. Mahabir et al proposed a stimulus-awareness-activism framework, in which an individual's awareness leads to both further online and offline activity related to the topic [20]. Mahroum et al assessed the digital behaviours in response to a Chikungunya outbreak by analysing the interplay between novel data streams, such as website searches or social networks [21]. GT was found to positively affect twitter activity. Essentially, users tended to search for "Chikungunya" on Google in response to notified cases, and then interacted with the topic on Twitter.

Further awareness can be acquired through browsing key topic websites. Users may find these through Google and thus subsequently directly access and use them as a source of health information. For instance, Kranenburg et al [22] explored Google Trends data for "blood donation" as a result of World Blood Donor Day, reporting that national level blood bank websites were visited twice as much as they would be typically, and this positively correlated with RSV for "blood donation". In light of this, it is possible that the initial surge in online health information seeking lasts longer than our data here might suggest, manifested though other data streams. Future studies should assess the relationships between traffic to disease specific websites/information sources and relevant Google RSV.

Publication of first cases of new or emerging diseases clearly promotes a surge in online health information seeking– especially if little is known about that condition. The spike in searching behaviours using Google occurs in a relatively short window, which has significant implications for the timely provision of accurate and evidence-based disease public health related information, around methods of infection, transmission prevention methods, symptoms etc. As seen in the RSV from the USA other events such as declaring a disease outbreak as PHEIC can lead to exponential increases in searching (although the surge in seeking is still short). Regardless, health bodies and governmental organisations must work to ensure that this information is searchable and in place (where it exists) as new disease cases or large news publication events are disclosed to the public. Conversely, this short window of public health information seeking is when harmful misinformation can also be found and become embedded in public consciousness.

In the countries where no significant trends in online health information seeking was found, particular endemic regions (Democratic Republic of Congo, Central African Republic and Cameroon) RSV remained relatively constant throughout the study period and reinforces the need for high quality disease information to be publicly accessible. As internet penetrance is low in these countries, the dissemination of public health related information (such as transmission prevention measures) must rely on different traditional infrastructures and media (newspapers, radio etc.). Further work is required to explore potential seasonal or climate-related factors on mpox searching trends in these countries. Research is also required on the effectiveness of the dissemination of public health information using traditional media is required and especially on how this information is interpreted.

There are limitations with using internet search query data and Google Trends data specifically as a measure of online health information seeking. First, only those with internet access can be accounted for in online health information seeking data, therefore, our findings are only valid for health information seeking that takes place online. Internet penetrance is high in the non-endemic countries, but substantially lower in the endemic countries and could have influenced our results [16]. However, a study on the worldwide Zika-related digital behaviour found that activity came mainly from the Central and South America region, even

though the Zika outbreak breached beyond this region and received global news coverage [23]. Second, the observed interest level is limited to those who use Google as a search engine. However, in the studied time period Google represented 95.6% of the search engine market share in Africa [24], indicating a sufficient level of internet access and use of Google [9]. Additionally, the calculation of the RSV is dependent on mathematical assumptions and approximations, which are not public. However, previous evidence suggests trends have been accurate in approximating the seasonality of conditions [25, 15] and at predicting influenza outbreaks comparable to the US CDC health surveillance [10]. Other factors may also contribute to the increase in online health information seeking behaviours observed in this study , such as general mpox news or the reporting of international mpox cases. Systematic review on the use of Google Trends in health-related research revealed poor documentation of the methodology in most studies, limiting reproducibility of study findings [7]. We have adhered to their documentation recommendations to ensure transparency and reproducibility of our methodology allowing for potential comparisons of findings over time.

In conclusion, we explored online health information seeking behaviours for mpox in endemic and non-endemic countries during the 2022 outbreak. We observed a large spike in searching for mpox related information after the announcement of the first case in the non-endemic countries and Ghana and Nigeria of the endemic countries. Consistent with our previous work we found that this increase in searching is only for a short period which has significant implications for the timely provision of accurate and accessible public health-related information online to increase public understanding of new diseases and reduce the likelihood of the spread of misinformation.

Acknowledgements

None

Data Availability

The data sets generated during and/or analysed during the current study are available from the corresponding author on reasonable request.

Conflicts of Interest

None identified

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None

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Supplementary Files

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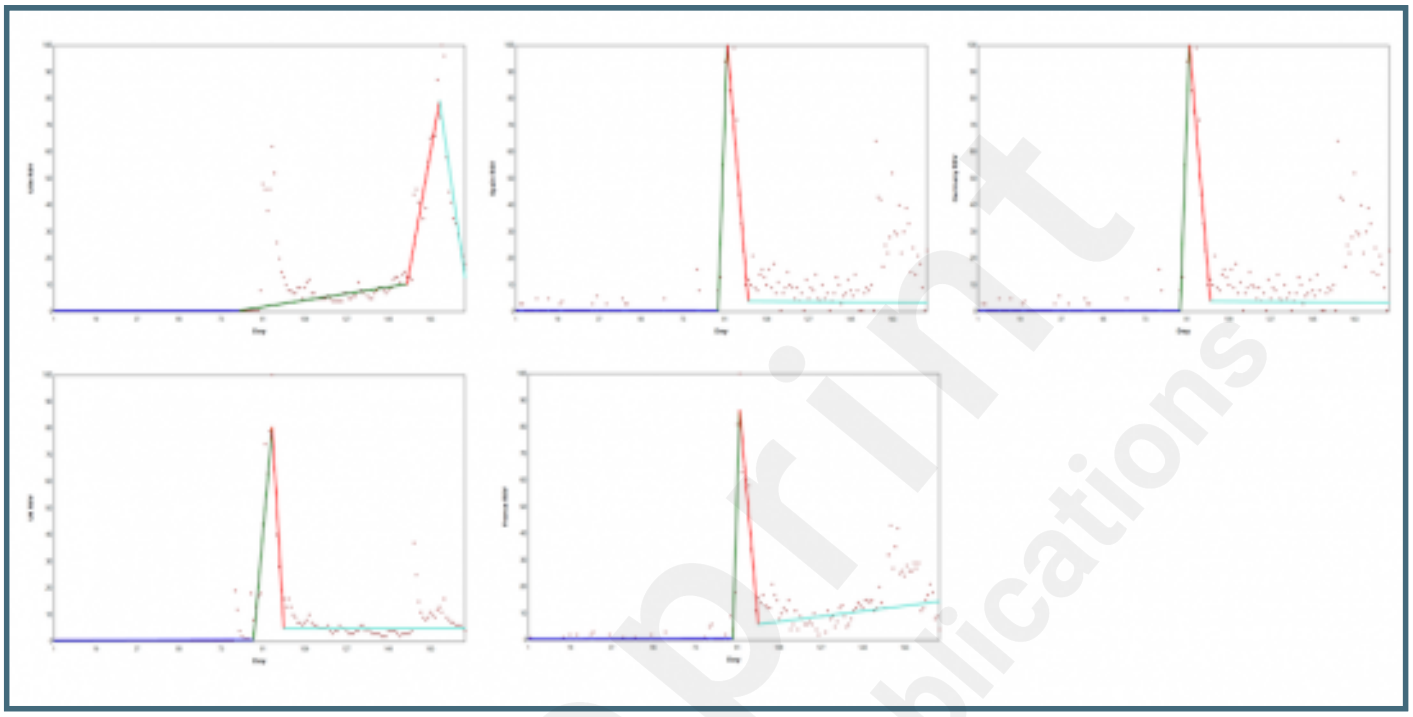
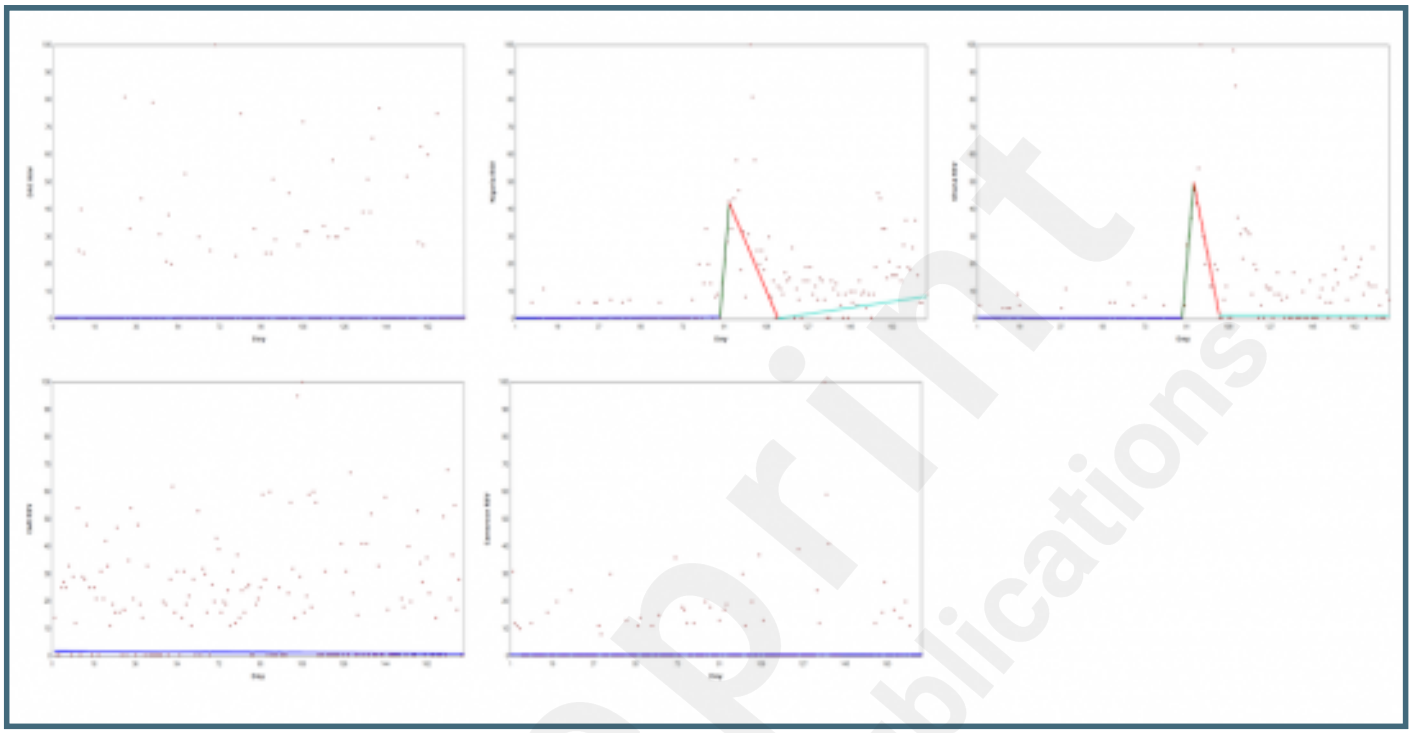
Figures

Changes in Relative Search Volume (RSV) for Monkeypox in non-endemic countries. Each data point indicates the Relative Search Volume (RSV) measured on the specified day. RSV is the query share of a particular term for a given location and time period, normalised by the highest query share of that search term. Colour scheme: Blue = 1st slope, green = 2nd slope, red = 3rd slope, mint green = 4th slope. Number of slopes present depends on the number of joinpoints identified. Joinpoints mark a statistically significant change in the linear slope of the trend in the studied time period.



Changes in Relative Search Volume (RSV) for Monkeypox in endemic countries. Each data point indicates the Relative Search Volume (RSV) measured on the specified day. RSV is the query share of a particular term for a given location and time period, normalised by the highest query share of that search term. Colour scheme: Blue = 1st slope, green = 2nd slope, red = 3rd slope, mint green = 4th slope. Number of slopes present depends on the number of joinpoints identified. Joinpoints mark a statistically significant change in the linear slope of the trend in the studied time period.



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