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EVALUATING GOOGLE TRENDS AS A PRIMARY CARE RESEARCH TOOL

A MULTIMETHOD STUDY

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INTRODUCTION

Google searches represent a snapshot of the world's interest in different topics. Data on this are collected and presented by Google Trends (GT), a publicly available tool that has gained recent popularity across various specialities of healthcare research. According to current literature, GT has the potential to indicate the seasonality of particular physical symptoms[1,2]; the suicide risk in populations[3]; and even how to control the current COVID-19 pandemic[4]. As a modern and real-time data source, GT is appealing to healthcare researchers, but whether it has a place in primary care research remains largely unaddressed.

GT collects relative search volume (RSV) data for different search terms and different topics. When a single term or topic is queried on GT, data are relative to all other Google searches in the chosen region across the chosen timeframe. RSVs are presented as a number between 0 and 100, where 100 represents the timepoint at which the particular search term/topic was at its peak popularity, relative to all other Google searches, within the chosen timeframe for the chosen region. When multiple search terms or topics are queried, the search volumes are relative to the inputted term/topic that had the highest RSV during the chosen timeframe. Regardless of the input into GT, no absolute data are accessible, yet RSVs can give promising insight into the public's interests and priorities, hence the incorporation of GT into recent healthcare research.

The importance of primary care in the community, although evidently different to speciality care in hospitals, has been well-documented. Primary care, being patients' first point of contact when accessing healthcare, is principal in identifying symptoms that warrant referral to appropriate specialities[5]. Influencing health behaviours and lifestyle changes is another key role of primary care physicians[6] and these components of primary care can be made more effective through research, thereby improving quality of care. As well as being effective, good quality of care is accessible[7] – a further dimension to primary care research.

This multimethod study aimed to explore GT as a research tool, with a focus on its potential in primary care research. It was necessary to find out whether sufficiently objective and reliable conclusions can be made from GT data, and whether the tool can be used to give useful indications about aspects of primary care, such as health problems that present to General Practitioners (GPs) and the specific groups of people who might experience these. Health behaviours and chronic disease prevention were also investigated using GT, as well as access to and experiences of primary care. This study aimed to evaluate whether GT is an appropriate tool for primary care researchers to incorporate into their future research.

METHODS

DESIGN

This was a multimethod study that involved using GT to explore RSVs for different search terms, incorporating patient involvement into the analysis and interpretation of GT data. Further investigations included an attempt to manipulate real-time GT data, as well as a comparison between GT and Twitter data. Data were also collected from the GP Patient Survey (GPPS) and a rapid review into the existing literature around GT. Finally, Patient and Public Involvement (PPI) were involved in the interpretation of GT data. All components of this study were considered in order to make final conclusions about GT as a primary care research tool.

USING GOOGLE TRENDS

RSV data can be quickly and easily collected from GT, so it was possible to collect data for range of search terms across various timeframes. All GT data collected were restricted to UK searches and, unless specified, all categories of searches were included. The input into GT was either a specific search term (referred to in the format *"this term"*) or a search topic. Topics suggested by GT include all searches relating to that topic, including search terms in different languages[8]. For each term/topic queried on GT, the 'Interest over time' data for a specified timeframe was downloaded in .csv format and used to produce line graphs. From these graphs, qualitative conclusions were drawn about the interesting trends and patterns in RSV, and these interpretations contributed to the overall evaluation of GT.

USING GOOGLE TRENDS TO RESEARCH HEALTH CONCERNS/CONDITIONS & SPECIFIC GROUPS THAT MIGHT EXPERIENCE THESE

One use of GT in primary care research is gaining insight into the health concerns or conditions that can present to GPs, in order to improve the early detection of diseases or conditions. Anorexia nervosa and health concerns or conditions in the Lesbian, Gay, Bisexual, Transgender (LGBT) population were chosen as specific examples to explore due to the lack of GT studies addressing these topics.

Although GT has been widely used in the surveillance of mental health problems, there is often a focus on depression[9] or suicide[10], rather than eating disorders. A significant proportion of GP appointments are about mental health[11,12] and given the crucial role of primary care in appropriately referring patients to specialist services, researching an area of mental health was appropriate for this study. Search terms relating to 'Pro-ana' - a harmful area of the internet that promotes eating disorder behaviours – were queried on GT with an aim to identify daily and longer-term patterns in relative search interest in 'Pro-ana' so as to get an insight into eating disorders.

With the Royal College of GPs recently launching LGBT online training modules for doctors[13], the recognition of health concerns specific to the LGBT population is increasing, hence exploring this area using GT. The general LGBT terms *"lgbt", "lesbian", "gay", "bisexual"* and *"transgender"* were inputted into GTs, and the effect of Google searches for lesbian pornography on the data was also investigated. Also, the 'Gay-Lesbian-Bisexual-Transgender' category on GT was explored using the term *"coming out"* in order to assess how this could be used to research the health concerns or conditions of the LGBT population specifically.

USING GOOGLE TRENDS TO RESEARCH HEALTH-RELATED BEHAVIOURS

Another aspect of primary care research is identifying and targeting the health-related behaviours, such as those that contribute to long-term health and those that lead to chronic disease. GT has the potential to help identify these behaviours and how they can be targeted. For example, RSV data for the term *"exercise bike"* were collected to indicate public interest in exercise. Smoking cessation and vaping were also explored by querying GT for the terms *"stop smoking", "vaping"* and *"stop vaping"* into GT. In addition, GT was queried for the term *"morning after pill"* to explore how GT could be used as an indicator of behaviours relating to sexual health.

USING GOOGLE TRENDS TO RESEARCH ACCESS TO AND EXPERIENCES OF PRIMARY CARE

Finally, GT has the potential to be used to research access to and experiences of primary care. Google has become a popular tool for quickly identifying and locating services, hence RSV data for primary care *"near me"* were collected. In order to determine whether this is a reliable indicator of access to primary care, relative search interest for *"near me"* in the categories 'Health', 'Arts & Entertainment' and 'Jobs & Education' were also explored.

Because Google is a search engine, it is designed to offer information by directing users to relevant information sources, so it's reasonable to expect that more emotive, experience-based searches are far less likely than query-based searches. Thus, the data that GT can offer on patients' experiences of primary care are limited, however RSVs for *"my doctor"* and *"a/the doctor"* were compared in order to get an insight into patient-physician relationships. *"My doctor"* would suggest a more personal, and perhaps long-term, patient-GP relationship than *"a/the doctor"* and this has been widely identified as a unique and valuable aspect of primary care.

MANIPULATION OF REAL-TIME DATA

GT presents one of two different samples of data – real-time and non-realtime[14] – depending on the timeframe that is filtered on. In order to investigate this further, an attempt to change the real-time data was made by asking 19 participants to simultaneously google the search terms *"cambridge" "gp" "primary care"* and *"nihr spcr"*. The participants were also asked to repeat the searches on another device, as long as the other device wasn't connected to the same Wi-Fi network, thus generating 38 simultaneous Google searches for each term specified. GT claims to exclude repeated searches made by the same person over a short timeframe[14]. The real-time 'Past hour' data on GT for each of these search terms were observed during the simultaneous searches.

COMPARISON WITH TWITTER DATA

In addition to search engines such as Google, social media platforms have the potential to be used in research, and data from these platforms could complement GT in research. Twitter's Application Programme Interface (API) allows public Twitter data to be accessed[15]. In order to compare GT to Twitter data, data on tweets relating to anorexia nervosa and LGBT health were imported. Tweets that include both *"proana"* and *"lgbt"* as well as other combinations of synonymous terms such as *"thinspo"* and *"gay"* were searched for. The number of tweets found for each of the 36 possible combinations (6 different 'Pro-ana' terms and 6 different LGBT terms) were recorded as a rudimentary example of data that can be collected from Twitter and not GT. Exploring Twitter data and comparing it to GT helped to identify and emphasise the strengths and weaknesses of using GT as a research tool.

GP PATIENT SURVEY (GPPS)

It was necessary to determine whether conclusions drawn from GT data are likely to reflect the interests/concerns/experiences of the population that access primary care. The weighted, national data for Question 5 – *Which of the following general practice online services have you used in the past 12 months?* – of the GPPS (2020) were collected using the Analysis Tool[16]. Data on answers to this question were also compared to the demographic factors age, ethnicity, long-term conditions, sexuality and working status in order to identify any biases in the population that use GP online services, thereby helping to identify any biases in the conclusions drawn from GT about patients' interests/concerns/experiences.

LITERATURE REVIEW

In this rapid review, the databases PubMed, Embase and Web of Science were initially searched for ("google trends" OR "google health trends" OR "internet search trends" OR "internet search log" OR "search engine trends") AND ("primary care"). Given the limited number of results from this initial search, an additional search was carried out on PubMed to identify studies that either used or reviewed GT for healthcare research not specific to primary care. These studies were identified by searching PubMed for studies that included “google trends” or “google health trends” in their title, so as to refine the search to studies that had a major focus on the use of GT.

The results of the search were discarded if they were duplicates, comments or errata. The titles and abstracts of all included studies were read and recurring themes across the different studies were noted, which allowed the studies to be sorted according to their main research themes. The contents of the abstract, the keywords and the MeSH terms were used to find out the main research themes. Studies that had no clear relation to any other study were assigned to the category ‘Other’. The studies that made a specific reference to an aspect of primary care were read in full and reviewed.

PATIENT INVOLVEMENT

The ‘Using Google Trends’ component of this study involved interpreting data from GT, often focussing on what the GT data could suggest about patients and their experiences. Therefore, it was useful to involve PPI in the analysis and interpretation stage of the study to hear unique interpretations of the data from patients. 9 members of the Cambridge University Hospitals (CUH) PPI Panel were sent Fig. 3, 4, 6 and 7. The panel were asked to make brief, qualitative conclusions from the graphs, guided by three questions assigned to each graph. Involving patients helped to evaluate the findings and make final conclusions about GT as a primary care research tool.

In addition, a patient panel recruited by the SPCR were consulted on this study as a whole. An outline of the methods and key findings from this study were presented to the patient panel, and participants were invited to give feedback on any aspect of the study.

RESULTS

USING GOOGLE TRENDS

USING GOOGLE TRENDS TO RESEARCH HEALTH CONCERNS/CONDITIONS & SPECIFIC GROUPS THAT MIGHT EXPERIENCE THESE

Table 1 – A summary of the findings from Google Trends when "proana" and synonymous terms were queried[17]

Timeframe	RSV trends for *"pro ana"* + *"proana"* + *"pro anorexia"* + *"proanorexia"* + *"proanorexic"*
Past 7 days	Consistent daily spikes at 02:00 or 03:00 with high fluctuation.
Past 12 months	Highly fluctuating RSV with no overall trends. Peak RSV for the timeframe is in early May.
Past 5 years	High fluctuation with no overall change until September 2017, after which there is a fluctuating decline in RSV until September 2018. Then no overall change but a possible spike in April 2020.
2004-present	Increase in RSV from January 2004 to January 2006, after which there is a highly fluctuating decline with a significant spike in April 2009, marking the time of peak popularity for this timeframe. Beyond this, the rate of decline and fluctuation become less significant, and RSV never exceeds 25.

Fig. 1 – A graph to compare RSVs for "lesbian" with "lesbian – porn – other related terms"[17]

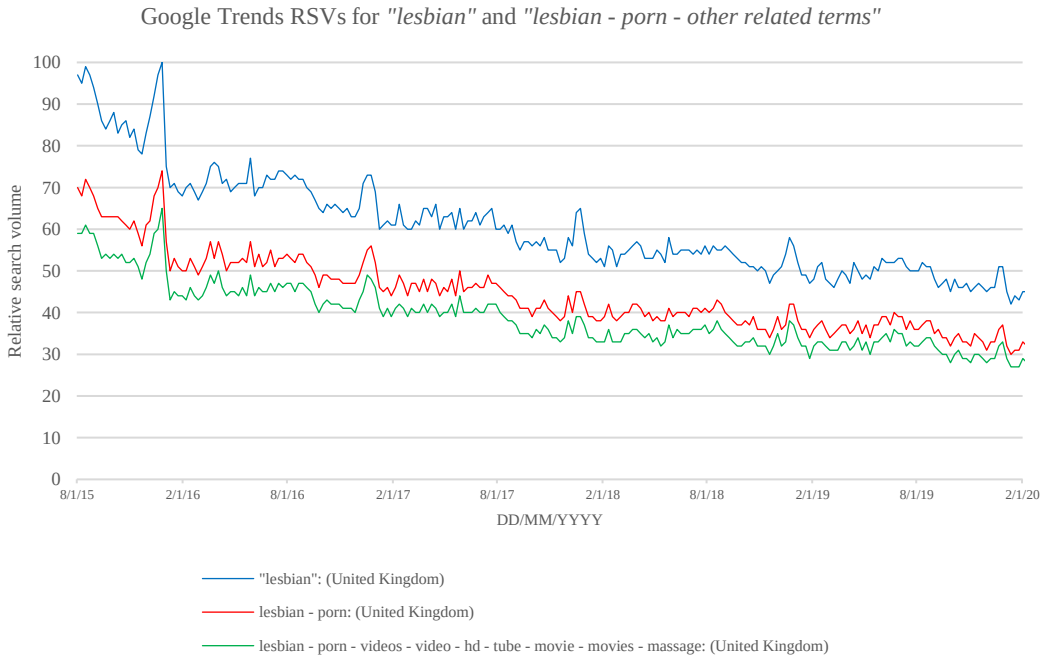
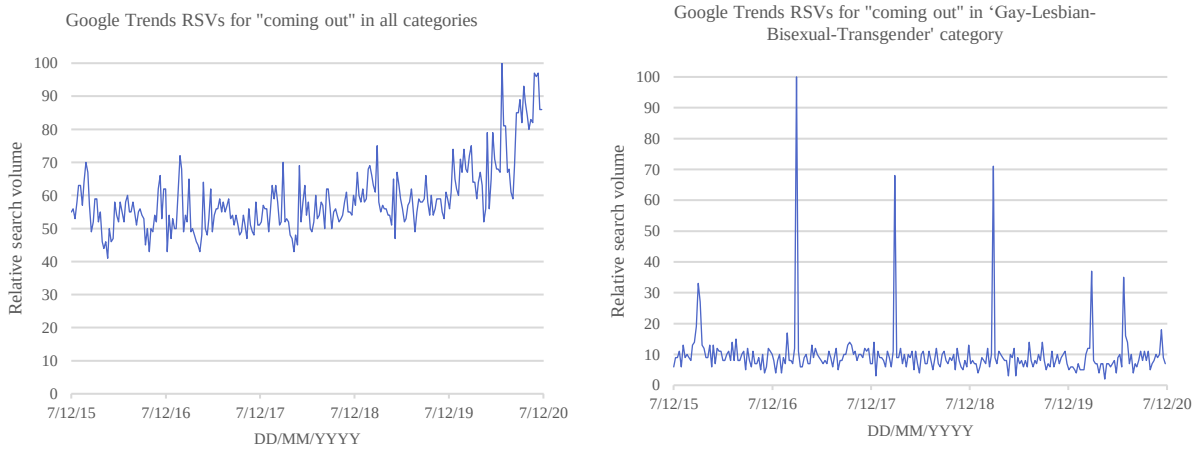


Fig. 2 – Two graphs used to compare RSV data for "coming out" in all categories and in 'Gay-Lesbian-Bisexual-Transgender' category[17]



Data interpretation

As shown in Table 1, GT data provided interesting patterns in searches for *"proana"* and synonymous terms across various timeframes. Data like these have the potential to improve support for people with anorexia nervosa, such as helping charities like Beat[18] secure funding for extending their helpline hours. This is relevant to primary care because charities like Beat can be recommended by GPs in order to help support those awaiting a referral to specialist services.

When the general terms *"lgbt", "lesbian", "gay", "bisexual"* and *"transgender"* were inputted into GT, the term *"gay"* was relatively the most popular, followed by *"lesbian"*. The other 3 inputted terms had far smaller RSVs over a 5-year timeframe. Due to *"gay"* being the most general of the terms, the higher RSV was to be expected. In order to account for the high RSV of the term *"lesbian"*, the top related queries were investigated, which included *"lesbian videos"* and *"lesbian tube"*, suggesting lesbian pornography accounted for a significant proportion of the high RSV for the term *"lesbian"*. Consequently, the 'Related queries' section on GT was consulted for the top related search terms, and those relating to pornography were excluded. Even when all these terms were excluded, the data in Fig. 1 generally follows the same pattern still, implying there are far more terms relating to pornography that would require exclusion. 'Related queries' only shows a maximum of 25 'top' search terms (and 25 'rising' search terms), so it's difficult to ascertain what further search terms would be necessary to exclude in this data collection, highlighting a limitation of GT.

It was difficult to identify a search term that could give an insight into health concerns specific to the LGBT population, hence exploring the impact of specifying the GT category 'Gay-Lesbian-Bisexual-Transgender'. The RSV data for *"coming out"* in all categories was compared to the data for the same term in the LGBT category, shown in Fig.1. The annual spikes in RSV for searches specific to the LGBT category happen around National Coming Out Day each year, illustrating the credibility of using this category to filter GT data to help research health concerns of the LGBT population.

Despite the GT LGBT category showing promise for the term *"coming out"*, its use for exploring search terms relating to health in the LGBT population was limited. For example, when *"proana"* and synonymous terms were queried on GT with the LGBT category specified, GT didn't have sufficient data to generate any results, suggesting a limited potential of GT for researching the health concerns of a specific group of people.

Fig. 3 – A graph to show RSV data for "exercise bike"[17]

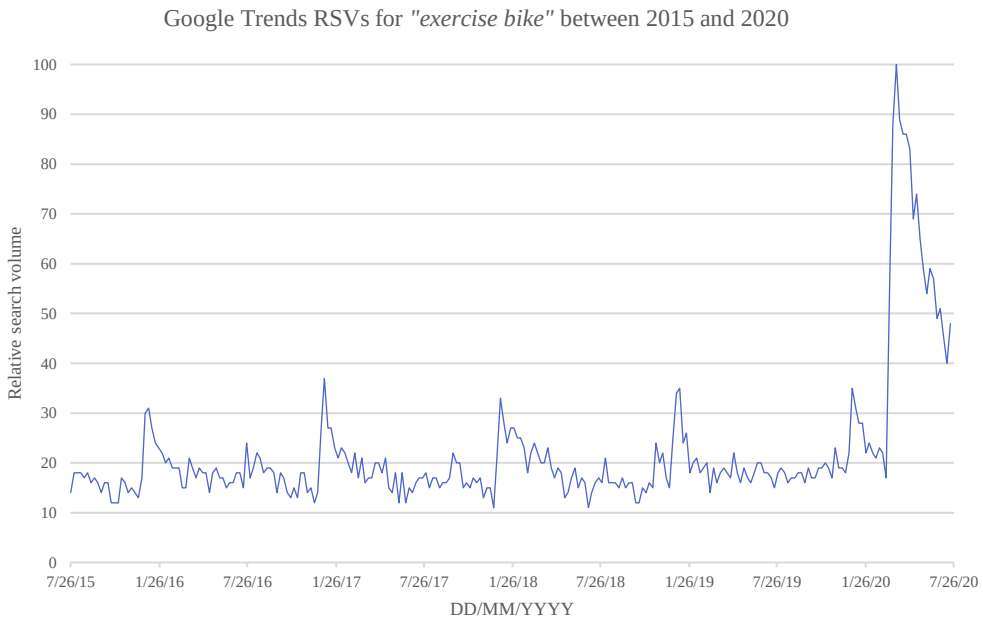


Fig. 4 – A graph to show RSV data for terms relating to smoking cessation and vaping across a 15+ year timeframe[17]

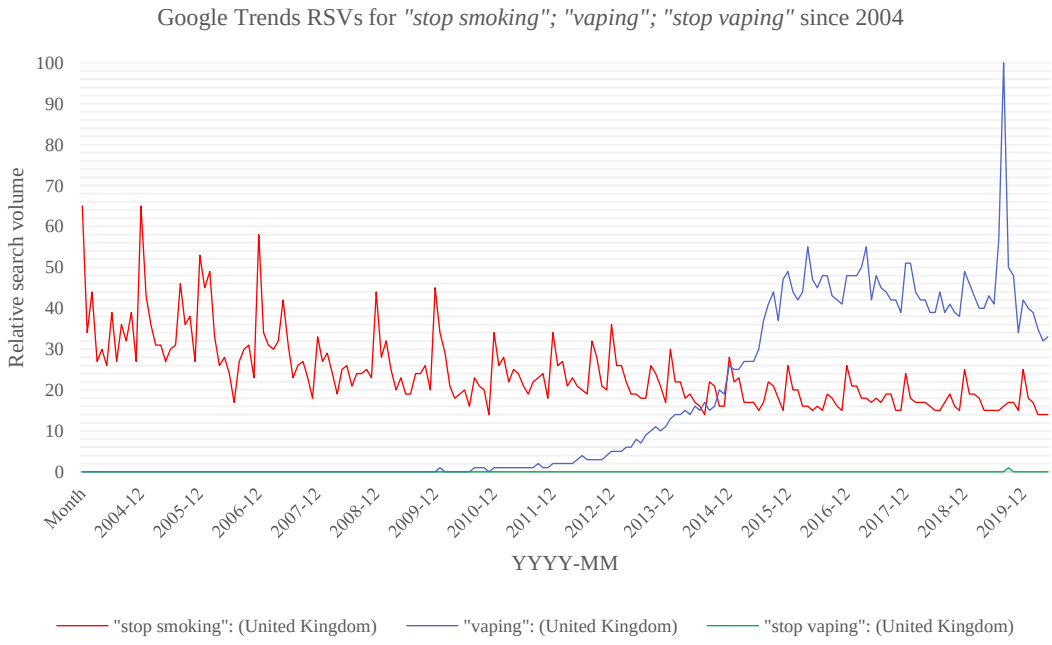
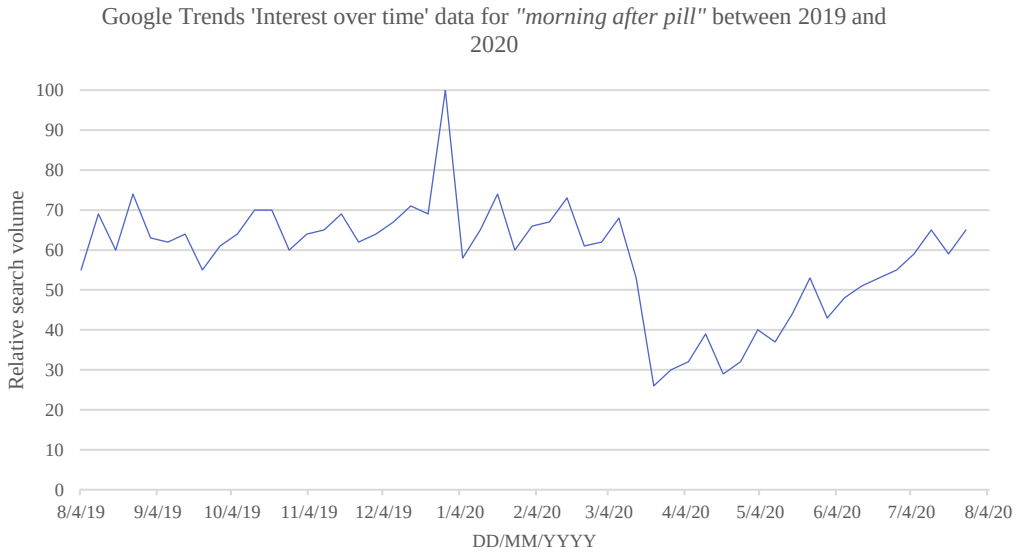


Fig. 5 – A graph to show RSV for the topic 'Emergency contraception' across a 7-day timeframe[17]



Data interpretation

Interestingly, there were clear seasonal trends in RSV for the terms *"exercise bike"* and *"stop smoking"*, such as annual spikes around January, perhaps suggesting the significant impact of New Years' resolutions on health behaviours. The huge spike in RSV in March 2020 seen in Fig.3 could be accounted for by the onset of the national lockdown in response to COVID-19, illustrating how GT can be used to monitor public interest in health behaviours, such as exercise. By identifying these trends in interest in health behaviours, the timing of campaigns and advertising could be tailored in order to have the most impact. The huge spike in RSV for *"vaping"* in August 2019 can be accounted for by news stories into the first reported death from vaping at the time[19].

Another interesting finding from GT data with regards to the national lockdown can be seen in Fig.5, in which there was a clear drop in RSV for the term *"morning after pill"* in mid-March 2020. This is an example of how GT could be used to provide insight into behaviour patterns, such as unprotected sex in this case. The search term *"morning after pill"* is a particularly useful search term to query on GT, because Google searches for the term are unlikely to be made by people other than those with an intention of taking the pill. This was supported by a supplementary query made on GT for the timeframe 'Past 7 days', which showed daily spikes in RSV for *"morning after pill"* in the early hours of the morning.

Fig. 6 – A graph to show RSV data for primary care "near me"[17]

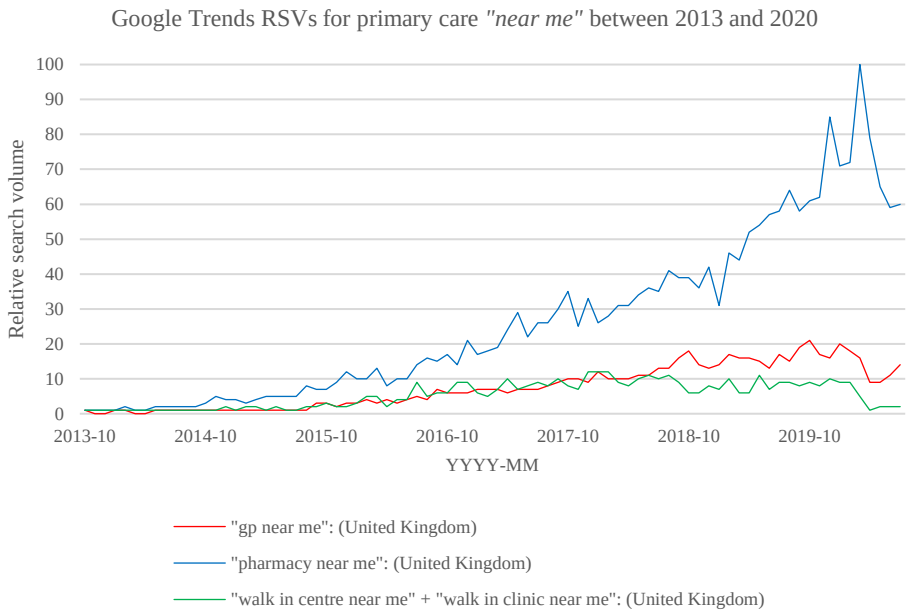
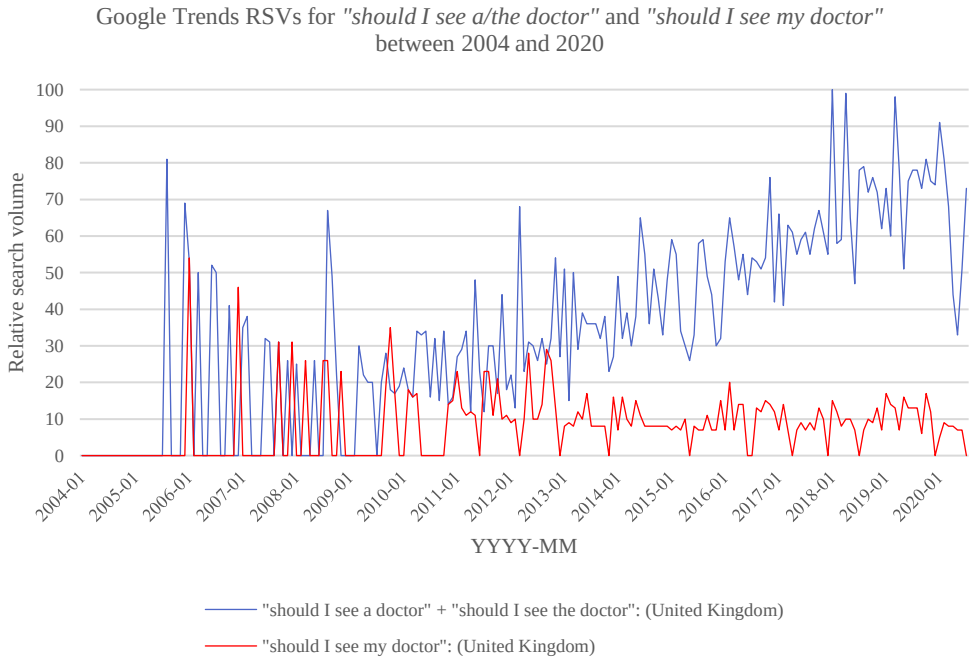


Fig. 7 – A graph to show RSV data for "should I see a doctor" + "should I see the doctor" versus "should I see my doctor"[17]



Data interpretation

The increases in RSV for *"pharmacy near me"* and other primary care near me search terms from 2015 to 2020 are shown in Fig. 6. At face-value, this could be interpreted to suggest an increase in access to primary care with time, however the term *"near me"* showed a similar increase since 2013 across different categories, suggesting there a general increase in the use of Google to locate nearby services over the past 7 years: a trend not specific to primary care access. In addition, the *"near me"* data from GT merely reflects trends in the use of Google to locate nearby services, rather than offering a complete reflection of the public's interest in accessing the services. Similarly, the insights into patients' experiences of primary care that GT can offer are limited. The comparison between *"my doctor"* and *"a/the doctor"* was intended to capture how patients might implicitly view their relationship with their GP, however it's unforeseeable that any firm conclusions could be made from using GT in this way, given the ambiguity of Google searches.

MANIPULATION OF REAL-TIME DATA

No obvious changes in the 'Past hour' data were observed for the search terms that were repeatedly googled. Given all GT data is relative, this was to be expected, because 38 simultaneous searches for the same term is a small number of searches relative to all other Google searches across the UK. However, an interesting observation was the difference between the real-time data observed within the hour in which the repeated searches were made, and the non-real-time data obtained after that hour. Despite the repeated searches not affecting the RSV data, GT did generate RSV data for the 'Past hour' for 3 of the 4 search terms. However, when the same search terms were inputted into GT beyond one hour after the repeated searches, and the hour of 15:00-16:00 (the hour in which the repeated searches were made) was specified, GT either didn't have sufficient data to display any interest over time, or the data that was displayed appeared markedly different to the 'Past hour' data. This highlighted the important distinction between real-time and non-real-time GT data that future GT studies should make clear.

COMPARISON WITH TWITTER DATA

Like GT, data from Twitter can offer an insight into the interests and concerns of internet users. However, there are clear differences between how each has the potential to be useful in primary care research. Twitter data offered evidence of tweets that include both the terms *"proana"* and *"lgbt"* and other combinations of synonymous terms – an example of a specific health condition in a specific population. Table 2 shows the number of tweets that include different combinations of terms: a rudimentary example of how Twitter data could be used to research a relatively niche interest/concern amongst a specific group of people. Data of this specificity couldn't be collected from GT.

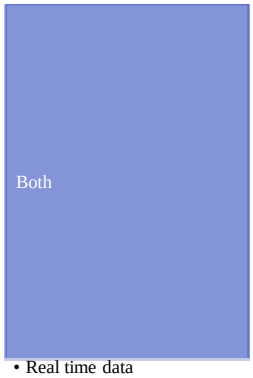
Furthermore, Twitter, like other social media platforms, involves hashtags, which allow tweets to cover a huge range of different themes that might otherwise seem completely unrelated. GT data is constrained by the fact that Google is intended to answer specific, short queries, and hence a single Google search doesn't involve such an expanse of themes. Similarities and differences between GT data and Twitter data are summarised in Fig.7.

Table 2 - Number of tweets that included both terms x and y as of 24/07/2020 13:00

		x					
		lgbt	*gay*	*lesbian*	*queer*	*bisexual*	*trans*
y	*proana*	4	7	48	0	14	2
	proanorexia	0	0	0	0	0	0
	thinspo	2	16	83	0	13	12
	thinspiration	0	1	0	0	0	0
	meanspo	2	1	58	1	7	11

Fig. 7 - A summary of comparisons between Google Trends and Twitter data

- Limited by time - data from 2004
- Relative data
- Geographical data
- Related queries section
- Data sorted into topics and categories
- Limited by ambiguity of Google searches - specific topics are difficult to research
- Automatic interest across time data



- Real time data
- Data allows interest in a search term/topic to be identified
- Comparisons between interest in different search terms/topics
- Interest across time data can be collected

- Limited by number of tweets - most recent 150,000
- Absolute data
- No geographical data unless incoporated into input
- No equivalent to related queries section
- No equivalent to topics and categories
- Use of hastags on social media allows more specific topics to be researched
- Interest across time data can be collected manually

GP PATIENT SURVEY (GPPS)

As shown in Table 3.1, the majority of GPPS respondents reported using none of the 3 specified GP online services. For the 5 different demographic factors that were considered (age, ethnicity, long-term conditions, sexuality and working status), the percentages of different demographic groups responding to question 5 with 'None of these' were different, as shown in Table 3.2.

Table 3.1 – National answers to Question 5 of the GPPS 2020[20]

Answer to Q5 - *Which of the following general practice online services have you used in the past 12 months?*	**National (%)**
Booking appointments online	18%
Ordering repeat prescriptions online	19%
Accessing my medical records online	6%
None of these	71%

Table 3.2 – Weighted percentages of different demographic groups answering 'None of these' to Q5[20]

Demographic factor	Demographic groups																		
	Age	**All**	**16-24**	**25-34**	**35-44**	**45-54**	**55-64**	**65-74**	**75-84**	**85+**									
		62%	77%	72%	71%	69%	68%	68%	78%	85%									
	Ethnicity	**All**	**English / Welsh / Scottish / Northern Irish / British**	**Irish**	**Gypsy or Irish Traveller**	**Any other White background**	**White and Black Caribbean**	**White and Black African**	**White and Asian**	**Any other Mixed / multiple ethnic background**	**Indian**	**Pakistani**	**Bangladeshi**	**Chinese**	**Any other Asian background**	**African**	**Caribbean**	**Any other Black / African / Caribbean background**	**Arab**	**Any other ethnic group**
		62%	71%	71%	81%	70%	73%	73%	68%	68%	68%	75%	75%	69%	73%	77%	76%	78%	73%	76%
	Long-term condition	**All – *including no long-term conditions***	**Alzheimer's disease or other cause of dementia**	**Arthritis or ongoing problem with back or joints**	**Autism or autism spectrum condition**	**Blindness or partial sight**	**A breathing condition, such as asthma or COPD**	**Cancer (diagnosis or treatment in the last 5 years)**	**Deafness or hearing loss**	**Diabetes**	**A heart condition, such as angina or atrial fibrillation**	**High blood pressure**	**Kidney or liver disease**	**A learning disability**	**A mental health condition**	**A neurological condition, such as epilepsy**	**A stroke (which affects your day-to-day life)**	**Another long-term condition or disability**	**I do not have any long-term conditions**	
		62%	77%	68%	71%	76%	64%	66%	71%	65%	68%	65%	67%	76%	61%	60%	72%	60%	78%	
	Sexuality	**All**	**Heterosexual or straight**	**Gay or lesbian**	**Bisexual**	**Other**	**Prefer not to say**													
		62%	71%	61%	66%	74%	75%													
	Working status	**All**	**Full-time paid work (30 hours or more each week)**	**Part-time paid work (under 30 hours each week)**	**Full-time education at school, college or university**	**Unemployed**	**Permanently sick or disabled**	**Fully retired from work**	**Looking after the family or home**	**Doing something else**										
		62%	70%	70%	75%	76%	69%	71%	72%	74%										

LITERATURE REVIEW

The initial literature search across three databases generated 8 results, however upon review of these studies, only 1 made a specific reference to primary care, hence a broader literature search was carried out.

The PubMed search for studies that included “google trends” or “google health trends” in their title generated 205 results, of which 12 were excluded. The remaining 193 studies were sorted according to their main research themes, shown in Table 4. 11 studies fell under more than one of the research themes in Table 3. Only 2 studies made a direct reference to primary care, one of which was identified in the initial literature search.

Table 4 – Research themes of Google Trends studies

Research theme	Examples	Number of studies
Infectious disease - forecasting/surveillance/public awareness/understanding/interest	COVID-19, influenza, dengue fever	52
Non-infectious disease - forecasting/surveillance/public awareness/understanding/interest	Rheumatoid arthritis, cancer, asthma	45
Medicine/treatment/intervention - public awareness/understanding/interest	CBD oil, cosmetic procedures, antibiotics	36
Impacts of awareness campaigns and health warnings on public awareness/understanding/interest	World Thrombosis day, pictorial health warnings, Breast Cancer Awareness month	12
Lifestyle choices/factors - public awareness/understanding/interest	Sunbeds, smoking cessation, tattoos	12
Other - public awareness/understanding/interest	Pollution awareness, overwork prevention, stock prices	11
Mental health – forecasting/surveillance/risk prediction	Mental health concerns during lockdown, suicide risk prediction, NSSI monitoring	10
Vaccination/screening/preventative measures - public awareness/understanding/interest	Sun protection, HIV vaccination, breast cancer screening	10
Google Trends as a healthcare research tool	Systematic reviews of Google Trends in research, methodology framework	7
General symptoms – surveillance	Oedema, headache, hair loss	6
Medical education/medical professions	Socioeconomic behaviours on dental profession, interest in orthopaedic surgery residency, informing anatomy education	3
Specific reference to primary care	Access to primary care, how Google Trends can inform pharmacy practice	2

Reviews of Google Trends studies relevant to primary care

Although the study into access to primary care by Ssendikaddiwa et al. (2019) was conducted in Canada, the authors defined primary care as "the first point of contact with the health care system" that "provides access to referred health care services"[21], therefore the study is helpful when considering the use of GT to research access to primary care in the UK. By comparing province-level data from GT to the results of a survey addressing patient-reported access to primary care, a positive correlation between walk-in clinic RSV and reports of getting same- or next-day appointments was identified. The authors interpreted this correlation, amongst others, as evidence of the plausibility of using GT as a public health indicator. In addition, the study identified a national increase in RSV for walk-in clinics across a seven-year timeframe, suggesting an increase in the use of the internet to find convenient, accessible primary care. The authors correctly acknowledged an inability to determine what this increase in RSV reflected, and that patterns in the public's primary care seeking are only partially reflected in Google searches. Therefore, the study concluded that GT *"may offer some insight"* but recommended further validation of using GT data to research service use.

Hanna et al. (2019) investigated the use of GT to inform pharmacy practice[22]. This study used GT 'Related queries' to research the types of information that people search for regarding commonly prescribed antibiotics. For example, the commonly searched *"what is/are antibiotics?"* was interpreted as a general lack of understanding of antibiotics by the public. The study also used Google to investigate the websites that people are directed to when medicines or medical conditions are queried; 'Related queries' were again used to inform the authors as to which terms to input into Google. GT was also used to identify seasonal patterns in interest in Irritable Bowel Syndrome and smoking cessation as respective examples of a particular medical condition and a social/lifestyle factor. The variety of methods that incorporated GT in some way was encouraging to see, and the authors optimistically concluded that GT can inform pharmacy practice when used alongside other data, potentially informing marketing strategies, public health policies and health promotion campaigns.

PATIENT INVOLVEMENT

Members of the CUH PPI Panel were most confident in their interpretations of GT data relating to health behaviours (Fig.3 and Fig.4). For example, the annual spikes in RSV in January seen in Fig.3 were consistently interpreted as evidence of New Years' resolutions, and the spike in March 2020 was accounted for by the national coronavirus lockdown. Therefore, the reliability of these conclusions was strengthened by PPI.

The panel also gave interesting interpretations of Fig.6 and Fig.7. A number of members referred to the difficulty of getting a GP appointment, and how this might account for the relative increase in searches across time for *"pharmacy near me"* seen in Fig.6. As one member put it, *"you just can't get an appointment these days when you try"*, which was a valuable, patient-centred interpretation of the data shown in Fig.6.

More variation was seen between the interpretations of Fig.7 by different members of the panel. While some were highly doubtful of any difference between the phrases *"a/the doctor"* and *"my doctor"*, others personally related to the difference in phrasing, for example:

> *"(…) for several years I would have said there was such a thing as 'my' doctor – indeed the family's doctor. From a certain point it became difficult to get an appointment with a specific GP, especially in the short term and I have had to accept whoever is there on the day."*

Despite reflections like the above, members of the panel were largely unsure of conclusions drawn from the data on access to and experiences of primary care and were summarised as *"highly speculative"* by one member.

One panel member offered a particularly interesting reflection on using GT in primary care-focussed research in general: *"more primary care visits are likely to be made by older people and more Google searches are likely to be made by younger people"*. This supports the notion that there is demographic bias in GT data, which is addressed in the *Evaluation of Google Trends.*

There were positive comments from the SPCR patient panel about the components of this study, as well as GT as an exciting potential research tool. A particularly interesting piece of feedback on this study was the need to address how patients would benefit from a research tool like GT. Although GT may not have the potential to directly benefit patients on an individual basis, patients can benefit from new research tools on a population level. For example, GT could be used to inform the timing of public health campaigns, which would be a population-level approach that would indirectly aim to benefit individual patients.

EVALUATION OF GOOGLE TRENDS

This study into GT has explored its opportunities and potential in primary care research. Using all the results collected in this multimethod study, the following section aims to comprehensively evaluate GT as a primary care research tool.

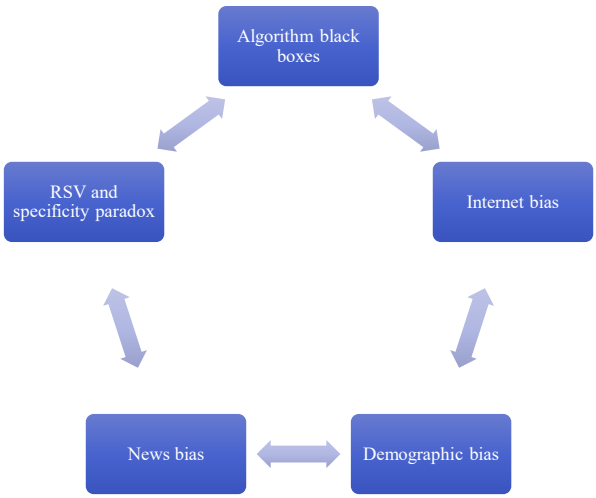
ACCESSIBILITY

The accessibility of Google Trends is its most appealing characteristic as a primary care research tool. The fact that Google Trends sorts RSV data according to a variety of factors such as location, timeframe and search categories, is another impressive feature of the tool. Google Trends 'Interest over time' data were focussed on in this study, however Google Trends also has sections on 'Interest by subregion' and 'Related queries'. These factors all contribute to Google Trends being an extensive data source that has an infinite range of *potential* uses.

KEY LIMITATIONS

Multiple limitations of GT were encountered during this study, and these can be refined to five key limitations summarised in Fig.8. As shown, these key limitations interact with and reinforce each other. By explaining these key limitations and the findings that support each of them, this section aims to help inform researchers on the necessary considerations to make when incorporating GT into future research.

Fig.8 – An infographic to summarise Google Trends' key limitations



ALGORITHM BLACK BOXES

A major limitation to GT as a research tool is the lack of transparency around how exactly different components of GT data are collected. These so-called algorithm black boxes result in unanswered questions including, but not limited to, the following:

- How exactly is 'Interest by subregion' data generated?
- How does GT sort search terms into topics?
- How are 'Related queries' identified?
- What is the threshold for low-volume searches to be filtered out by GT?

The fourth question regarding the filtering of Google searches to only include data on popular search terms and topics on GT is a particularly interesting algorithm black box. The attempt to manipulate real-time data on GT explored this question, because it was found that 38 simultaneous Google searches had no effect on the real-time data for any of the included search terms. The exact sensitivity of GT to manipulation of this kind remains unclear. Algorithm black boxes such as this diminish the reliability of any conclusions drawn from GT data, greater transparency from Google on its data collection would greatly strengthen GT as a research tool.

PARADOX BETWEEN SUFFICIENT RELATIVE SEARCH VOLUME AND SEARCH SPECIFICITY

As mentioned previously, GT will only present data on search terms that have sufficiently high RSV. According to Google, *"Trends only shows data for popular terms"*[14], and therefore search terms with insufficient RSV are automatically filtered out of GT data. As a result, broader, more vague terms are better to query on GT to increase the likelihood of generating data. For any query on GT, insight into the 'when' and 'where' components of RSV can be gained, but the context of the searches – i.e. the 'what' component of RSVs – are an area of ambiguity that largely involves logical guesswork. On this basis, highly specific queries are preferable, in order to be confident about the conclusions drawn from GT data. Yet, more specific queries are less likely to have sufficient RSV. Therefore, there is a paradoxical requirement for both high RSV and high search term specificity in order for GT data to have potential in practice. This greatly limits the number of search terms that are useful to query on GT.

Researchers can make use of the 'Related queries' section on GT to find out the predominant contexts of searches that include the inputted term. For example, for the term *"vaping"*, the top 'Related queries' for the timeframe of the data shown in Fig. 4 reveals *"vaping bad"* was 40% as popular as *"uk vaping"*. Therefore, the 'Related queries' section does help to address the otherwise ambiguous 'what' aspect of RSV data – *although GT only displays 25 'Related queries' for any given search term.*

INTERNET BIAS

All search terms lie somewhere along a spectrum of internet presence and internet absence. Internet slang or terms that originated online, such as *"proana"*, are internet present, whereas terms that are used far more in the real world rather than online are internet absent. GT is inevitably biased towards search terms with internet presence. It's very plausible that a range of search terms relevant to patient concerns are internet absent, and this is particularly implicated in primary care, because GT may not offer a full reflection of problems that often present to GPs. Demographic factors have a role in this limitation, because demographics less likely to use the internet, such as the elderly as suggested by the results of the GPPS, are plausibly less likely to Google search terms relating to their concerns. As a result, there wouldn't be an expanse of GT data for these search terms, reinforcing the internet bias. Therefore, internet bias limits the number of terms that would be useful to query on GT in future research.

DEMOGRAPHIC BIAS

As mentioned previously, the GPPS data suggested differences between the use of GP online services between different demographic groups. Assuming these differences at least partially reflect the use of the internet in general, any form of internet data, such as those from GT, will inevitably be biased towards particular demographic groups. Therefore, studies with an aim to gain insight into public interests or concerns can only rely on GT to offer a partial reflection.

NEWS BIAS

News stories bring implications for GT data. An example of this is shown in Fig. 4, in which the huge spike in RSV for *"vaping"* in August 2019 can be accounted for by news stories into the first death from vaping at the time[19]. Using GT to monitor interest in a health-related behaviour, in this case vaping, is implicated by interest in news stories about the health behaviour in question. In fact, a number of studies identified in the literature review used a statistical news debiasing tool to remove news bias from GT data[23].

SUMMARY

In summary, GT was found to be most useful for researching health-related behaviours, because the most reliable conclusions could be made from GT data addressing this theme. There is moderate potential for GT to be used to research health conditions/concerns, as long as the search term queried has sufficient RSV and is sufficiently specific to make reliable conclusions from. Factors such as internet bias and news bias bring particular implications for choosing appropriate search terms for this type of research. GT would appear to be the least useful for researching access to and experiences of primary care. This study used specific examples to explore the potential of GT, somewhat limiting the reliability of the conclusions made about the broad prospects of GT in primary care research, however the scope of the different queries made on GT was broad and varied so as to explore the myriad of potential uses of GT.

The findings of this study are intended to inform primary care researchers of the uses and possible implications of GT as a research tool. As discovered in the rapid review, the use of GT is widespread across different specialities of research, particularly in epidemiological studies. However, the evidence of GT for research that has a predominant focus on primary care is far more limited, hence this study aimed to explore whether this popular research tool has a part to play in future primary care research.

REFERENCES

1. Moccia M, Palladina R, Falco A, Al E. Google Trends: new evidence for seasonality of multiple sclerosis. *J Neurol Neurosurg Psychiatry*. 2016;87(9):1028-1029. doi:10.1136/jnnp-2016-313260

2. Kamiński M, Łoniewski I, Marlicz W. "Dr. Google, I am in Pain"—Global Internet Searches Associated with Pain: A Retrospective Analysis of Google Trends Data. *Int J Environ Res Public Health*. 2020;17(3):954. doi:10.3390/ijerph17030954

3. McCarthy MJ. Internet monitoring of suicide risk in the population. *J Affect Disord*. 2010;122(3):277-279. doi:10.1016/j.jad.2009.08.015

4. Wong SH, Teoh JYC, Leung C-H, et al. COVID-19 and Public Interest in Face Mask Use. *Am J Respir Crit Care Med*. Published online June 15, 2020. doi:10.1164/rccm.202004-1188le

5. Bankhead CR, Collins C, Stokes-Lampard H, et al. Identifying symptoms of ovarian cancer: A qualitative and quantitative study. *BJOG An Int J Obstet Gynaecol*. 2008;115(8):1008-1014. doi:10.1111/j.1471-0528.2008.01772.x

6. Bardach SH, Schoenberg NE. The Role of Primary Care Providers in Encouraging Older Patients to Change Their Lifestyle Behaviors. *Clin Gerontol*. 2018;41(4):326-334. doi:10.1080/07317115.2017.1376029

7. Campbell SM, Roland MO, Buetow SA. Defining quality of care. *Soc Sci Med*. 2000;51(11):1611-1625. doi:10.1016/S0277-9536(00)00057-5

8. Compare Trends search terms - Trends Help. Accessed July 27, 2020. https://support.google.com/trends/answer/4359550

9. Tana JC, Kettunen J, Eirola E, Paakkonen H. Diurnal variations of depression-related health information seeking: Case study in Finland using google trends data. *J Med Internet Res*. 2018;20(5). doi:10.2196/mental.9152

10. Kristoufek L, Moat HS, Preis T. Estimating suicide occurrence statistics using Google Trends. *EPJ Data Sci*. 2016;5:32. doi:10.1140/epjds/s13688-016-0094-0

11. Mind. 40 per cent of all GP appointments about mental health. *Mind - better Ment Heal*. Published online 2018. https://www.mind.org.uk/news-campaigns/news/40-per-cent-of-all-gp-appointments-about-mental-health/#.XJ0tbuv7Su5

12. RCGP. Mental Health Toolkit. Published 2015. Accessed July 20, 2020. https://www.rcgp.org.uk/clinical-and-research/resources/toolkits/mental-health-toolkit.aspx

13. Downey A. Royal College of GPs launches LGBT online training modules for doctors. Accessed July 22, 2020. https://www.digitalhealth.net/2020/01/royal-college-of-gps-launches-lgbt-online-training-modules-for-doctors/

14. Google. FAQ about Google Trends data. Published online 2020. https://support.google.com/trends/answer/4365533?hl=en

15. Twitter. About Twitter's APIs. Accessed July 22, 2020. https://help.twitter.com/en/rules-and-policies/twitter-api

16. GP Patient Survey - Analysis Tool. Accessed July 27, 2020. https://gp-patient.co.uk/analysistool?pageid=15

17. Google. Google Trends. Accessed August 5, 2020. https://trends.google.com/trends/?geo=GB

18. Beat. Beat Homepage. Accessed July 28, 2020. https://www.beateatingdisorders.org.uk

19. First death linked to vaping reported in Illinois - BBC News. Accessed July 24, 2020. https://www.bbc.co.uk/news/world-us-canada-49452256

20. GPPS Analysis Tool. Accessed July 27, 2020. https://gp-patient.co.uk/analysistool

21. Ssendikaddiwa J, Lavergne R. Access to Primary Care and Internet Searches for Walk-In Clinics and Emergency Departments in Canada: Observational Study Using Google Trends and Population Health Survey Data. *JMIR Public Heal Surveill*. 2019;5(4):e13130. doi:10.2196/13130

22. Hanna A, Hanna L-A. What, where and when? Using Google Trends and Google to investigate patient needs and inform pharmacy practice. *Int J Pharm Pract*. 2019;27(1):80-87. doi:10.1111/ijpp.12445

23. Lampos V, Moura S, Yom-Tov E, et al. Tracking COVID-19 using online search. 2020;(ILI):2-13. http://arxiv.org/abs/2003.08086

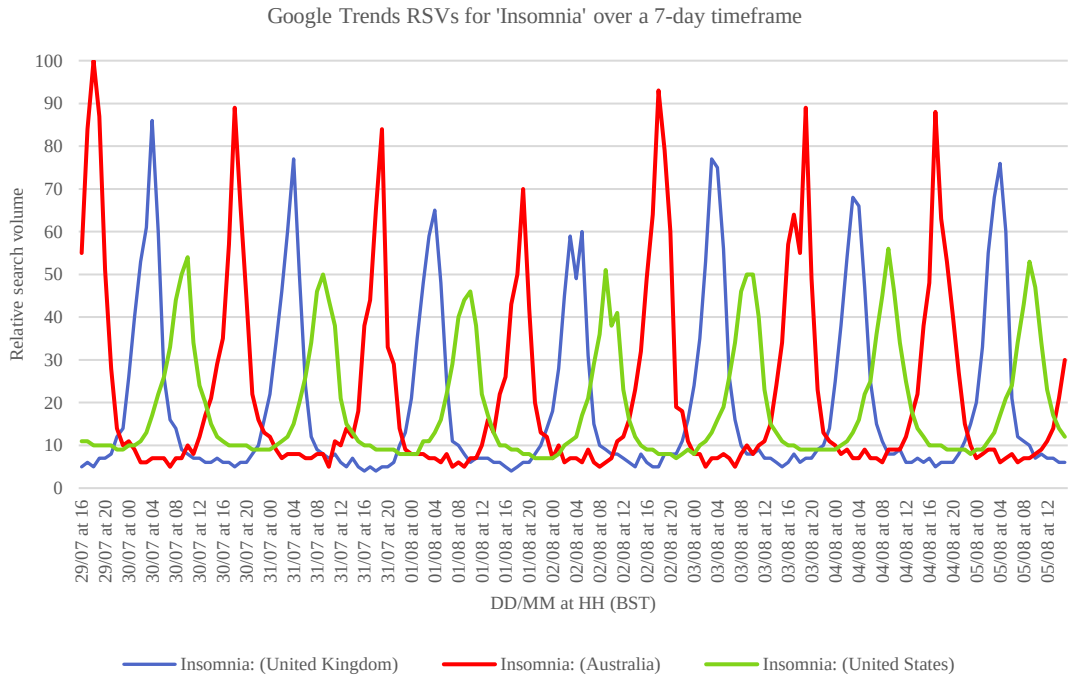
APPENDICES

AN OVERVIEW OF GOOGLE TRENDS

⇒ Inputs
- "*this term*" – searches for exact term, including searches with words before and/or after
- *"term 1" + "term 2"* – searches that include term 1 OR term 2
- *"term 1" – "term 2"* – searches that include term 1 and NOT term 2
- Choosing a specific category is useful for investigating terms with different meanings in different contexts – by choosing the relevant category, the GT data will reflect searches for the particular term in the context of interest

⇒ Downloading data
- Download raw data in .csv format and convert into any graph using any appropriate programme e.g. Microsoft Excel
- Although the graphs appear automatically on GT, the graphs aren't downloaded, only the raw data

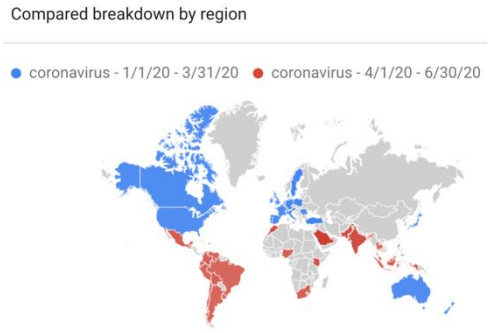
⇒ Interest over time
- Popularity of a search term across the time period, relative to the peak time of popularity in the chosen period
- If inputting multiple terms, the popularity of an individual term is relative to the highest point on the graph i.e. when the most popular term was the most popular
- The times on the *x*-axis are in local time (i.e. GMT/BST if located in the UK), therefore this is a necessary consideration when comparing locations with different time zones – the example below of 'Interest over time' for the topic 'Insomnia' illustrates this
- The spikes in RSV for 'Insomnia' in the UK are around 4am BST each day; in Australia they are around 6pm BST; and in the USA they are around 9am BST each day



17

⇒ Compared breakdown by subregion, metro or city

- Compare relative popularities of different search terms or relative popularities of a single search term in different time periods in different subregions, metros (US) or cities e.g. countries when searching worldwide; UK cities; different states in America etc
- When more than one term is inputted, a breakdown of relative percentage searches for each of the terms in each subregion/metro/city is available (must use the same time period)
- Alternatively, input the same term in different time periods and again compare subregion/metro/city breakdowns
- The examples below show how either search term or timeframe can be inputted as an independent variable



17

⇒ Interest by subregion, metro or city

- For each term inputted, a value between 0 and 100 is assigned to each subregion/metro/city to indicate the term's popularity as a fraction of total searches in that location
- This allows the subregion/city in which the term was the most popular to be identified

⇒ Related topics/queries

- Lists of topics/terms that users who searched for a particular term also searched for is generated
- 'Top' related topics/queries are those that were searched the most, where a value of 100 is assigned to the most popular related topic/query
- 'Rising' related topics/queries are those that increased in popularity during the chosen time period, shown as the percentage increase in popularity – 'Breakout' indicates an increase in popularity of over 5000%

GOOGLE TRENDS SEARCH FRAMEWORK

This framework offers a recommended procedure for using GT efficiently for research, based on my own experiences using GT. I aim to offer clarification on how to access GT data, and efficiently build a search strategy suitable for inclusion in a paper's methodology.

PUNCTUATION ESSENTIALS

- *this term* – searches that include the words *this* AND *term* in any order, with words before and/or after
- "*this term*" – searches that include the exact term, no change in word order, with words before and/or after
- *"term 1" + "term 2"* – searches that include *term 1* OR *term 2*
- *"term 1" – "term 2"* – searches that include *term 1* and NOT *term 2*

CHOOSING SEARCH TERMS

Classification of literal search terms

1. Search term indicates an interest in information/news about *x*
    - Difficult to find a search term that doesn't apply to this
2. Search term indicates a desire/need for *x*
    - *"x near me" "x for sale" …*
3. Search term indicates a desire/need to remove/get rid of *x*
    - *"how to sell x" "get rid of x" …*

- Researchers should decide which of the above, or multiple, could apply to a particular search term by pilot searching GT and looking at the Related queries box
- The more types that apply to a search term, the weaker the GT data for the search term will be, in terms of being able to make reliable conclusions from the data
- The majority of terms searched for across all categories would fit type 1 at some point in time, so it would be at the discretion of the researcher to decide whether type 1 searches about *x* account for a significant proportion of all searches that include *x* across the chosen timeframe
  ⇒ E.g. A spike in searches for "morning after pill" in July 2017 can be accounted for by the news story of a controversy involving Boots' pricing. This, combined with "chemist near me" being a breakout related query across the 5-year timeframe, would suggest "morning after pill" doesn't fit type 1, and exclusively fits type 2
- If a particular search term fits all 3 types, then it should be revised if any reliable conclusions are to be made from the GT data, and an ideal search term only fits into one type

More abstract indications of search terms

- *x* doesn't necessarily have to be included in the search term itself
  ⇒ E.g. "best diet" could be an appropriate search term for finding out about the interest in weight loss, i.e. the search term "best diet" would fall under type 2 (& type 1) where *x* is weight loss
- However, for these search terms, analysis of the related queries is even more important, because it's more likely that some searches are in an irrelevant context, due to the more abstract nature of the search term and intended indication
  ⇒ E.g. related queries for "best diet" include "best diet for menopause" and "best diet for ibs" so not all searches are relevant to the context of weight loss

INVESTIGATING A SINGLE SEARCH TERM

- Once a suitable search term has been chosen, filters and categories can be modified in order to fully investigate the GT data for that search term
- Keep the search term under 'All categories' to begin with, and alter the time filter
- The geographical filter can also be varied if appropriate, but avoid focussing on very small regions in the early stages – I would advise against changing the geographical filter to regions any smaller than single countries or US states at this stage
- Another filter is type of search, however for the vast majority of research, the default 'Web search' is the most appropriate
- Due to how easy and quick it is to alter the filters on GT, the more filtering variations investigated, the better
- It's advisable to plan out the different filters to be applied and keep a log of results with date and time of access, due to the real-time nature of GT
- Once a vague picture of the query's Trends pattern under 'All categories' has been built, the search term's data under different individual categories can be investigated
- I would advise picking a timeframe during which the search term showed a consistent Interest over time pattern, or the timeframe of interest to the researcher
- Keep the timeframe constant and pick the category that best fits the context of interest, followed by the subcategory, logging each of these separately
- GT doesn't provide direct comparisons between searches for the same term under different categories/subcategories, however this can be easily done by downloading the data in .csv format for each separately, and combining the data for comparison in a programme of choice
- This is useful for determining whether changing the category/subcategory makes a difference to the term's Interest over time – defining and consistently using a specific category/subcategory (or using 'All categories') is a crucial aspect of a researcher's final search strategy
- If a researcher plans to compare different search terms, then I would advise investigating each individually as above to ensure they all individually meet the preliminary criteria before inputting more than one search term into GT

DEFINING A SEARCH STRATEGY

- Once the preliminary investigations into the search term have been carried out as above, it should be possible to define a specific search strategy to include in the methodology section of a research paper
- This should include
  - ⇒ The search term(s) to be investigated, and under which category/subcategory
  - ⇒ The geographical region(s) to be investigated
  - ⇒ The timeframe(s) to be investigated
  - ⇒ The date(s) and time(s) that GT data will be collected
  - ⇒ Any comparisons to be made between different search terms, such as their relative Interest over time or any geographical comparisons to be made