Evaluation of Google Search Trends for Liver Diseases in Europe

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ABSTRACT

Background & Aims: Chronic liver diseases belong to the most common diseases worldwide and are associated with increased morbidity and mortality. Although more than one in three adults are estimated to have metabolic dysfunction-associated steatotic liver disease (MASLD), awareness of this condition is low amongst the general public, health care professionals and policy makers. However, meaningful knowledge transfer is essential for raising awareness and improving prevention and treatment. This study set out to investigate the use of the major internet search engine to understand how knowledge transfer has evolved by analyzing liver-related searches trends.

Methods: We investigated Google search trends by measuring the number of hits relating to liver diseases between 2004 and 2021 in seven languages and European countries but also worldwide. All analyses were performed in R using the R Google trends package gtrendsR.

Results: We found that interest in MASLD [formerly non-alcoholic fatty liver disease (NAFLD)] has generally increased over time, but that interest in metabolic associated steatohepatitis (MASH) - the most severe form of MASLD - has decreased. Interest in viral hepatitis C has decreased, whereas the number of queries regarding viral hepatitis B have been stable but dominated by interest in vaccination for it. Recent medical developments (in viral hepatitis) did not lead to a noticeable change in overall search behavior. Users preferred searching using their native language and less complex medical terms and acronyms (e.g., fatty liver instead of NAFLD).

Conclusions: In the last two decades, Google search trends have followed the general development in the field of hepatology. Searches were dominated by non-experts and are not being rapidly influenced by novel scientific developments. Also, users preferred search terms in their native languages rather than English and tended to avoid complex medical search terms. Awareness and communication strategies around MASLD should consider these preferences when addressing the general public.

Key words: Google – search engine – search trends – liver disease – NAFLD – awareness – internet – hepatitis B – NASH – alcoholic – PBC – digital.

Abbreviations: MAFLD: metabolic dysfunction-associated steatotic liver disease; NAFLD: non-alcoholic fatty liver disease;

INTRODUCTION

Liver diseases are a growing public health problem [1,2]. Metabolic dysfunction-associated steatotic liver disease (MASLD), a metabolic liver illness, alone is estimated to be prevalent in approximately 25-30% of the adult population across Europe and 30% globally, with its prevalence increasing globally [3]. Other liver diseases such as viral hepatitis B and C or alcohol related liver disease substantially add to the overall prevalence of chronic liver disease worldwide [1]. If detected early enough, MASLD may be fully reversible [4]. However, most patients do not experience symptoms during the early stages of the illness and early signs of liver disease are often overlooked or misinterpreted by both patients and physicians [5]. If detected late, MASLD may lead to the full range of chronic liver disease including cirrhosis and liver cancer [6] and it often co-occurs with cardiovascular disease [7] and diabetes mellitus [8]. Lack of awareness about liver diseases is highly prevalent in the general population and access to public information is challenging for effective prevention and early care of MASLD

[9]. Although MASLD, and more generally chronic liver disease, is estimated to increasingly affect the burden related to liver disease [2], policies and strategies to address MASLD at the national and global levels are largely lacking in most countries [10].

With the digital, and thus in high availability of medical information through the internet, the possibility for patients to inquire about liver specific symptoms and lab tests and to participate in the diagnostic and treatment process is increasing. Generally, these internet-based resources are easily available at a low-cost and any time to patients, the general public and even clinicians through, for example, social media [11, 12].

In order to be able to use such publicly available information to improve medical care, a number of hurdles are still to be overcome. Particularly, patient comprehensibility of medical information needs systematic evaluation. Additionally, it is unclear how the integration of the patient's perspective might affect their outcome [13]. The benefit of a collaborative effort between patients, physicians and healthcare providers is also currently still unclear due to the lack of high-quality evidence [14]. The possibility of a reduction in diagnostic and treatment errors through a shared knowledge base represent an additional interesting research inquiry [15, 16]. Furthermore, a systemic evaluation of current search behavior of the general public and primary care physicians, with respect to liver diseases, may give valuable indications on how to improve the quality and use of internet or social media-based information for the diagnosis and treatment of these illnesses.

In 2021, Google had a share of 93% of the complete global search engine market. The second most used search engine, Bing, accounted for only 3% of all global internet searches. Thus, studying search behavior on Google offers novel opportunities to systematically analyze these textual, unstructured data in order to better adapt public health strategies and public policy. Furthermore, studying Google trends has been demonstrated to be useful in several other fields of health care such as coronavirus disease 19 (COVID-19) or mental diseases [17, 18].

We therefore aimed to evaluate and compare Search Trends from Google across Europe in order to investigate if patients and/or the general population followed the general interest in diseases, the influence of novel scientific developments and their use of simple and native languages versus medical terms.

To capture knowledge transfer in the field of liver disease, we aimed to describe liver-related search trends from Google across Europe to investigate whether they evolve according to liver disease epidemiologic trends and innovations in screening or care.

METHODS

Google Trends Analysis

Google Trends (https://trends.Google.com/trends) were analyzed utilizing the Google Trends R package ´gtrendsR´ available from The Comprehensive R Archive Network CRAN (Version 1.5.0, https://cran.r-project.org/web/packages/gtrendsR/index.html). The software package served as an interface for retrieving and displaying the information returned online by Google Trends. Trends (number of hits) over the time were investigated and graphically displayed. In order to improve visualization all data underwent smoothing using the geom_line() and geom_smooth() functions of the ggplot2 R package also available from the available from The Comprehensive R Archive Network CRAN. Trends were analyzed for global (worldwide) search behavior and geographic representation of the results. All software was available under the GNU General Public license.

In order to check for reliability and quality of searches related to MASLD (formerly NAFLD), we also documented related search topics, defined as topics that people who searched for a specific term in the context of our study also searched. The terms "MASLD" or "MAFLD" were not included in our searches as they did not represent official terminology at the time. This information was also available from the gtrendsR based analysis of the Google Trends data. All related search information is available in Supplementary file.

Topic Generation

Topics were translated from German and English into language and country specific terms by hepatologists from France, Italy, Poland, Romania and Spain. All utilized terms are listed in Supplementary file.

Evaluation of Specificity of Search Terms

In order to confirm specificity of search terms to liver disease we also checked the top 25 topic results. A targeted search for fatty liver can be assumed as the searches "fatty liver", "fatty liver what to do?", "fatty liver recipes", "fatty liver more effective than alcohol" and "causes of fatty liver" corresponded to the top five fatty liver related searches.

Availability of Data and Materials

The datasets used and/or analyzed during the current study available from the corresponding author on reasonable request. Approach and findings were summarized in a Prisma Checklist (Supplementary file).

RESULTS

Global changes on Google search trends

Globally, the public interest in metabolic and viral liver diseases has changed significantly over time. As shown in Fig. 1, the interest in fatty liver disease, i.e., the use of the different search terms "fatty liver" or "NAFLD", has steadily increased over time. In contrast, the interest in viral hepatitis C has decreased with a temporary increased interest observed between approximately 2013 and 2016, followed by a sharp decrease. The interest in viral hepatitis B has remained continuously high and stable over time.

Comparative analysis of Google trends in diverse European countries

Topic "fatty liver"

Since 2004, there has been an overall increase in searches using the term "fatty liver" in most European countries; only the use of the topic "steatosis" decreased in the Italian language (Fig. 2).
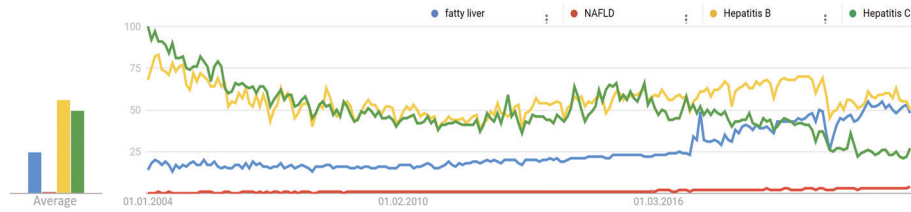
Fig. 1. Global Google search trends for the following search terms: "fatty liver", "NAFLD", "Hepatitis B", and "Hepatitis C". Numbers on the graph represent normalized data Each data point is divided by the total searches of the geography and time range it represents to compare relative popularity (Relative Search Volume, Y-axis).
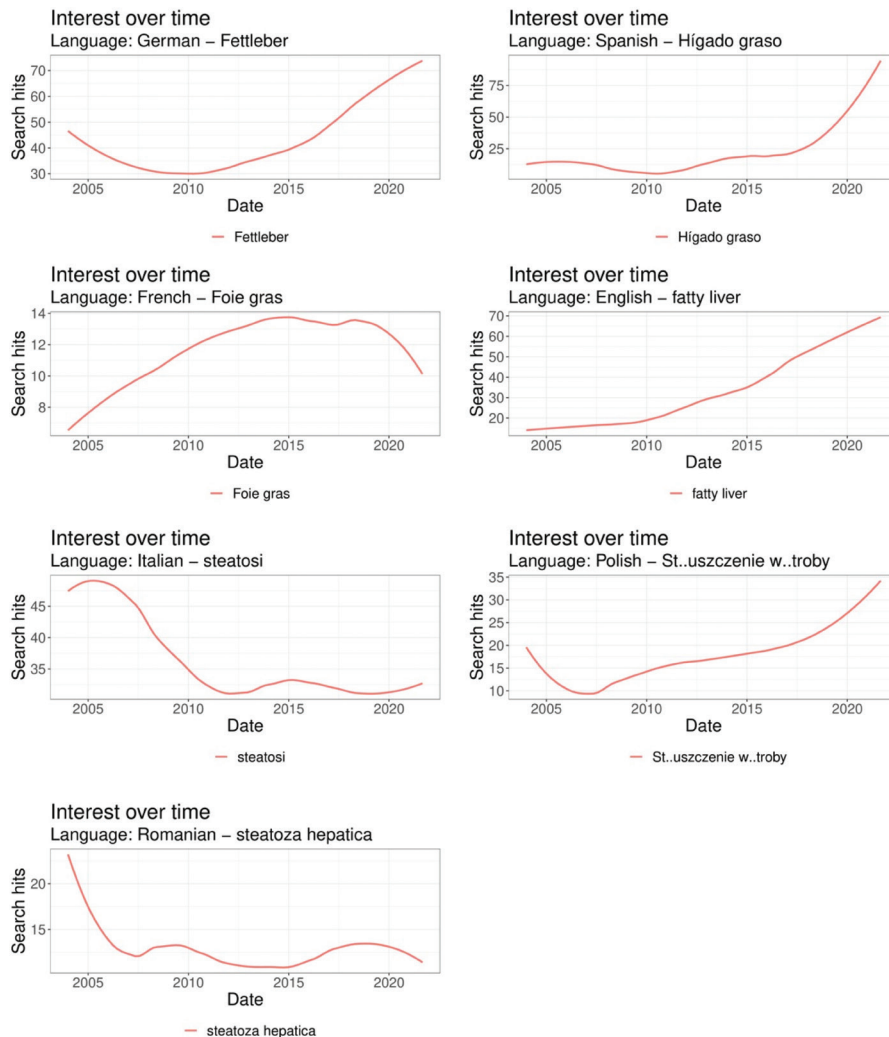

Fig. 2. Language and country specific Google search trends for "fatty liver" and translated terms in diverse European languages. Numbers on the graph represent normalized data Each data point is divided by the total searches of the geography and time range it represents to compare relative popularity (Relative Search Volume, Y-axis).

The same trend applies to searches for the term "fatty liver" worldwide (Supplementary file).

There has also been a clear, continuous increase in the search for this term since 2009. Globally, the top related searches were "liver disease", "fatty liver disease symptoms", "fatty liver", "liver fat diet" and "what is fatty liver". Thus, the data points to the fact that fatty liver disease is being sought out specifically.

Topic "non-alcoholic fatty liver disease"

Investigating the global, mostly English-speaking country search volumes, the trend for "non-alcoholic fatty liver disease" search queries has been increasing continuously during the past seven to eight years. As the main search terms were "non-alcoholic fatty liver disease", "fatty liver", "fatty liver disease", "non-fatty liver disease", "non-alcoholic fatty liver" and "fatty liver symptoms non-

alcoholic fatty liver disease", the data shows that NAFLD is being searched for specifically. Since nomenclature was changed just recently we did not evaluate search frequency for "MASLD"

The findings were similar in other languages such as French, Italian and Polish, which also demonstrated a steady increase in the search for this term for the past five to 10 years. However, the somewhat cumbersome topic "non-alcoholic fatty liver disease" does not contain enough data in several languages or countries (among them Germany, Spain and Romania), indicating a lower interest of the general population in this complex search term (Supplementary file).

Topic "NAFLD"

In most of the evaluated European languages, the abbreviation "NAFLD" was searched more often than its long version, "non-alcoholic fatty liver disease" (Fig. 3). The term "NAFLD" performed well in country and language specific evaluations of queries. In all countries except for Spain, a similar and increasing search trend was observed.

Furthermore, this was also in accordance with global Google Trends for "NAFLD", which have been slowly and continuously increasing since at least 2010 (Supplementary file).

Topic "NASH"

In contrast to other liver disease specific search terms, the search for "NASH" has been decreasing overall rather than increasing (Fig. 4).

This was, at first glance, surprising as NASH is the more severe form of fatty liver disease and also the main focus of therapeutic efforts. This finding may be partially due to the occurrence of non-specific searches which are not aimed at searching for medical knowledge but are rather aimed at searching for other information, particularly last names of famous artists, as the top search terms were: "kate nash", "john nash", "carole nash", "harvey nash" and "kevin nash".

Topic "Alcoholic Liver Disease"

The topic „alcoholic liver disease" showed insufficient data in several languages, among them French, Polish, Romanian
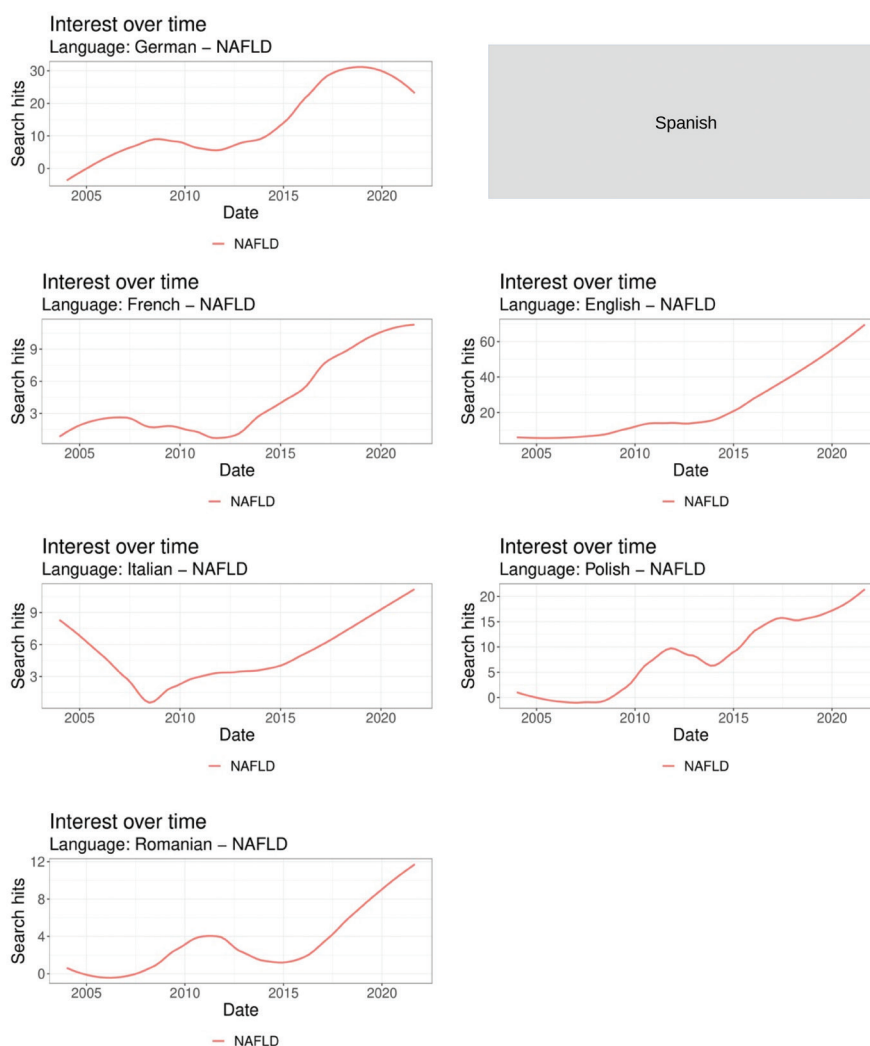

Fig. 3. Language and country specific Google search trends for "NAFLD" and translated terms in diverse European languages. Numbers on the graph represent normalized data Each data point is divided by the total searches of the geography and time range it represents to compare relative popularity (Relative Search Volume, Y-axis).
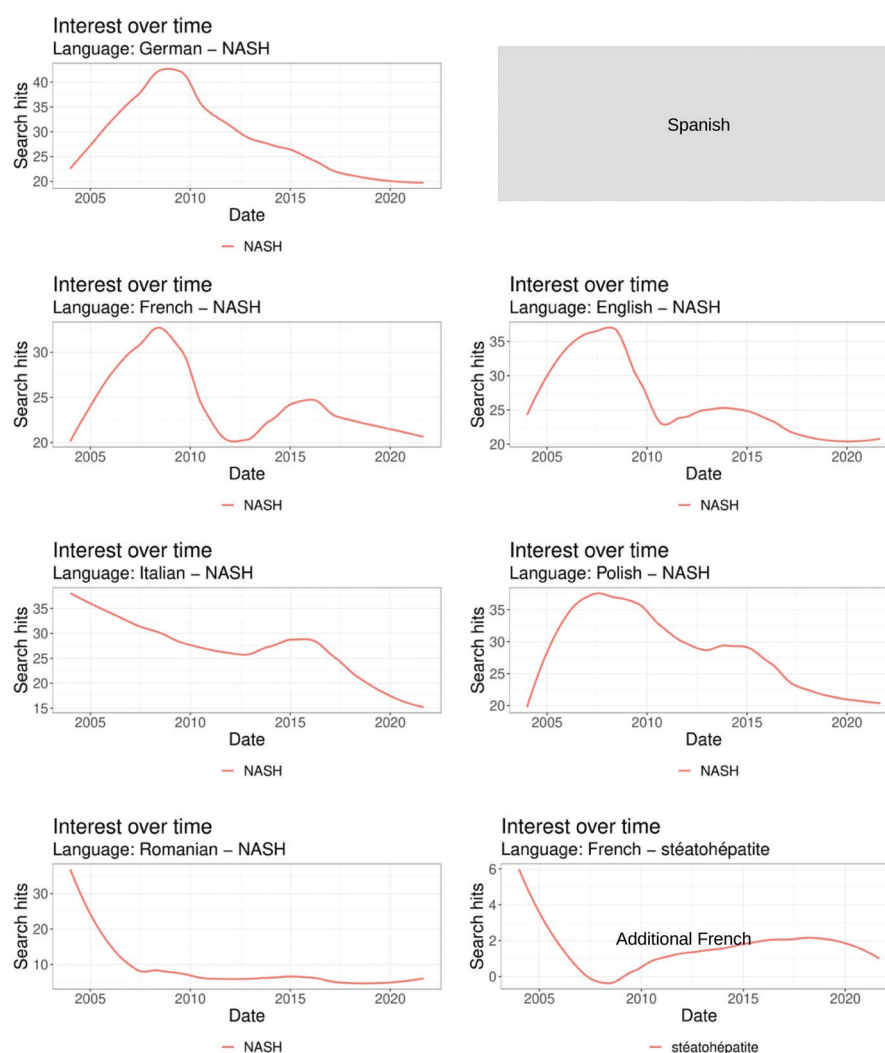
Fig. 4. Language and country specific Google search trends for "NASH" and translated terms in diverse European languages. Numbers on the graph represent normalized data Each data point is divided by the total searches of the geography and time range it represents to compare relative popularity (Relative Search Volume, Y-axis).

and Spanish (Fig. 5). In addition, interest in Germany decreased after a short period of increased interest between 2012 and 2017. In Italian, interest in the subject remained more or less unchanged over the past 15 years. As per the analysis of English-speaking queries, the term "alcoholic liver disease" picked up considerable attention and has been steadily increasing for more than 10 years.

Topic "Hepatitis C"

The data on Google searches for hepatitis C shows that there has been a steady decline in the interest in this topic, as per the number of search queries, since 2004. This observation was uniform across all investigated languages (Fig. 6).

The overall hepatitis C searches must be assumed to be rather specific as the top search terms were symptoms hepatitis C, hepatitis C vaccination, symptoms hepatitis, hepatitis vaccination, transmission hepatitis C, HIV, infection hepatitis C, hepatitis C test, hepatitis C virus, these were highly specific for hepatitis C.

Topic "Hepatitis B"

Interest in hepatitis B was diverse among languages and countries (Fig. 7, Supplementary file). However, the top ranked inquiries in all languages related to hepatitis B vaccination. Search queries on new drug developments were not within the top 25 search queries (Supplementary file).

Worldwide, an increase in search interest has not been recorded and the main topics were of more general interest, i.e., "hepatitis B vaccine", "hepatitis vaccine", "hepatitis symptoms", "la hepatitis b", "hepatitis b symptoms", "what is hepatitis" or "what is hepatitis b". Similar to the per country results, the ten most frequent search queries do not relate to hepatitis B treatment or new therapy options.

Topic "PBC" (Primary Biliary Cholangitis)

Despite novel therapeutic options for PBC (Supplementary file), there has been a mostly decreasing search interest trend since 2004 on autoimmune liver diseases. This holds true across different countries and languages (Fig. 8).
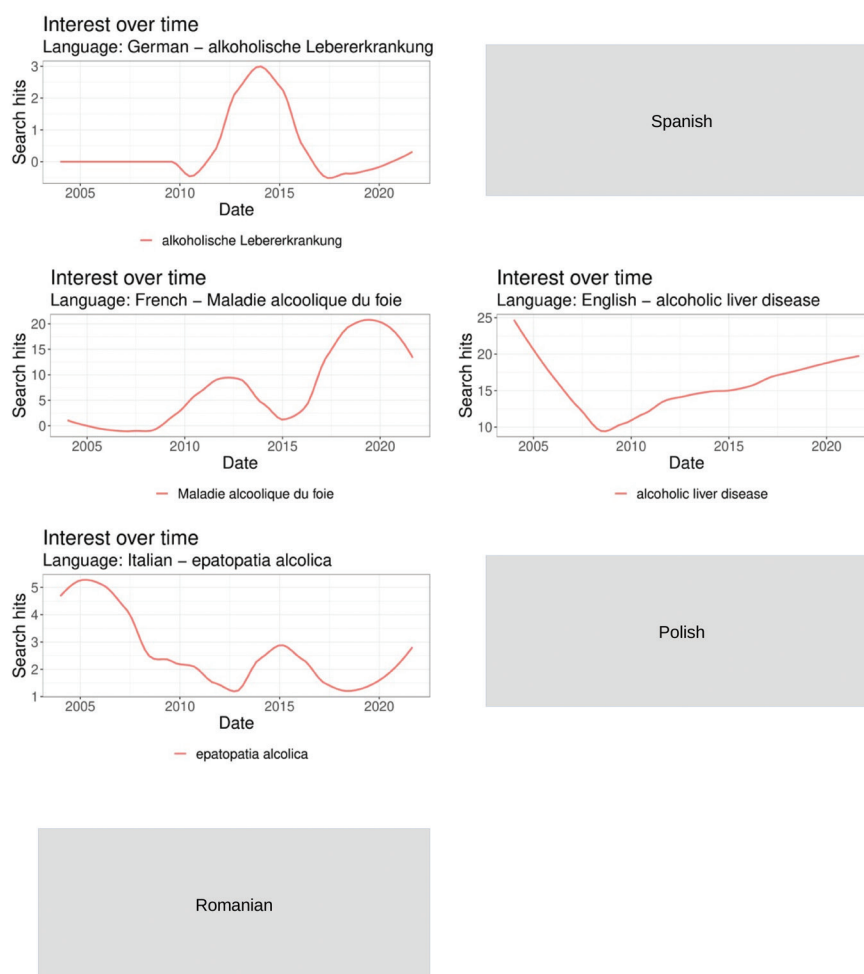
Fig. 5. Language and country specific Google search trends for "alcoholic liver disease" and translated terms in diverse European languages. Numbers on the graph represent normalized data Each data point is divided by the total searches of the geography and time range it represents to compare relative popularity (Relative Search Volume, Y-axis).

However, the queries for "PBC" may, in many languages, show only a very limited association to the medical condition PBC since terms such as "Global entry program" or "Deutsche Bank", which clearly have nothing to do with autoimmune liver disease, dominate in some languages (Supplementary file).

From a global perspective, we found that there was a temporary increase in interest in PBC around 2009, followed by a drop in the number of inquiries. Globally, too, there is a mixed picture of the specificity of the queries with terms like dB PBC, PVC, PBC.

DISCUSSION

In this study, we aimed to investigate how much Google queries reflect awareness about liver disease over time. We focused on awareness about specific liver diseases, their correlation to advances in medical science and overall burden of disease, as these parameters may be of high relevance for awareness campaigns, preventive measures and patient adherence to therapy.

Our study showed three main results. First, interest in NAFLD has generally increased over time, a trend which parallels the increasing prevalence of NAFLD in the general population. This also mirrors the increased awareness of what this disease is, as searches mainly used the term "fatty liver". Since nomenclature changed just recently we did not evaluate "MASLD" or "MASH" as search terms. Going beyond Google search trends, the general interest in fatty liver disease has also been increasing over almost the entirety of the past two decades [10]. Second, searches concerning hepatitis C have tended to decrease. This finding follows the decreasing prevalence or burden of the disease globally, as efforts to eliminate the disease have increased globally [19, 20]. Similarly, general interest in hepatitis C has been decreasing beyond search queries. Third, HBV searches have remained relatively stable and mainly restricted to vaccination. Overall, these results reflect both epidemiological trends of the prevalence of the different liver diseases and the epidemiological effects of medical innovation curing HCV and making HBV a treatable chronic disease. Recent estimates of the global changes of the prevalence of viral hepatitis concluded a significant decrease in HCV but almost stable HBV prevalence in Europe until 2030 [21]. Also, the EASL HEPAHEALTH report provided by the European Association for the study of the Liver (EASL) stated an increase in average BMI in the population, in both males and females and across all regions of Europe [1] (Supplementary file).
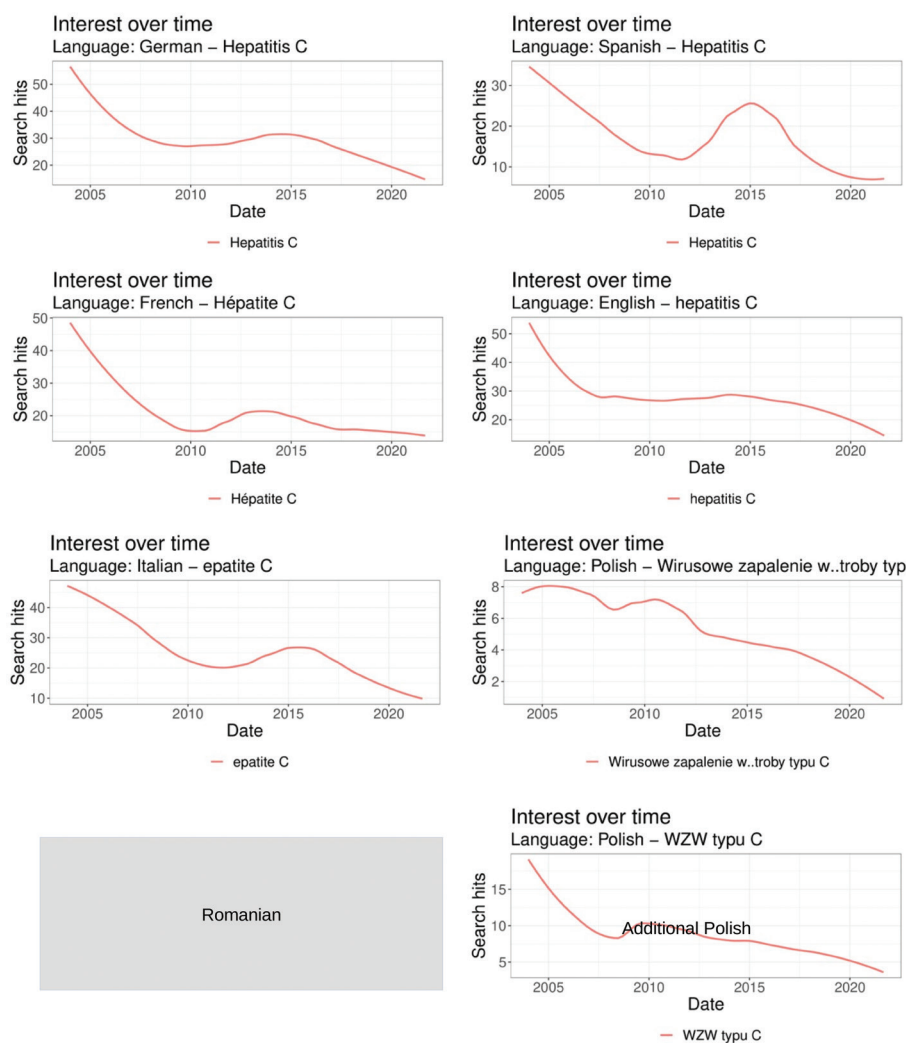
Fig. 6. Language and country specific Google search trends for "hepatitis C" and translated terms in diverse European languages. Numbers on the graph represent normalized data Each data point is divided by the total searches of the geography and time range it represents to compare relative popularity (Relative Search Volume, Y-axis).

The speed at which medical innovation has an impact on awareness about diseases within the general population remains to be determined. At least for hepatitis B, for instance, for which many novel therapeutic agents and strategies are being developed in early-stage clinical trials, major search queries related to the issues of hepatitis B vaccination and general explanations of the disease. Unfortunately, for another liver disease where some progress in pharmacological therapy was reported over the past five years, PBC, search terms were too unspecific in many languages or did not even hit the margin of significance in order to be registered.

The increasing trends found for NAFLD-related searches are also likely linked to improvements in the awareness on fatty liver disease [22]. Healthcare providers may specifically search for the latest developments, research data or clinical practice guidelines about a specific disease. As involvement in the clinical decision-making processes appears to have a positive influence on patients [15], the broad availability of the latest clinical information and data, sometimes even specifically aimed at patients, may further improve treatment adherence and coping strategies to deal with a disease. Subjectively, better-informed patients felt clearer about their treatment wishes and goals, which probably resulted in a more active role in decision-making and a more precise perception of risk [23, 24].

Beyond general search interests, interests in obtaining health advice or information online is continuously increasing and web search engines have become pervasive, making it easier to obtain information on various topics (among them disease-related and patient-related topics and health consumer information). As a result, health and health policy researchers are starting to take note of potential data sources for surveillance and research, such as Google Trends, a publicly available repository of information on real-time user search patterns [25].

Moreover, given the high prevalence and burden of liver disease, prevention has become an extremely important (and effective) health (and economic) aspect. As internet-based information plays an increasing role as a source of health consumer information, search engines and queries within those engines become increasingly important to the general
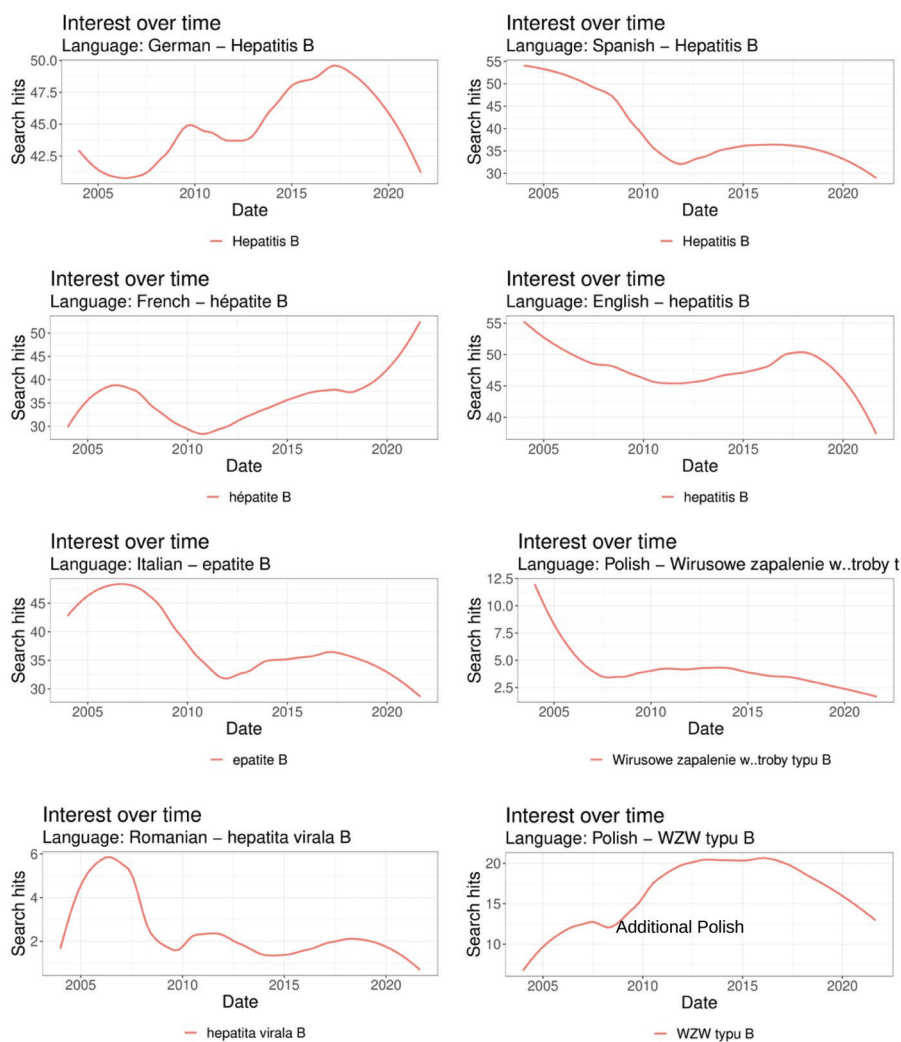
Fig. 7. Language and country specific Google search trends for "hepatitis B" and translated terms in diverse European languages. Numbers on the graph represent normalized data Each data point is divided by the total searches of the geography and time range it represents to compare relative popularity (Relative Search Volume, Y-axis).

population in obtaining information on specific medical issues. Analyzing those queries will be essential to further improve health information delivery to the general population.

One interesting result is that the general population seems to avoid complex medical search terms in general. For NAFLD, the clearest trends were observed for the term "fatty liver disease" in each respective language. The medical term "non-alcoholic fatty liver disease" showed more trend diversity, although it basically defines the same disease. In several countries, among them Germany, Romania and Spain, there appeared not to be enough queries to generate statistical trends.

As for NASH, the most severe form of fatty liver disease, which one would think would generate the greatest interest and need for medical advice and information, showed decreasing trends throughout all languages. We do not know whether searches for NASH may have been concealed by other interest groups and more popular, attracting "nash" terms related to names of artists and musicians. We do not know to what extent this decreasing trend is due to a more frequent early diagnosis of patients at the NAFLD rather than the NASH stage.

Nevertheless, though in people with NAFLD/NASH a lack of knowledge of liver fibrosis stage seems to be highly frequent and related with poor patient-provider communication [16]. Given the low awareness about liver fibrosis stage in NASH patients, patients tending to avoid complex search terms in our analysis and the current reach of simple search terms and pieces of information such as fatty liver or NASH not being successful in creating efficient awareness, we may think to use terms that patients really understand [26].

A limitation to our study is the characterization of queries from only one search engine. However, the Google engine was chosen as it is the most widely used, with more than 93% of the worldwide search engine market share [27]. Also, online search data is anonymous and demographic data is lacking. Finally, some search terms may also relate to non-medical, e.g. NASH as a popular last name among various artists. This may be critical as the presence of a condition and motivation for online searches remain unclear. However, as key findings of our study were demonstrated independently in several countries and across languages,
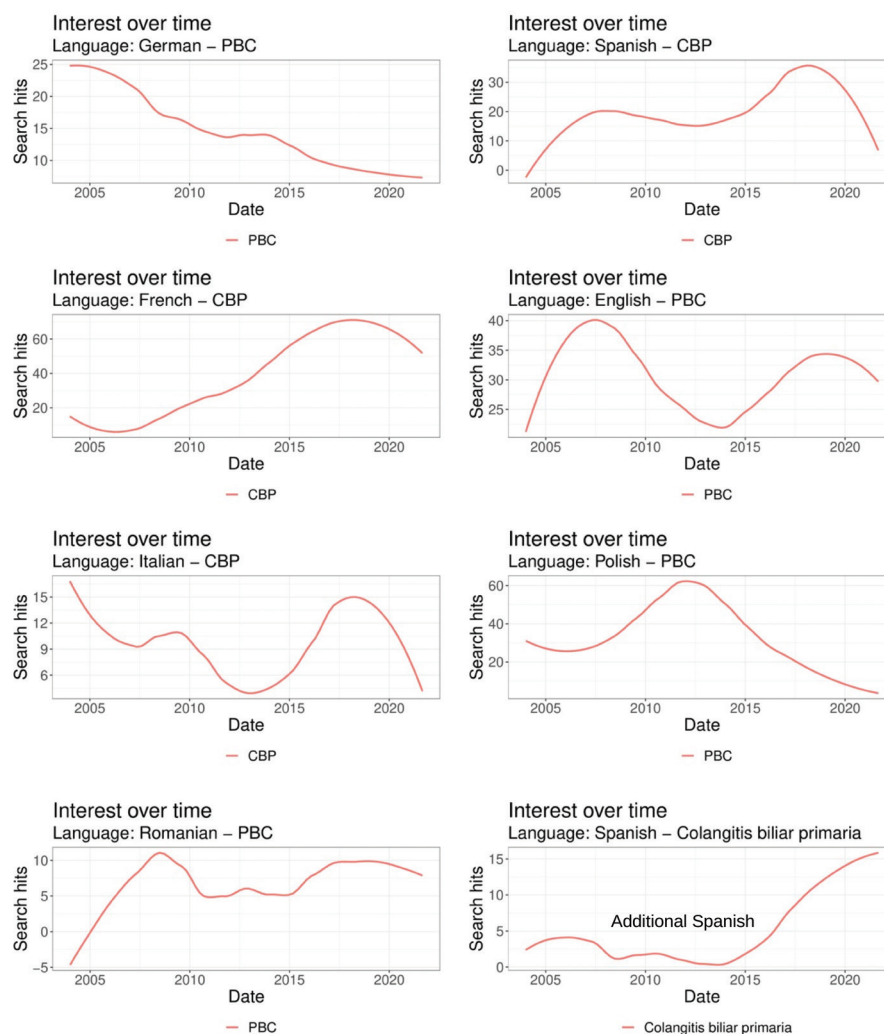
Fig. 8. Language and country specific Google search trends for "PBC" and translated terms in diverse European languages. Numbers on the graph represent normalized data Each data point is divided by the total searches of the geography and time range it represents to compare relative popularity (Relative Search Volume, Y-axis).

we believe that those trends may be assumed to be robust. Finally, the queries do not reflect the information retrieved by the persons querying.

CONCLUSIONS

Overall, search data as a potential surrogate for patient awareness seemed to generally reflect the burden of disease and long-term improvement of therapeutic options. However, recent novel medical developments did not rapidly lead to a noticeable change in search behavior. Furthermore, users preferred search terms in their native language, searched for more general content and seemed to avoid complex medical search terms overall. However, as searches can be assumed to be dominated by non-professionals due to the avoidance of complex and specific medical terms, the medical community may need to adjust to the changing and increasing demand for web-based medical information acquisition; a challenge that medical community may not yet be ready for. Therefore, awareness and communication strategies around various liver

diseases and nowadays particularly MASLD should consider these preferences, when addressing the general public.

Given these novel insights on information acquisition on liver disease by the general public, in order to improve liver health, the scientific community needs to make a larger investment in order to provide enough general and high-quality medical information.

Conflicts of interest: None to declare.

Authors' contribution: A.T., T.I., J.V.L. and F.T. conceived and designed the study. A.Z., D.D., E.B., L.V., L.C., P.C., J.C., M.R.-G., R.F., M.K., M.E. collected the data. A.T. interpreted the results and drafted the manuscript. A.Z., D.D., E.B., L.V., L.C., P.C., J.C., M.R.-G., R.F., M.K., M.E. critically revised the manuscript for important intellectual content. J.V.L. and F.T. supervised the projects. All the authors approved the final version of the manuscript.

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