Perception of "coronavirus" on the Polish Internet until arrival of SARS-CoV-2 in Poland

Percepcja „koronawirusa" w polskim Internecie do czasu potwierdzenia pierwszego przypadku zakażenia SARS-CoV-2 w Polsce

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Abstract

Background. Although the SARS-CoV-2 virus, which causes the COVID-19 disease, was discovered only in late 2019 in vicinity of the city of Wuhan (Hubei province, China), in January 2020 it already became a global threat to public health. The first case of the SARS-CoV-2 in Poland was confirmed as late as on March 4, 2020. The perception of pandemic risk in Polish society seems to overestimate the actual risk; therefore, there is a danger of development of adverse phenomena, such as panic.

Objectives. Along with the proliferation of SARS-CoV-2 infection, a need for an analysis of the perception of these problems in Poland arose. Such analysis should consider the variation of intensity of interest in events related to "coronavirus" over time. The presented analysis is of a preliminary and signaling nature, due to facts losing their timeliness and changing social moods.

Material and methods. To study the perception of the COVID-19 virus in Polish society, we used quantitative analysis of the digital footprints on the Internet (Twitter, Google, YouTube, Wikipedia, and electronic media represented by Event Registry) from January 2020 (the first information about the virus) till March 3, 2020 (announcement of the first confirmed case of COVID-19 in Poland). Data mining, natural language processing and social network analysis techniques were used. Because of the diversity of target groups, representativeness and type of communication of each platform studied were analyzed.

Results. Interest in the virus is wave-like and can be divided into 2 phases – "Chinese" and "Italian" – on all platforms. A rise in interest could be observed concerning the special Legal Act to combat COVID-2019 during a so-called commentary phase. Semantic analysis has shown that the topics most searched for are concentrated in threat, fear and prevention areas. The Twitter network reflects the Polish society and its worldview and political divisions most precisely. Two categories of internet users were distinguished: active and passive users, characterized by information needs and communication schemes different for each category. Key actors and influencers who can become leading agents of influence were identified.

Conclusions. Traditional and social media not only reflect reality, but also create it. Monitoring of behavior of social media users can be utilized as a predictor of decisions concerning management of risk related to epidemics of infectious diseases.

Key words: Internet, medical sociology, epidemiological monitoring, SARS-CoV-2, communications media

Streszczenie

Wprowadzenie. Wirus SARS-CoV-2, wywołujący chorobę COVID-2019, mimo że odkryty dopiero pod koniec 2019 r. w okolicy Wuhan (prowincja Hubei w Chinach), już w styczniu 2020 r. stał się globalnym zagrożeniem zdrowia publicznego. Dopiero 4.03.2020 r. potwierdzono pierwszy przypadek wirusa w Polsce. Percepcja pandemicznego ryzyka w społeczeństwie polskim wydaje się wyolbrzymiona, więc istnieje niebezpieczeństwo rozwoju niekorzystnych zjawisk, takich jak panika.

Cel pracy. W związku rozprzestrzenianiem się zakażeń wirusem SARS-CoV-2 pojawiła się potrzeba analizy percepcji problemu w Polsce z uwzględnieniem natężenia zainteresowania wydarzeniami związanymi z „koronawirusem" w czasie. Powyższa analiza ma charakter wstępny, sygnalizacyjny – fakty szybko się dezaktualizują, a nastroje społeczne – zmieniają.

Materiał i metody. Zbadano percepcję wydarzeń związanych z „koronawirusem" w polskim społeczeństwie za pomocą analizy ilościowej śladu cyfrowego w Internecie (Twitter, Google, YouTube, Wikipedia i media elektroniczne reprezentowane przez Event Registry) pozostawionego od pojawienia się pierwszych informacji w styczniu 2020 r. do 3.03.2020 r., czyli pierwszego potwierdzonego przypadku zachorowania na COVID-2019. Wykorzystano proste techniki data miningowe, przetwarzania języka naturalnego czy analizy danych społecznościowych. Ze względu na różnorodność targetu każda badana platforma internetowa została poddana analizie reprezentatywności użytkowników oraz typu komunikacji.

Wyniki. Zainteresowanie wirusem ma charakter falowy i jest podzielone na informacyjne fazy – „chińską" i „włoską" – na wszystkich platformach. Zaobserwowano zwyżkę zainteresowania dotyczącego m.in. wprowadzonej w Polsce specustawy w tzw. fazie komentatorskiej. Analiza semantyczna wykazała, że najczęściej wyszukiwane zagadnienia koncentrują się wokół obszarów zagrożenia, strachu oraz prewencji. Sieć społecznościowa Twittera w największym stopniu odzwierciedla polską scenę polityczną i podziały światopoglądowe. Wyróżniono 2 kategorie internautów: aktywną i pasywną. Charakteryzują się one różnymi potrzebami informacyjnymi i schematami komunikacyjnymi. Zaprezentowano aktorów i influencerów, którzy mogą stać się głównymi agentami wpływu.

Wnioski. Media tradycyjne i społecznościowe nie tylko odzwierciedlają rzeczywistość, ale także ją tworzą. Monitorowanie zachowań użytkowników sieci społecznościowych może być wykorzystywane jako predyktor decyzji dotyczących zarządzania ryzykiem związanym z epidemiami chorób zakaźnych.

Słowa kluczowe: Internet, socjologia medycyny, monitorowanie epidemiologiczne, SARS-CoV-2, media komunikacyjne

Introduction

The "coronavirus" as a phenomenon and its social significance

Although a large part of the Polish population heard about coronaviruses only at the beginning of 2020, in fact, we have been dealing with them for a long time. The emergence of a new strain from Wuhan has enriched the colloquial meaning of the term "coronavirus", identifying it with "Wuhan virus" and its medical term: SARS-CoV-2 (severe acute respiratory syndrome coronavirus 2; formerly: novel coronavirus – 2019-nCoV). It is also commonly associated with the name of disease it causes: COVID-2019 (coronavirus disease 2019). Less than half of Poles believed that the "coronavirus" was the most important topic in the 2nd half of February in 2020.[1] Although (on the basis of the state of knowledge at the beginning of March 2020) the viral infectivity is moderate (basic reproduction number: $R_0 \sim 2$)[2,3] and mortality in non-affected populations is low (<1%),[2] the virus contributes to profound changes in economic (global shortages in product supply, declines in stock exchanges), social (fear, restrictions on migration and participation in mass events) and cultural (restrictions on freedoms and rigorous mitigation measures, closure of companies and institutions, loss of income sources) aspects. On 11 March, 2020 the World Health Organization (WHO) announced the state of pandemic.[4] Since that day, the information situation has begun to intensify rapidly – no media phenomenon has been observed on such a scale as the interest in the "coronavirus" in the history of the Internet.

The disease (officially) did not occur in Poland until March 3, 2020; however, reports on the epidemic developing in remote regions of the world had already reached our country. The items of information were provided in a selective and irregular way. An inevitable increase in information needs occurred when first cases of SARS-CoV-2 infection had been observed in Europe. Regardless of official announcements of the government or services responsible for epidemiological safety, we are constantly dealing with – spontaneously created – media and social meanings of information. The gap between risk analyses by experts and public perception of risk causes the constant need to update media coverage.[5] Monitoring the information behavior of Internet users is an important predictor of real behavior related to preparation for a possible infection and epidemic prevention.

The aim of this paper is exploratory, preliminary, quantitative evaluation of the perception of phenomena related to SARS-CoV-2 (and COVID-2019 disease caused by it) in Poland by means of a digital analysis of user agents and events in the online media (mainly social media) using simple exploratory techniques.[3]

Research on network phenomena and public health tasks

The user activity in social media is analyzed worldwide to better understand disease perception. In some cases,

the spread of infectious diseases can be traced.[6] Information management is also important in achieving the objectives of health education and disease prevention, including social panic prevention. Catalysation of social fears[7] can cause panic,[8] which, through emergent[9] and private actions of individuals, can lead to an escalation of such undesirable phenomena as: riots,[10,11] overreactive and pathological (inadequate to the threat and recommendations) social distancing,[12] i.e., stigmatization,[13] or other irrational behavior. The inevitable effect of social distancing is a demand shock (e.g., people purchasing fewer products and less often) and supply shock (due to restrictions, fewer products are produced and fewer services are provided). In addition, the panic surrounding the COVID-2019 epidemic may limit trade, services and industry; it negatively affects business and education cooperation as well as many other areas and sectors; ultimately, it is likely to result in a global and local economic recession (to a larger extent than direct consequences of SARS-CoV-2 infections[14]). Such phenomena occur both during pandemic and as its aftermath. Monitoring of types of behavior based on social imitation can be part of a system for effective stopping the unwanted phenomena.

Preliminary reports from China prove the great involvement of scientists and authorities in the monitoring (and control) of social media in connection with SARS-CoV-2 epidemic.[15–17] By analyzing the key moments of media discourse around the phenomenon of the spread of "coronavirus" in Poland, it is assumed that it will be possible to recreate the processes of forming behaviors preceding a possible panic around the epidemic and of building the epidemiological awareness of Polish society. The analysis of a digital footprint presented in this article may also be an exemplification of the public's information needs in the face of the threat of an unknown infectious disease, which, if not addressed, may lead to panic. Polish experience from the previous pandemic in 2009–2010, i.e., H1N1 influenza A, indicates a major role of the media in creating an atmosphere of danger and social fear at the beginning of the pandemic and in promoting prevention and discussion about the culprits in later stages.[18]

The analysis of the digital footprint is significant in the context of documenting social behavior and recognizing the most important trends and social cognitive paths of perception through latent variables[19]:

– fear (e.g., fear of the unknown, a sense of threat towards self and loved ones);
– anger (e.g., anger at the poor state of healthcare in Poland or mistakes of the government).

A reconstructed digital footprint can provide answers to such questions as:

– What is the intensity of information needs in the face of public health threats?
– What information needs does the public at risk of an infectious disease pandemic have?
– What is the specificity of description language regarding the pandemic?

The measurement of the current social perception of "coronavirus" (in this case, its Internet dimension) is an introduction to the formation of an optimal model for communicating about the epidemiological situation and risks, preventing overreactive behavior (e.g., panic). However, this ultimate goal can only be achieved after further in-depth qualitative and quantitative analyses. The analysis of the digital footprint on the Internet proposed here should therefore complement traditional monitoring of the spread of infectious diseases.

Spreading of information (i.e., product life cycle) usually has 3 stages[3]: early adoption, majority and lagging stage. In the context of "coronavirus", smaller interest cycles can be observed in Poland (similar level of interest to other health threats[20]).

The analysis of social networks has great potential, as it can explain the network specificity regarding the epidemic[21] and detect patterns of spreading disinformation.[22] In addition, it allows to assess collective behaviors, e.g., xenophobic, such as blaming the Chinese or the Italians for the outbreak of the epidemic and using symbolic violence against them on the Internet (quote from Twitter: "forbid the Chinese to arrive" (https://twitter.com/PO210ISOTOPE/status/1227846305747263488)).

The role of the Internet in information management

By democratizing access to information, the Internet has distorted a traditional model of communication: sender – message – recipient; hence, we observe in our research significant differences between the online branches of traditional media and strictly online media. Such entities as companies, organizations or institutions use the Internet to build their brand or promote their content, e.g., through viral marketing (the content is virtually distributed in a way similar to the spread of infectious diseases[23]). For Polish medical institutions, the Internet is also an essential communication and information platform, affecting perception in its environment.[24] It changes the health professional–patient relationship[25] by democratizing it, as well as by objectifying it.[26] Furthermore, many people and institutions have accounts on more than one platform (so-called multilayer structure) to diversify the repertoire of activities (e.g., Twitter's limit is 280 characters per message, so it forces the sender to produce concise messages, whereas posts on Facebook can take more elaborate forms). Social media provide information and disinformation[27] about the "coronavirus" globally, with unprecedented swiftness, fueling panic and creating the so-called infodemic, hitting entire countries, such as Italy.[28] Right before our very eyes, a new research department, infodemiology,[30] which deals with the analysis of Internet content in the context of health phenom-

ena,[31] is emerging from the combination of epidemiology, e-health, and e-health[29] and information science.

The study of social behavior, consisting in the analysis of popular keywords and topics, has specific objectives. It should be stressed once again that we operate here with social, not medical, meanings. A good example is the highest peak of interest in the topic of HIV in the 21st century, which took place in the autumn of 2015 (the number of Google queries more than quintupled) when Charlie Sheen admitted to being seropositive.[32] This event was not related to medical advances in immunology or vaccinology, but it was a virtual reflection of mental representations, understood as the mapping of social processes.

The Internet provides a fertile ground for expression of views and opinions that often contradict the current state of medical knowledge, using propaganda and persuasion techniques as well as the susceptibility of certain target groups to "conspiracy theories".[33] The authors of such content can, in their own way, serve as "useful idiots"[27] and polarize society,[34] which may be the aim of foreign intelligence service intervention.[27] The epidemic caused by the virus is thus accompanied by behavior related to information panic, and the Internet can be a mediating element.

Material and methods

Theoretical background

The relationship between mass culture and medical knowledge is very complicated. In recent years, we have observed a lack of direct translation between scientific evidence (e.g., on the effectiveness of protective masks in preventing infection) and models of common knowledge describing the infectious disease.[35] In view of the fact that various social actors (people and organizations) differ in perception of the risks related to the virus (including scientists presenting different opinions, frequently not supported by any research), an analysis of social perception of phenomena is necessary and this is the main aim of this article.

In this paper, using the quantitative analysis of digital footprints on the Internet (e.g., social networks), a picture of the discourse around the "coronavirus" has been recreated in such key dimensions as:

– forms of action (e.g., the number and nature of social events, such as information searching);
– symbolic conceptual schemes (e.g., analysis of a sentiment and conceptual fields);
– interaction with the social and political environment (e.g., social network analysis of persons and topic modeling techniques or testing the presence of external factors).

The sentiment (overtone) analysis[9] is based on the identification and classification of statements with emotional aspect (usually positive, neutral or negative). An analysis of social networks was used,[9] as it presents various links among social actors (social influence, trust, friendship or hostility, etc.), as well as characteristics of the actors (political affiliation, views, etc.). Topic modeling[9] aims to automatically cluster texts with similar characteristics into thematically coherent categories. The result is an image/map of the digital footprint regarding the behavior of senders and recipients of information (with an emphasis put on the recipients).

In addition, using elements of the actor-network theory (ANT),[36] the interaction between a biological factor and human behavior (actors) was emphasized. The field is a space of potential semantic connections among the meanings expressed by representatives of different organizations, social capitals or ideologies. We are also interested in the way actors collaborate with each other[37] when distributing resources or the way they enter into conflict, building (perhaps even unconsciously) clear boundaries. Our research is therefore an introduction to the creation of a model of the flow of viral information, causing a change in society's behavior as a result of "coronavirus". It is also about the documentation of a new method used to study human behavior in contemporary times during infectious disease pandemics.

Empirical implementation and characteristics of data sets

For methodological reasons, the analysis is limited to quantitative data on the digital footprint left online from January 2020 to March 3, 2020 on Google, Facebook, Wikipedia, YouTube, and Event Registry (electronic media aggregator) platforms, taking into account the representativeness of their users and the content generated.

In January 2020, the total number of Internet users in Poland was 28.1 million[38] (28.6 million in January 2019[39]). Internet saturation (access to Internet resources) is at the level of 85% of the total literate population of the country. Therefore, the passive representativeness of the Internet (content reception) is relatively high; however, younger age groups predominate in active representation (generation of own content – teenagers are much more active on the Internet; a statistical Polish teenager spends approx. 5 h daily online[40]) – as well as women (up to 85% of health-related content in social media is generated by women, and over 99% of young Polish women use the Internet[26]). Surveys on German Internet users[41] showed that the largest share of active Internet users is on Twitter (approx. 70%), average share – on Facebook (approx. 50%) and low share – on YouTube (approx. 15%).

Each platform described above has load and methodological limitations. Tech giants (i.e., Google, Twitter and Facebook) promised to include fact-checking in information filtering system. As a result, the material collected was already pre-filtered to varying degrees, namely:

– Twitter – raw data were collected;
– Google and YouTube – aggregators provided by the platforms;
– Facebook – processing of data by commercial companies;
– online articles – the selection of texts was conducted by means of AI techniques using the Event Registry tool.

The analysis of Twitter data was conducted in R software, used for natural language processing and network analysis. Figures were made using such tools as: Microsoft Excel, R, Answer The Public, Google Trends, and Event Registry.

Computational techniques used in social sciences,[3] despite their many drawbacks and rather purely exploratory nature, provide the possibility to analyze big data at low cost and in a short time.

Results

Google Trends

Google has 95% reach among Internet users with more than 8 billion hits per month and is an unquestionable leader on the Polish Internet market.[38] The interest in the "coronavirus from Wuhan" can be measured with a number of queries in the Google search engine using the Google Trends[39] tool (a free and public service that allows the analysis of searches by checking the intensity depending on time and geographical location). Using Google Trends, it is possible, e.g., to correlate the prevalence of influenza (also in Poland[31]) with the searching for terms related to symptoms (i.e., syndromic medicine).

In Poland, in comparison with other parts of the world (USA, Western Europe), the interest in this topic was generally low until the 1st half of February 2020[43] and was still only moderate in the 2nd half of February and in early March 2020 (Fig. 1).

As Google provides only relative differences, not the total number of queries, these numbers can only be estimated. According to Google Ads, the average monthly number of queries about "coronavirus" in December 2019, January 2020 (when there was no interest in the virus yet) and February 2020 was probably about 2 million, which means that at the end of February, the daily number of queries was probably over 50,000. However, before the confirmed emergence of the virus in Poland, other topics (such as sports, gossip, tabloid, cultural, or political) were definitely more popular than the topic related to coronavirus, both according to the really simple syndication (RSS) measurements and trends (a list of the most popular topics or slogans). Topics and keywords related to "coronavirus" constituted less than 10% of top trending topics and slogans. No topic or keyword related to "coronavirus" was among 25 top topics and slogans.

The analysis of queries allows for distinguishing 2 phases of interest in the "coronavirus" topic by Polish Google users (Fig. 2).

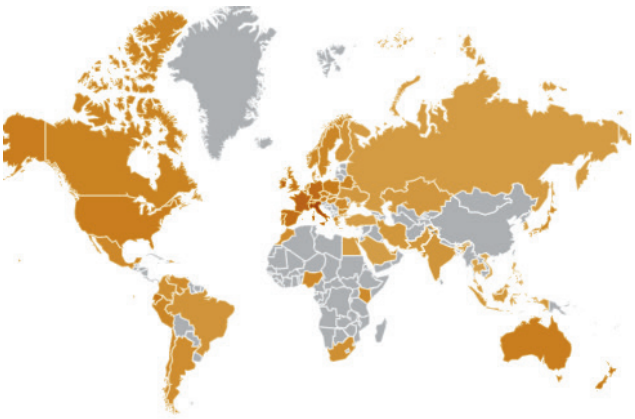

Fig. 1. Interest in "coronavirus" by country worldwide as reflected by Google (February 17 – March 3, 2020). The darker the shade of a given color, the greater the intensity. Generated from Google queries using the Google Trends tool

Ryc. 1. Geografia intensywności tematu „koronawirusa" na świecie w Google (17.02–3.03.2020 r.). Im ciemniejszy odcień danego koloru, tym większa intensywność. Wygenerowano z zapytań Google przy użyciu narzędzia Google Trends

The 1st one took place at the turn of January and February, when a number of infections in China was increasing dramatically. It comprised an insignificant peak (approx. January 25) – death of Liang Wudong, a well-known Chinese physician dealing in SARS-CoV-2, and a significant peak (January 29) – first case in Germany. This 1st increase in search for information was called by us the "Chinese phase".

The 2nd phase came at the end of February, when the number of infections was increasing in Italy. The peak of February 27, shown in Fig. 2, may be related to the media confusion surrounding an alleged SARS-CoV-2 case in Łódź. Due to further developments, we called this phase of information needs the "Italian phase". In Fig. 2, it can be seen that inquiries about "coronavirus" in the "Italian phase" almost exceeds twice those in the "Chinese phase". It is hard to resist the impression that the information needs of Poles increased by leaps and bounds when the danger was defined as serious (deadly) and close. Bringing the virus to Europe was the trigger of the 2nd global outbreak of the disease, so at the end of February, the search for information might have been an expression of the information needs that were only emerging.

Further analysis of the digital footprint regarding the interest in the "coronavirus" topic was to check top words related to types of behavior aimed at preventing the spread of the infection. The search for information on the infection was still lower than in socially advanced countries (Fig. 2; taking into account the fact that countries with a high degree of connectiveness regarding the movement of persons[44,45] already had confirmed cases of the disease).

Additionally, we observe that by far the most popular search phrase is "maseczka antywirusowa" [antiviral

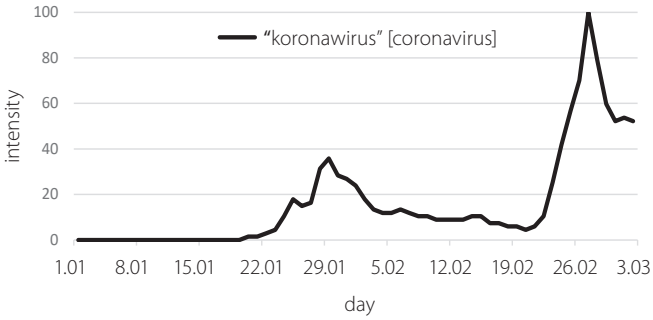

Fig. 2. The intensity of queries with the word "koronawirus" [coronavirus] in Polish Google (January 1 – March 3, 2020). Generated from Google queries using the Google Trends tool

Ryc. 2. Intensywność zapytań (średnie dzienne wartości wyszukiwań) ze słowem „koronawirus" w polskim Google (1.01–3.03.2020 r.). Wygenerowano z zapytań Google przy użyciu narzędzia Google Trends

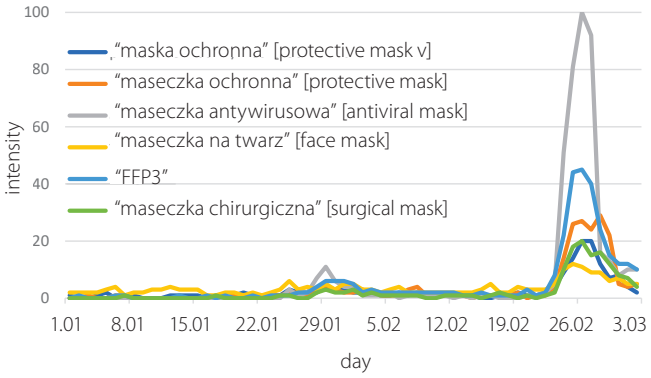

Fig. 3. The intensity of queries with the phrases "maska ochronna" [protective mask v], "maseczka ochronna" [protective mask], "maseczka antywirusowa" [antiviral mask], "maseczka na twarz" [face mask], "FFP3", "maseczka chirurgiczna" [surgical mask] in Polish Google (January 1 – March 3, 2020). Generated from Google queries using the Google Trends tool

Ryc. 3. Intensywność zapytań (średnie dzienne wartości wyszukiwań) z frazami „maska ochronna", „maseczka ochronna", „maseczka antywirusowa", „maseczka na twarz", „FFP3", „maseczka chirurgiczna" (1.01–3.03.2020 r.) w polskim Google. Wygenerowano z zapytań Google przy użyciu narzędzia Google Trends

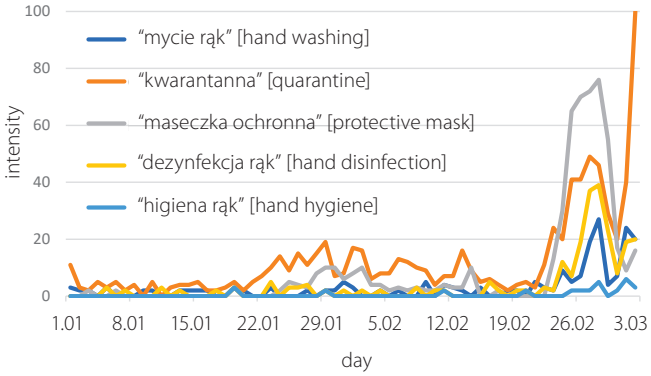

Fig. 4. The intensity of queries with the phrases "mycie rąk" [hand washing], "kwarantanna" [quarantine], "maseczka ochronna" [protective mask], "dezynfekcja rąk" [hand disinfection], "higiena rąk" [hand hygiene] in Polish Google (January 1 – March 3, 2020). Generated from Google queries using the Google Trends tool

Ryc. 4. Intensywność zapytań (średnie dzienne wartości wyszukiwań) z frazami „mycie rąk", „kwarantanna", „maseczka ochronna", „dezynfekcja rąk", „higiena rąk" w polskim Google (1.01–3.03.2020 r.). Wygenerowano z zapytań Google przy użyciu narzędzia Google Trends

mask], referring to personal protective equipment (Fig. 3). It should be noted that in the medical sense, such a term does not exist and may be related to fear, which precedes panic. When searching for a product that does not exist in the professional sales sector, customers might have experienced the feeling that there was no effective way to prevent the infection. This fear can extend to perception of the availability of other important commodities, such as food, and be a trigger for irrational behavior.

Internet users' inquiries indicate poor knowledge of epidemiological prevention measures (Fig. 3,4). It should be noted that in the period under consideration, professional vocabulary (e.g., "higiena rąk" [hand hygiene]) hardly appears in queries (below the information noise threshold when compared to other epidemiological terms – Fig. 4). Perhaps low information penetration in comparison with other countries[43] (Fig. 1) and the use of quasi-medical neologisms are related to Poles' poor epidemiological knowledge.[46]

The query results on infection prevention measures are illustrated in Fig. 4. In data from January 1 to February 19, 2020, we observe a slight spike in searches for such expressions as "maseczka ochronna" [protective mask] and "kwarantanna" [quarantine]. Simultaneously, we did not observe any change in the frequency of queries in relation to such expressions as "mycie rąk" [hand washing] and "dezynfekcja rąk" [hand disinfection]. Issues related to hand hygiene and quarantine had their peak in February and March. Inquiries about masks reached a peak in popularity at the end of February; however, the frequency of their search did not change significantly in March (as opposed to other epidemiological terms), which may be due to, e.g., the effectiveness of information campaigns regarding their efficacy rate or simply due to the lack of availability of products. The masks were searched not only by Google, but also by transactional websites and comparison shopping websites. In the period from January 10 to February 15, 2020, a multiple increase in prices for masks was observed in Ceneo comparison shopping website[47] as well as in pharmacies, e.g., in Ktomalek application, where the peak of searches for masks took place around February 23, 2020.[48]

An illustration of social representations (definition of the situation) collected during semantic query analysis is presented in Fig. 5. By analyzing the semantic networks of queries, one can recreate the phrases which most frequently co-occurred with the word "coronavirus" in the denominator. Such a network contains information on how the predicate – the noun "coronavirus" – is linked to its arguments in the interrogative phrase.[49]

In this convention (Fig. 5), the questions are most often related to risk (e.g., whether the virus is in Poland / whether it will reach Poland / whether it is close to Poland / whether you can die / how it kills), and subsequently to prevention (e.g., how to prevent / protect / treat yourself). In addition, there are tertiary threads, such as symptoms, history or restrictions. The aspect of geographical proximity is also very important, as locatives "w pobliżu" [nearby], "blisko" [near], "obok" [next to], and "niedaleko" [close] dominate the semantic field around the word "coronavirus". This would indicate some type of information needs of the recipients. The 1st (low) level of needs is the estimation of the risk and potentiality of its occurrence (equivalent to the "Chinese phase"). The 2nd level refers to the search for directions of activities regarding "how to protect yourself" (equivalent to "Italian phase"). The 3rd level of information needs is an attempt to identify the resources necessary to operate – "how fast", "when" and "how much time do I have left" (equivalent to "waiting phase").

Facebook

Facebook reach amongst Internet users constitutes 79% out of approx. 4.5 billion hits per month (via the browser).[38] A large number of hits from the application must be added. Facebook achieved the highest penetration rate

Fig. 5. Semantic net of the word "koronawirus" [coronavirus] in Polish Google (January 1 – February 28, 2020). Generated using the Answer The Public tool[50]

Ryc. 5. Sieć semantyczna fraz ze słowem „koronawirus" w polskim Google (1.01–28.02.2020 r.). Wygenerowano przy użyciu narzędzia Answer The Public[50]

among all social media in Poland (with the participation of approx. 17 million users) and dominates almost all demographic categories (age, gender, education, place of residence) except for teenagers.[51] Facebook does not provide any data from its portal for direct analysis automatically, excluding paid advertising campaigns. Nevertheless, thanks to companies monitoring the media market, the most important information about the discourse on "coronavirus" in this medium, in the period from the beginning of January to February 29, 2020, can be elucidated.[52,53]

The fastest-growing profile in January and February 2020, on the whole Polish Facebook site, is Konflikty i Katastrofy Światowe [Conflicts and World Disasters]. In January, it gained over 120,000 new fans owing to an increased activity related to informing about "coronavirus". Facebook has not been so far a typical source of searching for medical expertise, with a dominant role of support network.

In January 2020, the most popular post in "Vlogs" category was a video *Wuhan market* on the profile of SA Wardęga (@sawardega), which was finally considered as containing false information.[52]

Wikipedia

A movement on Wikipedia is another indicator of social activity, which is the knowledge source regarding the perception of the risk of SARS-CoV-2 infection in Poland. Wikipedia has a 57% reach with over 350 million hits per month[38] and is characterized by overrepresentation of people with higher education and residents of cities with over 200,000 inhabitants (in both cases, the affinity index was[54] over 115). In order to achieve the objectives, we took a closer look at the history of the views and discussions around such entries as *SARS-CoV-2* and the *Szerzenie się zakażeń wirusem SARS-CoV-2* [Spread of SARS-CoV-2].[55,56]

Figure 6 shows a growing trend in the number of inquiries with a small peak around February 13 and an explicit peak around February 27 (the peak of interest in the "Italian phase" with a possible additional effect of the rumor concerning the first case in Poland). First days of March, on the other hand, were characterized by a slight decrease in interest; the society was probably overloaded with basic definitions. A heated discussion concerns, among others, the effectiveness of protective masks and the reliability of data from China. The lack of data before February 10 is related to changes in titles of the articles, caused by changes in the name of the virus and the disease by WHO.

Event Registry

We selected Event Registry[57] as a content aggregator because it contains a large database of Internet sources /

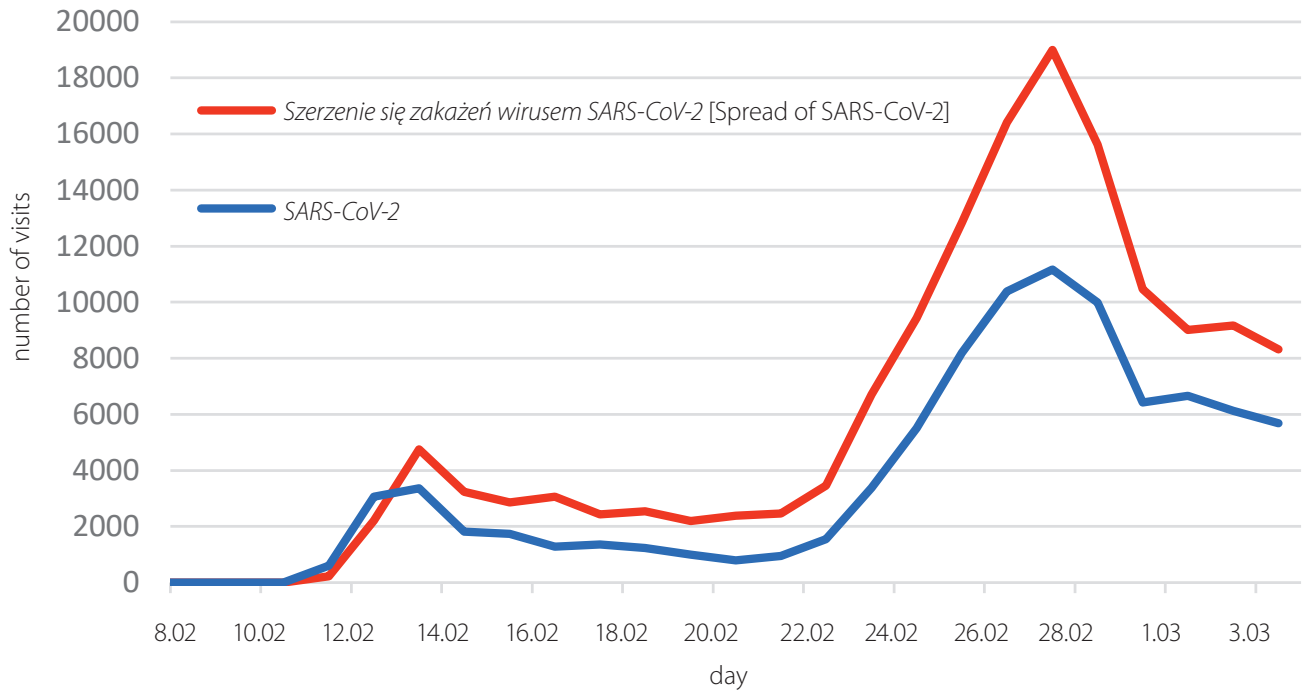

Fig. 6. The number of views of the articles *Szerzenie się zakażeń wirusem SARS-CoV-2* [Spread of SARS-CoV-2] (February 10 – March 3, 2020) and *SARS-Cov-2* (February 8 – March 3, 2020) on Polish Wikipedia

Ryc. 6. Liczba wyświetleń artykułu *Szerzenie się zakażeń wirusem SARS-CoV-2* (10.02–3.03.2020 r.) oraz *SARS-CoV-2* (31.01–3.03.2020 r.) na polskiej Wikipedii

media representing various political orientations. It also gives priority to digital versions of physical broadcast channels, including television, radio and newspapers. Between January 31 and March 1, 2020, the system selected 4,603 representative articles (the period between January 31 and March 3, 2020; a total of 5,622 articles) for the given topic: "coronavirus" location: Poland, language: Polish. Event Registry uses artificial intelligence[9] (among others, machine learning, natural language processing, network analysis, and sentiment analysis) for automatic text selection and text analysis.

Articles are characterized with one-week cycle and one can see 3 peaks in interest: at the end of January (peak: January 31) – "Chinese phase", in the 2nd half of February (peak: February 27) – "Italian phase", and early March (peak: March 1) – "waiting phase" (Fig. 7).

The most common categories (selected by means of thematic modeling) are geographical names, followed by epidemiological terms, then disease symptoms; the list closes with institutions (Fig. 8). The graph reflects the global digital footprint of "coronavirus": epicenters of the disease (endemic regions until early March) and subsequent infected countries. Reliance on medical institutions (such as WHO and governmental institutions) can be observed.

The source selection made by Event Registry system is largely oriented towards the mainstream media (mainstream – most popular), which means that this data set includes primarily reporting and information transfer

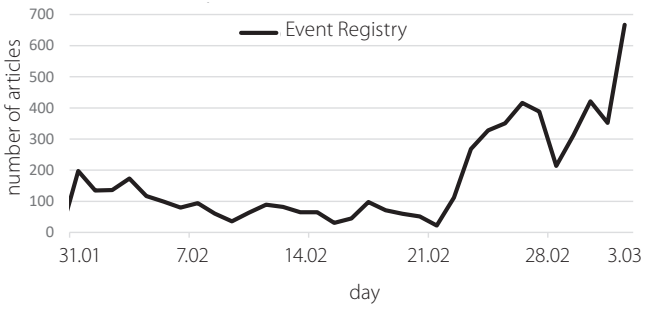

Fig. 7. Number of Polish articles about "coronavirus" in time at one-day intervals (January 31 – March 3, 2020). Generated using the Event Registry tool

Ryc. 7. Liczba polskich artykułów poruszających temat „koronawirusa" w czasie w jednodniowych interwałach (31.01–3.03.2020 r.). Wygenerowano przy użyciu narzędzia Event Registry

(Fig. 9). Owing to this selection, a significant reach (percentage) among Internet users was recreated. It should be noted that the public service media are in a clear minority in the collection of relevant articles; therefore, they are probably not an important source of information about the "coronavirus" among Internet users.

Twitter

Twitter is not very popular in Poland (approx. 3 million registered users and small reach – approx. 15% of

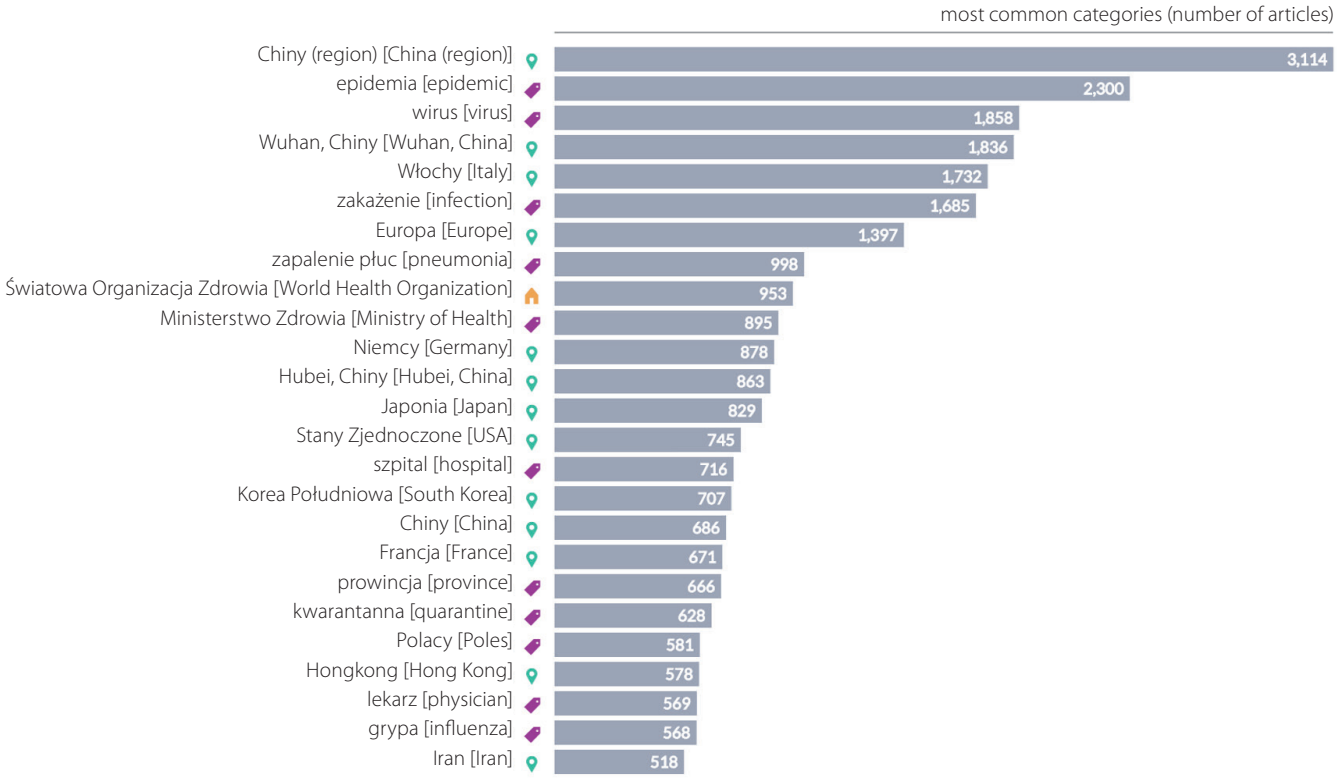

Fig. 8. Top 25 topics in Polish articles about "coronavirus" automatically generated by the system (January 31 – March 1, 2020). Generated using the Event Registry tool

Ryc. 8. Top 25 tematów w polskich artykułach o „koronawirusie" automatycznie wyznaczonych przez system (31.01–1.03.2020 r.). Wygenerowano przy użyciu narzędzia Event Registry

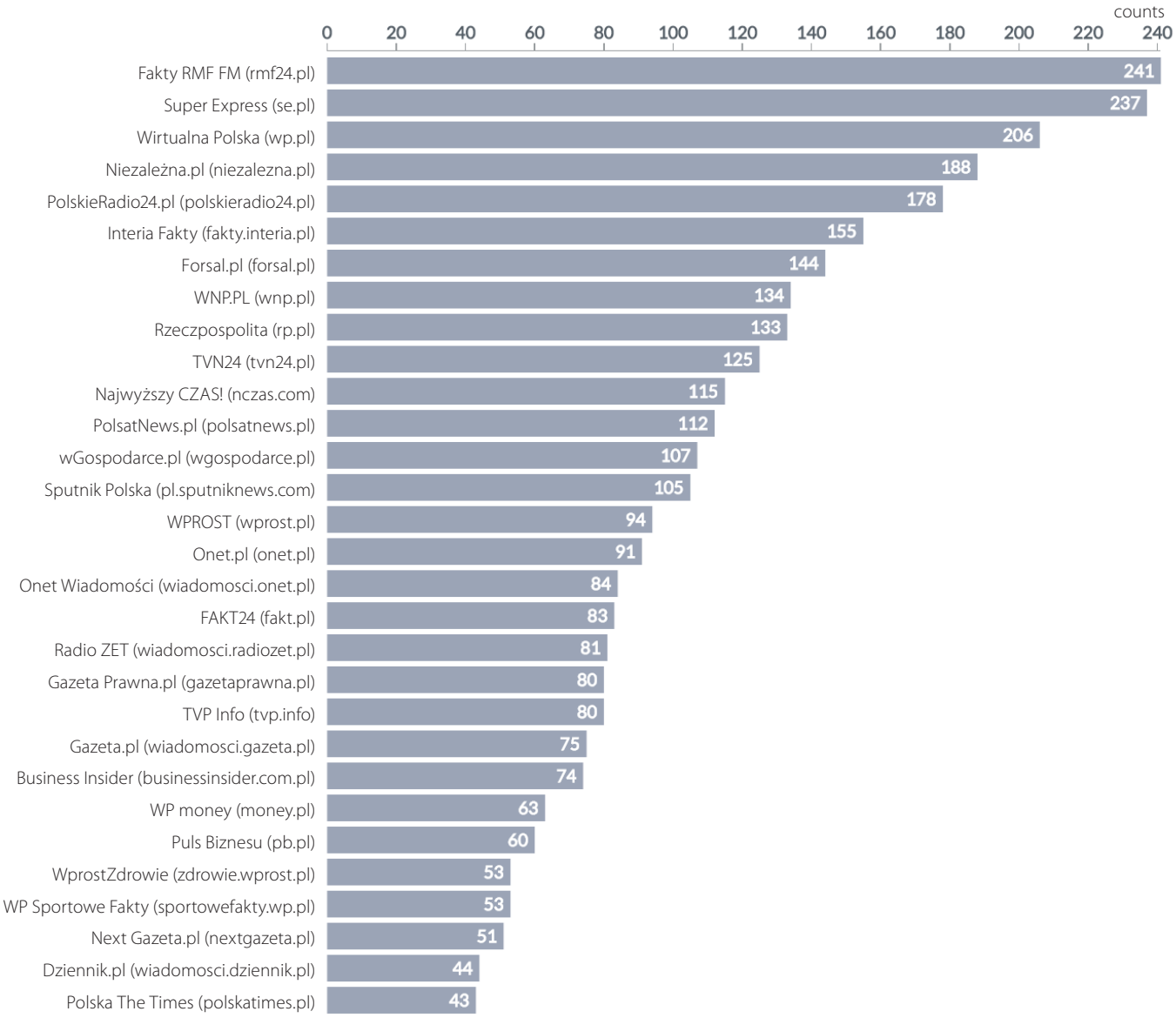

Fig. 9. Top 30 sources of Polish articles about "coronavirus" (January 31 – March 1, 2020). Generated using the Event Registry tool

Ryc. 9. Top 30 najczęstszych źródeł polskich artykułów o „koronawirusie" (31.01–1.03.2020 r.). Wygenerowano przy użyciu narzędzia Event Registry

users) and is mainly used by foreigners, journalists and politicians.[58] Twitter provides API (Application Programming Interface) to the general public. This enables one to analyze not only tweets themselves, but also their context (following, retweets, comments, etc.). A lot of interest in SARS-CoV-2 infection on Twitter can be noticed after the frequency of use of #koronawirus hashtag in Polish tweets (70,277 tweets within approx. 30 days). Twitter had 2 clear peaks: at the end of February (February 28) and at the beginning of March (March 3), and a small one at the end of January (January 29 – Fig. 10). It should be noted that the rapid (tenfold) increase in interest in the last days of February, which may indicate a collective intensification of action at the turn of the "Italian phase" and "waiting phase".

Social networks were used for the analysis of Twitter resources.[9] These networks reflect various links between Twitter accounts used by social agents (which allows for analyzing social impact, trust, friendship, etc.) and characteristics of the agents (e.g., specific political affiliation, views, etc.). An automatic community detection algorithm was used for this purpose; vertices were colored with its help. The retweet network (Fig. 11) shows that the discourse is divided into the ruling camp (grey), the opposition (orange) and Paweł Chojecki's religious-political group Idź Pod Prąd [Go Against the Stream] (yellow). Only accounts that have generated at least 3 tweets and connections that represent at least 2 retweets are shown in this network (Fig. 11).

In addition, further participants in the discourse have been distinguished (Fig. 11). The violet color is used to mark users who exchange funny and ironic content. Interestingly, neither the far right (except for the Protestant movement) nor the far left form their own clusters and are to a large extent located in the communities marked

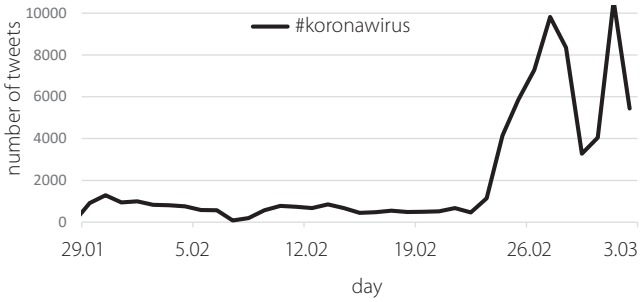

Fig. 10. Number of tweets in Polish with the #koronawirus [coronavirus] hashtag per day (January 27 – March 3, 2020)

Ryc. 10. Liczba tweetów w języku polskim z hashtagiem #koronawirus dziennie (27.01–3.03.2020 r.)

in blue – on the periphery between the ruling camp and the main opposition. The small communities representing extreme views concerning this situation do not show their own optics or strategy.

Before the occurrence of the first case of COVID-2019 in Poland, the "coronavirus" topic on Twitter had political and conflictogenic potential. A clear dispute could be observed between the ruling camp promoting informational content and convincing that Poland is prepared to fight the virus (grey cluster), and the opposition denying the ability to fight the virus (orange cluster) (Fig. 11). The Prime Minister and provincial governors, using their powers under the current COVID-2019 special

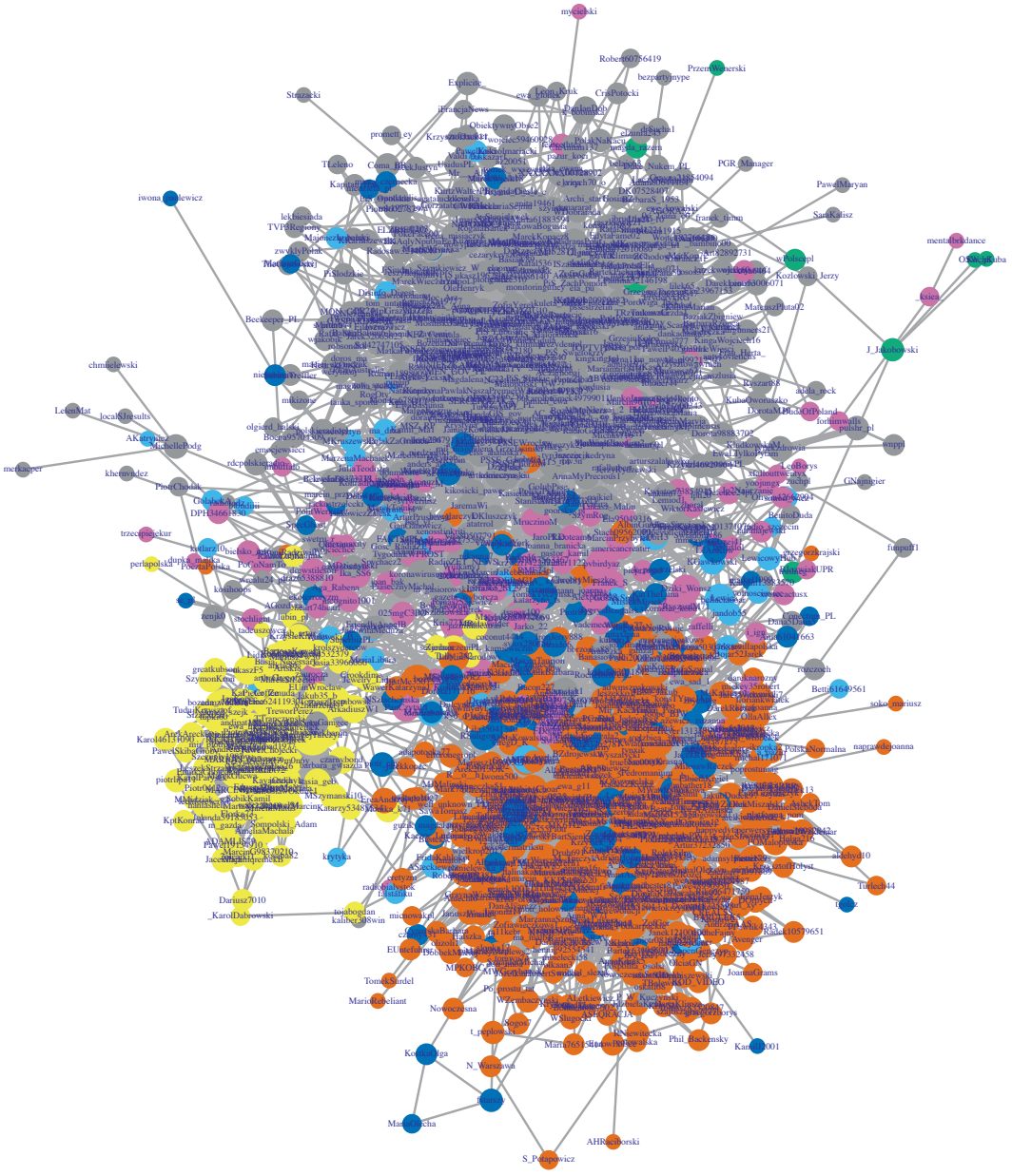

Fig. 11. A network of retweets in Polish with the #koronawirus [coronavirus] hashtag (February 18–28, 2020).
Gray – the ruling camp; orange – the opposition; yellow – the Protestant group Idź Pod Prąd [Go Against the Stream]

Ryc. 11. Sieć retweetów w języku polskim z hashtagiem #koronawirus (18–28.02.2020 r.).
Kolor szary – obóz rządzący; kolor pomarańczowy – opozycja; kolor żółty – protestanckie środowisko Idź Pod Prąd

law,[16] can diversify news channels and order the blocking of accounts and content spreading disinformation or supposedly linked with agents of foreign intelligence influence. For instance, Twitter accounts classified as potentially belonging to the so-called "Russian trolls" (in other studies, they were classified as the far right in the context of elections to the European Parliament, such as Albert301271,[59] or the far left in the context of depopulation of wild boars[60]), promoted the content being a part of the buffer zone (blue), attacking both the ruling camp and the main opposition parties. The results of voting in the Parliament (March 2, 2020) on the rapidly enacted legislation concerning the special law on the prevention, counteraction and combating of COVID-19[61] agree with a non-trivial division of the community into Twitter networks.[62] Four hundred MPs from the ruling party Prawo i Sprawiedliwość [Law and Justice] (grey) and the main opposition (orange), including Koalicja Obywatelska [Civic Coalition], Lewica [The Left] and Polskie Stronnictwo Ludowe [Polish People's Party] supported the project, contrary to 18 MPs from the far right and the far left (blue) (Fig. 11).

By analyzing the count of words, simple sociolinguistic analyses of tweets can be conducted.[3] Thirty-four top words were selected (without lemmatization). Because of the political and journalistic nature of Twitter, the content published on the portal includes mainly words related to political topics (Table 1). Not until the 34th item there is an emotionally charged word – "strach" [fear].

The most central vertices are political and government accounts, as well as those related to the Protestant environment (Go Against the Stream) (Table 2). Centricity is a social impact measure, hence the accounts on this list are worth to be involved in information campaigns because of their important position in the flow of information on the network, especially that they were already operating in the early stages of the epidemic (early adopters).

Table 1. Counts of 34 most frequent words (without stop words) in tweets in Polish (February 18–28, 2020)

Tabela 1. Zliczenia 34 najczęstszych słów (bez stop listy) w tweetach w języku polskim (18.02–28.02.2020 r.)

Order	Word	Counts
1	dziś [today]	447
2	14	421
3	minister [minister]	401
4	głosowanie [voting]	291
5	premier [Prime Minister]	283
6	rząd [government]	199
7	prezydent [President]	187
8	panie [Mr.]	182
9	epidemia [epidemic]	180
10	Donald	178
11	objawy [symptoms]	163
12	Polska [Poland]	148
13	.@M_K_Blonska	143
14	Sławomir	140
15	lekarze [physicians]	131
16	podstawowe [primary]	129
17	szef [Head]	126
18	mamy [we have]	122
19	wygadywanie [talking drivel]	118
20	.@StKarczewski	116
21	świat [world]	114
22	pierwszy [first]	110
23	niestety [unfortunately]	105
24	propozycja [proposal]	102
25	wszyscy [all]	102
26	zakończyło [have ended]	100
27	przewodniczący [chairman]	95
28	informacja [information]	92
29	odnoszę [I refer to]	89
30	wczoraj [yesterday]	85
31	pacjent [patient]	81
32	kolejne [another]	78
33	Włochy [Italy]	74
34	strach [fear]	65

YouTube

YouTube has 68% reach among the Internet users and approx. 700 million hits per month via the browser.[38] Additionally, streams via YouTube application should be taken into account, as this is the most frequently owned mobile application by Poles.[38] For the analysis, we have selected videos whose main subject is "coronavirus".[63] Amongst the most frequently watched films, news broadcasting prevails: materials with over 1 million views were sent by such channels as: the Ministry of Health, Niesamowite Fakty [Amazing Facts] and Nauka To Lubię [Science. I Like It]. Direct news reports from China are very popular: channels with over 1 million hits in this category include Weronika Truszyńska, CJ Channel and Chiński Biznes [Chinese Business]. These channels are followed by vlogs commenting on present events using conspiracy theories – channels with over 1 million views: Wideoprezentacje [Video Presentations] and Globalista TV [Globalist TV]. There are also many minor – expert, political, humorous, financial, or concerning stock market – reports. Hundreds of thousands of views have also been acquired by physicians with revoked right to practice their profession, such as Hubert Czerniak or Jerzy Jaśkowski. YouTube blocked Jerzy Zięba's channel – one of his videos recommended the treatment of SARS-CoV-2 infection with intravenous infusions of perhydrol (commercially available bleach). Furthermore, YouTube already uses keyword search algorithms, such as "corona-

Table 2. The most central 26 accounts (apical weighted centrality) in the Polish Twitter network (February 18–28, 2020)

Tabela 2. Dwadzieścia sześć najbardziej centralnych (centralność wierzchołkowa ważona) kont w sieci polskiego Twittera (18.02–28.02.2020 r.)

Order	Account	Centrality
1	MichalSzczerba	949
2	Leszczyna	914
3	MZ_GOV_PL	820
4	PremierRP	800
5	Platforma_org	654
6	AndrzejTurczyn	590
7	KONFEDERACJA_	538
8	MiroslawSuchon	520
9	KrzysztofBrejza	494
10	idzpodpradpl	468
11	M_K_Blonska	443
12	GIS_gov	406
13	MikiWrobelek_	360
14	prezydentpl	356
15	Bart_Wielinski	344
16	AndrzejDuda	331
17	LewitujacyUmysl	326
18	Jowita_W	298
19	PiotrMuller	283
20	KChojecka	280
21	michalrachon	274
22	KancelariaSejmu	269
23	PawelChojecki	263
24	pigmalion55	263
25	KosiniakKamysz	234
26	ADReverse	205

virus", and limits the reach of videos from non-scientific accounts, where such expressions appear.

YouTube is owned by Google and Google Trends application allows also for the analysis of searches on YouTube, taking into account the same reporting and terminology. There were 3 peaks on YouTube (as in all social media); however, there was 1 peak with 2 bulges in a short time in January (January 28 and 31). Other peaks could be observed on February 28 and March 3 (Fig. 12). Until the time the virus was officially brought to Poland, other topics (e.g., those concerning music, computers, sports, or cooking) were definitely more popular than "coronavirus" (no "coronavirus" topic in top topics and top trends; presence only in top trends in keywords).

Discussion

There is no efficient vaccine or registered specific pharmacotherapy for COVID-2019 (as of early March 2020).[2]

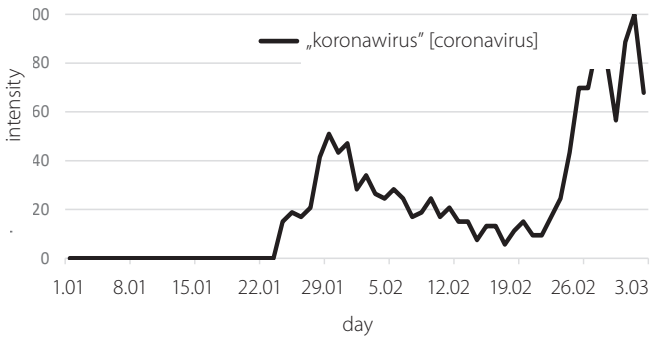

Fig. 12. The intensity of queries with the word "koronawirus" [coronavirus] on Polish YouTube (January 1 – March 3, 2020). Generated using the Google Trends tool

Ryc. 12. Intensywność zapytań (średnie dzienne wartości wyszukiwań) ze słowem „koronawirus" na polskim YouTube (1.01–3.03.2020 r.). Wygenerowano przy użyciu narzędzia Google Trends

We are dealing with epidemics in EU countries (Italy, France, Germany) and the only mitigation techniques are: social contact reduction (e.g., isolation / quarantine or restrictions for travelers and mass gatherings) and lessening of the risk of infection (e.g., standard precautions like hand hygiene, or immunomodulation, such as getting enough sleep). Therefore, the virus (from the perspective of early March 2020) will probably soon cause an epidemic in Poland, and its eradication will not be possible in the perspective of at least several months. A quantitative analysis of the perception of "coronavirus" in Poland should, as a social diagnosis, be the basis for crisis management.[64] This is of great importance, e.g., in developing protective policies in the area of risk management and adequate education of citizens (taking into account the stakeholders identified in Poland), especially that – according to empirical research – society is accustomed to expect institutional actions and in the case of an epidemic, it is the "state [...] that is responsible for the poor health" of the population.[35]

Phases of interest, information campaigns and targeting

Facing the COVID-2019 epidemic (and from March 11, 2020 – pandemic[4]), we are dealing with an unprecedented deluge of information (information noise). Until the confirmation of the first case of the disease, we observed 2 information phases in Poland (the end of January – "Chinese phase" and the 2nd half of February – "Italian phase") and 1 commentary and update phase in social media at the beginning of March – "waiting phase", related to, among others, the special Law (Table 3). As one can see in Table 3, the information and content media (Wikipedia and Google) do not demonstrate the 3rd phase, probably because the need for theoretical knowledge of the infection has already been satisfied, and Poles

are now interested in the main update reports (provided by Twitter, YouTube or electronic media).

The "Chinese phase" is a reflection of the still low information needs, which are only related to the satisfaction of knowledge needs and estimation of the risk potential. An increase in information needs occurred with the first case of "coronavirus" infection in Italy. The "Italian phase", therefore, seems to be the best time to start an essential epidemiological information policy. The analysis of the tweets suggests that the ruling party and the opposition took part in the political discussion about the "coronavirus" rather than in the information activity about it, aimed at educating the public. In the context of "coronavirus", the reach of online public media was much smaller than that of private broadcasters (Fig. 9). This may mean that information campaigns in online public media agencies had reached a smaller number of recipients than it was assumed on the basis of their reach achieved by means of traditional media.

It seems that Poles were generally less interested in the "coronavirus" topic (Google, YouTube) when compared to other developed countries. Simultaneously, this topic was very strongly present in social media, online media and blogs. On websites popular among teenagers (affinity index >150),[65] such as Instagram, the "coronavirus" topic (outside the meme context) was not dominant either. Therefore, the potential explanation for the appearance of the March peak of interest only on some platforms in the "waiting phase" (Table 3) can be divided into 2 categories of agents:

– majority category, consisting of passive users searching for information on the Internet (susceptible to information campaigns). In this category, the agents are characterized so far by passive activity on the Internet in the context of "coronavirus" (possible overrepresentation of teenagers and "mature adults"[66]). Perhaps in this cohort there are people to focus on in online and traditional information campaigns;
– minority category, consisting of active users generating and exchanging content (with varying degrees of susceptibility to traditional information campaigns). The agents in this category are characterized by commenting on articles and other texts, and sending and generating posts / news. In this segment, there is possible overrepresentation of "young adults".[66] When it comes to this cohort, consideration should be given to the use of agents of influence (listed Facebook, YouTube and Twitter accounts (Table 2) and online broadcasters (Fig. 9)), selecting and moderating social media content.

Epidemiological awareness, disinformation and panic

The empirical material collected suggests low epidemiological awareness of Polish society. Online search for "antiviral masks", which are not medical products, along with the huge popularity of controversial agents of influence (e.g., YouTube videos of quack doctors and physicians deprived of the right to practice) and false content (e.g., a case of the video from the market in Wuhan on Facebook) constitute a significant situation. The neologism "epidemiczny" [epidemical] present in the queries of Internet users demonstrates the foreground of consumption panic that occurred a few days later, after an increasing number of infections had been recorded.

The boundaries between various types of information and knowledge are blurring now. As a consequence, in the conditions of the market and consumer society,

Table 3. Timeline of events related to "coronavirus" and reactions on them on various Polish media platforms with Web trace

Tabela 3. Linia zdarzeń związanych z „koronawirusem" i reakcji na nie w polskich mediach społecznościowo-infomacyjnych ze śladem internetowym

Event	Medium				
	Google	Twitter	Event Registry	YouTube	Wikipedia
"Chinese phase"	medium interest	low interest	medium interest	medium interest	no data
January 25, 2020 – death of Liang Wudong, MD, PhD	significant peak on January 28, 2020	no data	no data	no changes	no data
January 28, 2020 – first COVID-19 case in Germany	no changes	delayed insignificant peak on January 29, 2020	no data	insignificant peak on January 28, 2020	no data
January 31, 2020 – declaration of state of emergency	no changes	no changes	insignificant peak on January 31, 2020	insignificant peak on January 31, 2020	no data
"Italian phase"	high interest	high interest	high interest	high interest	high interest
February 27, 2020 – fake news about the virus in Poland	significant peak on February 27, 2020	clearly delayed peak on February 28, 2020	insignificant peak on February 27, 2020	clearly delayed peak on February 28, 2020	significant peak on February 27, 2020
"Waiting phase"	decrease in interest	increase in interest	increase in interest	increase in interest	decrease in interest
March 3, 2020 – voting on the special law	no changes	significant peak on March 3, 2020	significant peak on March 3, 2020	significant peak on March 3, 2020	no changes

the private goals of individuals are in conflict with the responsibility of the whole society or the community. Hence, for instance, the supply / demand effect of the increase in the prices of medical devices and other aspects of the desire to use the epidemic for their own purposes. Collective behaviors on the financial market have been observed as well – in spite of the global recession since mid-February, caused by disruptions in supply chains and a stirring of panic among investors, an increase in the prices of shares of medical device manufacturers, such as Mercator company in the Warsaw Stock Exchange (January 20–March 3, 2020), occured.[67] As with SARS-CoV-2, there are theories spreading virally on the Internet, such as: "the virus has escaped from a BSL-4 class laboratory near Wuhan" (https://wgospodarce.pl/informacje/74490-skad-ten-wirus-czemu-wszyscy-milcza-o-tym-laboratorium), "it is an American biological weapon that gives an advantage over China in a trade conflict" (https://www.planeta.pl/Ciekawostki/Koronawirus-to-bron-biologiczna-Chiny-oskarzaja-USA-o-atak-i-epidemie) or vice versa (https://petitions.whitehouse.gov/petition/petition-president-donald-trump-hold-chinas-government-accountable-coronavirus), "the virus serves massive population reduction" (https://mega.nz/#!flVzRIzZ!hW6Q0EvYLQ7QfCZ4VvTsmQe-IXnmDrbJkDHWiQ3TgPM) and "establishment of a world government" (http://teresagarland.neon24.pl/post/153672,koronawirus-czyli-nowy-podzial-swiata-na-strefy-wplywow), "the virus is harmless and serves the interests of pharmaceutical companies" (www.youtube.com/watch?feature=youtu.be&v=RjDp2jDLWbo&fbclid), "the virus is a punishment for godlessness of the Chinese" (https://www.o2.pl/artykul/koronawirus-jest-plaga-zeslana-przez-boga-duchowny-oburzyl-6472964912736385a), or "the infection can be avoided with hidden treatments about which the physician will not tell you".[68] The analysis identified several potential sources of disinformation (e.g., Twitter and YouTube accounts). Such theories fall on fertile ground because of the scripting mechanism[69] used for simplifying the reality, as simpler explanations are assimilated by people more easily, especially that little is known about SARS-CoV-2 and the recommendations and opinions of such authorities as WHO, European Centre for Disease Prevention and Control (ECDC) and Centers for Disease Control and Prevention (CDC) are still being updated.

Social panic can occur when the risk is overestimated or when members of the population do not understand its mechanism, but also when the countermeasures taken are not sufficient enough to control the situation.[8] The more frequently the information about the "coronavirus" is repeated, the more important topic it seems (positive feedback). Due to the observation of information bubbles (e.g., on Twitter), public information campaigns may have less impact on society than expected (at least until the first case of the disease occurred). Until then, the phenomenon of "coronavirus" remained a political issue, not a problematic one. For this reason, some activities in the area of public health may not have received the due attention of Poles. The ethical role of media platforms,[70] which have technical capacity to moderate the discourse on infection, should also be mentioned. This also applies to traditional journalism, which in its pursuit of luring the reader fuels sensational content.[71] In the social media, preventive censorship can be considered in justified cases,[72] especially that the new special law offers such possibilities.

Limitations

Although all media (particularly social media) provide information about SARS-CoV-2, unfortunately, only Twitter, enabling remote access (via its API), can be used to reliably analyze the perception of the virus and its impact on society. Only by analyzing the data from Twitter do we have full control over research methods and techniques, even though it represents a small and very unrepresentative sample of Polish Internet users (only 15%), let alone Poles as a whole. Facebook meta-information is most difficult to obtain. Despite the highest penetration rate, population representativeness and the largest reach, it does not provide any automatic analysis[73]; thus, we can only rely on manual, time-consuming research by commercial companies,[51–53] whose research methods may differ from scientific standards. In the case of Event Registry, we are also forced to use tools whose methods are not under our control. Additionally, at the beginning of March, Google created a new tab concerning COVID-19, which could redirect users' queries directly to the highlighted tab. Furthermore, data analysis may be biased due to the overload of data collection or the involvement of media platform algorithms in the discourse, even if the amount of digital footprint (even for Poland) is enormous.

Conclusions

It is important to note that this article is intended to present the problem immediately in a data-driven exploratory convention. There is therefore a need to continue the research in the form of a reliable, confirmatory, quantitative, and qualitative analysis of the perception problem in order to prepare for risk management and do so in an optimal way. Although it has been possible to include the information media as well as social and content media with the highest coverage in Poland, some gaps have occured due to the lack of possibility to conduct a quantitative analysis in each of them. The next step will be a qualitative analysis of Facebook content, followed by blogs and comments below articles.

Perhaps one of the reasons for the success of the Chinese in controlling the spread of the infection is that their social media (e.g., WeChat[16,17]) and Internet forums[74] have been penetrated by algorithms.[75–77] This includes

more than just research on the impact of public information campaigns or internal public opinion surveys for parties and organizations. Proper information activities and cooperation with communication platforms are now an extremely strong health policy tools for preventing the spread of the epidemic and targeting citizens' actions.

The Internet research presented in this article is necessary for crisis management teams and public relations departments in order to prepare detailed solutions for taking actions to minimize the public health risk.[68] Owing to the tools used, we can obtain a picture of communication activities and information needs of the Polish society to assess the situation from the point of view of the effects of the epidemic in the long term. In conjunction with further results, the data collected can be used to analyze risk management in health policy. In addition, such a project may fill gaps in sociomedical research on collective action in a situation of public health risk regarding a significant infectious disease.

It should be noted that, until the date of submission of this manuscript, this article has been the first analysis of SARS-CoV-2 Internet perception regarding a country being a member of the European Union. Moreover, despite the great interest in the subject of the worldwide perception of diseases on the Internet, counted in hundreds of publications per year, no quantitative analysis of Polish society has been carried out so far,[78,79] despite the fact that in other areas of medicine, or even for "coronavirus", similar analyses have been conducted by Polish scientists for other countries in the world.[80,81]

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