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FAKE NEWS, MEDIA MANIPULATION, AND HEALTH EFFECTS OF 5G: A SMALL-
SAMPLE DISCOURSE-ANALYTIC CASE STUDY OF THE CROATIAN NEWS WEBSITE
INDEX.HR

SUMMARY

This study investigated whether the Croatian news website Index.hr manipulates information on the health effects of 5G. We constructed one experimental corpus, containing all articles by Index.hr on health effects of 5G, and two control corpora, one with articles about health effects of 5G published by reliable media, and one with articles about science published by Index.hr. Compared to Index.hr science articles, Index.hr 5G articles were 288.14 times likelier to express the author's opinion, 16.95 times likelier to express a subjective opinion, 10.78 times likelier to contain no references, 10.78 times likelier to contain misinformation, and 4.20 times likelier to contain no scientific references. The simultaneous increase in misinformation and reduction in referencing suggests that the misinformation doesn't stem from other sources, but that it is produced within Index.hr. An increase in opinion expression, and opinion subjectivity in the context of misinformation suggests that Index.hr is manipulating the information on health effects of 5G. Furthermore, all articles were written by different authors, indicating that this phenomenon is systematic within Index.hr. Still, the small sample size warrants a degree of caution.

Key words: fake news ; misinformation in media ; electromagnetic fields ; 5G ; Croatia

SAŽETAK

Ova je studija istražila manipulira li hrvatski informativni portal Index.hr informacijama o učincima 5G-a na zdravlje. Izradili smo eksperimentalni korpus koji je sadržavao sve članke o učincima 5G-a na zdravlje objavljene na portalu Index.hr, te dva kontrolna korpusa, jedan s člancima o učincima 5G-a na zdravlje objavljenima u pouzdanim medijima, i jedan s člancima o znanosti objavljenih na portalu Index.hr. U usporedbi s znanstvenim člancima portala Index.hr, za

članke portala Index.hr o učincima 5G-a na zdravlje bilo je 288.14 puta vjerojatnije da će izraziti autorovo mišljenje, 16.95 vjerojatnije da će izraziti subjektivno mišljenje, 10.78 puta vjerojatnije da neće sadržavati referencije, 10.78 puta vjerojatnije da će sadržavati dezinformacije te 4.20 puta vjerojatnije da neće sadržavati znanstvene referencije. Istovremeni porast u broju članaka s dezinformacijama i pad broja članaka s referencijama sugerira da dezinformacije ne proizlaze iz drugih izvora informacija, već da nastaju unutar portala Index.hr. Porast u broju članaka s izraženim mišljenjem kao i subjektivnim mišljenjem sugerira da Index.hr manipulira informacijama o učincima 5G-a na zdravlje. Nadalje, sve su članke napisali različiti autori što ukazuje na sustavnost ovog fenomena unutar portala Index.hr. Ipak, potrebna je pažnja pri interpretaciji rezultata zbog male veličine uzorka.

Ključne riječi: lažne vijesti ; dezinformacije u medijima ; elektromagnetska polja ; 5G ; Hrvatska

1. INTRODUCTION

The expansion of wireless information and communication technologies using man-made electromagnetic fields has exploded in the last couple of decades. Once limited to particular social and/or geographical groups of people, these technologies have become practically omnipresent and they have been systematically incorporated into everyday human functioning. Currently, the new generation of wireless information transfer – the 5G – is expected to be globally introduced. It is predicted that 5G will provide faster and more extensive data transmission through the use of additional higher frequency bands (Simkó & Mattsson, 2019, p. 1). Thus, 5G has been welcomed by a multitude of interest groups, however, many have expressed their concerns about its possible

adverse effects on human health. While some of these concerns have been *a priori* assumed unconvincing and/or categorized as “conspiracy theories” in the media, some of them have been raised by scientists and published in reliable sources.

There is a far-reaching history of research on the health effects of wireless radiation (Belpomme Hardell, Belyaev, Burgio, & Carpenter, 2018; Deruelle, 2020; Desai, Kesari, & Agarwal, 2009; Di Ciaula, 2018; Doyon & Johansson, 2017; Havas, 2017; Kaplan et al., 2016; Kostoff & Lau, 2013, 2017; Lerchl et al., 2015; Levitt & Lai, 2010; Miller et al., 2019; Pall, 2016, 2018; Panagopoulos, 2019; Panagopoulos, Johansson, & Carlo, 2015; Russell, 2018; Sage & Burgio, 2018; van Rongen et al., 2009; Yakymenko et al., 2016). Kostoff, Heroux, Aschner, & Tsatsakis (2020) summarize these findings reporting that exposure to radio frequency radiation below the American Federal Communications Commission guidelines can result in the genesis of several types of cancer, DNA and chromatin damage and/or dysfunction, mutagenesis, teratogenesis, neurological and psychiatric disorders (including Alzheimer’s disease and autism), reproductive problems, excessive reactive oxygen species/oxidative stress, inflammation, apoptosis, blood-brain barrier disruption, pineal gland/melatonin production dysfunction, sleep disturbance, headache, irritability, fatigue, concentration difficulties, depression, dizziness, tinnitus, burning and flushed skin, digestive disturbance, tremor, cardiac irregularities, and general dysfunction of the neural, circulatory, immune, endocrine, and skeletal systems.

Specific research on the health effects of 5G has been scant. Nevertheless, the majority of the existing literature demonstrates that exposure to 5G, i.e. higher frequency bands, has biological effects on humans, but the relationship between these biological effects and human health is still unclear, mainly due to methodological limitations of the studies (see Simkó & Mattsson, 2019 and papers cited therein). As an illustration of the difficulties in relating these biological effects to

eventual implications for human health, the following citation is provided: “A study that was conducted on bacteria and fungi showed an increase in cell growth ... The other in vitro study was performed on fibroblasts (25 GHz, 0.80 mW/cm², 20 min), with genotoxic effects observed at high SAR levels (20 W/kg) ...” (Simkó & Mattsson, 2019, p. 5). However, in a number of these studies the biological effects appear to be more indicative of possible adverse health effects on humans than not (e.g. eye and skin damage in laboratory subjects). Kostoff et al. (2020) further predict that compared to technologies using lower frequency bands exposure to high-band wireless radiation as used in 5G would lead to disproportionate increases in skin and eye diseases, and, likely, effects on the nervous system, heart, and the immune system (cf. Mehdizadeh & Mortazavi, 2019). Interestingly, a recent review on the effects of 5G found no relationships between the effects of exposure, and intensity, exposure time, and frequency (Simkó & Mattsson, 2019, p. 16). Be as it may, there is no scientific consensus on the health effects of 5G (i.e. higher frequency bands), mainly because this topic remains understudied, the existing studies employ heterogeneous methodologies, and the methodology in this field is severely limited. As discussed by Kostoff et al. (2020), most studies have been conducted in laboratory settings implying predominant use of non-human compared to human subjects, frequent omission of extremely low frequencies which are regularly present in all telecommunication, as well as frequent use of only one toxic stimulus as a stressor, whereas in real-life settings humans are exposed to numerous stressors which can exacerbate the existing adverse effects of radiation. Simkó & Mattsson (2019, p. 16) also criticize the quality of some of the research: “[T]oo few studies fulfill the minimal quality criteria to allow any further conclusions.” Kostoff et al. (2020) conclude: “[A]lmost all of the wireless radiation laboratory experiments that have been performed to date are flawed/limited with respect to showing the full adverse impact of the wireless radiation that would be expected under real-life

conditions.” What is more, “studies have shown that industry-funded research of wireless radiation adverse health effects is far more likely to show no effects than funding from non- industry sources [Carpenter, 2019; Huss et al., 2007].” (Kostoff et al., 2020). It should, however, also be emphasized that technological innovations of 5G are expected to bring benefits for the public health as well, particularly in the domains of telemedicine and extremity rehabilitation (Li, 2019; Li & Wang, 2019).

Despite the lack of consensus, the use of 5G technology clearly poses a possible public health issue (cf. Bircher & Kuruvilla, 2014; Mason, Lindberg, Read, & Borman, 2018). In this regard it has been recognized that media and journalists play a decisive role in how public health issues are perceived in the public, how the public will respond to the issue, and what the public knows about the issue (Leask, Hooker, & King, 2010; Wallington, Blake, Taylor-Clark, & Viswanath, 2010). Furthermore, media can act as catalysts to promote particular health practices in the public (Institute of Medicine 2003). However, there appears to be an increasing amount of misinformation on health topics in the media (Dhoju, Rony, Kabir, & Hassan, 2019; Scheufele & Krause, 2019), rendering the relationship between the media and public health complicated. We are not aware of any studies specifically investigating media misinformation on the health effects of 5G. On the other hand, a number of studies investigating media-related phenomena used articles from Index.hr, among other sources, in their studies (Brautović & Miloslavić, 2009; Britvić, Đurić, & Bužić, 2014; Capurso, 2019; Čižmešija, Sorić, & Lolić, 2017; Granić, Mitrović, & Maragunić, 2011; Hazdovac Bajić, 2013; Jakopović & Mikelić Preradović, 2016; Mijatov & Radenović, 2019; Tanta, Barić-Šelmić, & Levak, 2017). Conversely, we are aware of only one (unpublished) study which focused specifically on the news website Index.hr. Ivica Jeđud presented his study at the 7th Stulikon Student Linguistic Conference in May 2018 in Zagreb, Croatia in which he found that

Index.hr articles do not adhere to the suggested people-first language prescriptions when describing people with mental disorders, and that when the title does contain people-first language, the news is far more likely to be of negative than positive emotional valence (people-first language frequently didn't appear in the main text, even when the title contained such constructions; for the conference abstract see Jedud, 2018).

2. METHODOLOGY

2.1. Materials (corpora)

News articles for the experimental corpus were extracted from the Croatian news website Index.hr (<https://www.index.hr/>). We extracted all news articles marked with “#5G” or “#5G mreža (‘5G network’)” from the website. We selected only those articles which addressed health effects of 5G. News articles written by the Croatian News Agency and published on Index.hr were not included in the experimental corpus. The search generated nine news articles altogether. Two of the nine articles were identical in content. Thus, one was excluded with the experimental corpus finally consisting of eight news articles. All articles were written by different authors. The oldest article was published on April 8, 2019 and the newest article was published on April 7, 2020.

We constructed two control corpora with articles which were published in approximately the same time frame as their experimental counterparts. The first control corpus consisted of eight randomly chosen news articles about the health effects of 5G published by reliable mainstream media. Problematically, there exist no robust criteria for media reliability: “The matter of reliability is subjective.” (Dhoju et al. 2019: 94). The reliability of the media in the present study was thus

determined by the author based on his experience with these media, and his expertise in linguistics and communication. The media included news websites by BBC, Tagesschau, Spiegel Online, Hrvatska radiotelevizija, Zeit Online, Frankfurter Allgemeine Zeitung, and Süddeutsche Zeitung. All articles were published by different media. The oldest article was published on January 16, 2019 and the newest article on July 17, 2019. If there would be significant differences between the Index.hr 5G, and reliable 5G corpora, this would suggest that Index.hr reports more unreliably on the health effects of 5G than our corpus of reliable media articles, and would thus tentatively indicate that Index.hr reports unreliably on the health effects of 5G.

The second control corpus consisted of eight randomly chosen news articles from Index.hr which were about science, but not 5G. All articles in the second control corpus were written by different authors and none of the authors was the author of any of the news articles from the experimental corpus. The oldest article was published on June 4, 2019 and the newest on February 24, 2020. If there would be significant differences between the Index.hr 5G, and Index.hr science corpora, this would suggest that Index.hr has a different approach to 5G–health articles compared to other articles on scientific topics, and would further possibly indicate that Index.hr manipulates information on the health effects of 5G.

All news articles were assessed by the author on the presence of references, presence of scientific references (clear information about and/or links to a scientific paper or a summary of a scientific paper), presence of clear misinformation (in the present study: erroneous referencing, and denial of the existence of scientific literature on a particular topic), expression of an opinion about the issue, and expression of a subjective opinion about the issue. In the present study opinions were identified as subjective if they were expressed with the use of subjective words, or if they were not backed by any type of external information. Words used for opinion expression were categorized

as subjective if they were emotionally salient, or if they simultaneously had a weak ability in delivering facts, and a high ability in expressing opinions (for the second criterion see Wang et al., 2018).

We also assessed the number of hyperlinks in each article. Hyperlinks referencing to articles published by the same medium were excluded from analyses. According to Dhoju et al. (2019: 94), articles published by reliable media contain more hyperlinks compared to articles published by unreliable media. In their study reliable media had a median of eight hyperlinks per article, while most articles published by unreliable media had less than two or no hyperlinks. Furthermore, we assessed the number of visual media in each article. According to Dhoju et al. (2019: 95), no differences in the number of visual media per article between reliable and unreliable news media should be expected. In their study, articles from reliable media had a mean of 13.83 visual media, while articles from unreliable media used 14.22 visual media on average.

2.2. Statistical analyses

Statistical analyses were conducted in JASP 0.11.1.0. The chi square test was used to compare categorical variables between groups. We report the Likelihood ratio because of the small sample size (< 30), along with Cramer's V for effect sizes (ES). We also manually calculated the odds ratio (note: not the relative risk, cf. Stare & Maucourt-Boulch, 2016). If a contingency table contained a count which was $= 0$, the Haldane-Anscombe correction was applied. We only report odds ratios > 1 , as proposed by Osborne (2006). The independent sample t-test, namely the Mann-Whitney U and Welch's tests were used for the analyses of group differences in the number of hyperlinks and visual media. Rank-biserial correlation, and Cohen's d were reported for ESs, respectively. Normality of distribution was tested using the Shapiro-Wilk test of normality, and the Levene's test of equality of variances was used for the assumption of homogeneity of variance.

3. RESULTS

Group values of the categorical variables are shown in Table 1. References and scientific references were detected in all corpora. Articles with the author's opinion were found in the Index.hr 5G and reliable 5G corpora, but not in the Index.hr Science corpus. Articles with misinformation, and articles with a subjective opinion by the author were identified only in the Index.hr 5G corpus. Regarding misinformation, two cases of erroneous referencing, and one case of denial of the existence of scientific literature on the health effects of 5G were detected (Table 2). Subjective opinions are shown in Table 3. All subjective opinions favored the hypothesis that 5G had no adverse health effects. Subjective words in the expression of subjective opinions included *sulud* 'silly', *naravno* 'naturally, of course', and *lud* 'crazy'. Perhaps notably, the oldest Index.hr 5G article was the only article in the Index.hr 5G corpus which contained scientific references, and further contained no misinformation, nor a subjective opinion. The author's opinion was, nevertheless, expressed, conveying that science has thus far been unable to say whether 5G has adverse effects on human health, and that it is necessary to continue exploring this topic since 5G is putatively to unstoppably continue his expansion around the world. This oldest article and the second oldest article were temporally divided by 103 days (April 8, 2019 compared to July 20, 2019). The opinion in the second oldest article already denies without reservation that 5G has any possible adverse health effects, with the title reading: "Čuli ste za opasnost koja prijeti od 5G mreža? To ne postoji" 'Have you heard of the danger behind the 5G networks [sic]? That [sic] doesn't exist'. However, this article contains references, and contains neither misinformation nor a subjective opinion. In all other Index.hr 5G articles an opinion is expressed which generally

states that 5G has no adverse effects on human health. One Index.hr 5G article which had no references, no scientific references, and expressed a subjective opinion (but had no misinformation) was written by a doctor of psychology. No other article displayed biographical information on the author(s).

Table 1

Group values of the categorical variables

Group/Corpus	Articles with references	Articles with scientific references	Articles with misinformation	Articles with the author's opinion	Articles with a subjective opinion by the author
Index.hr 5G	5/8	1/8	3/8	8/8	4/8
Index.hr Science	8/8	3/8	0/8	0/8	0/8
Reliable 5G	7/8	6/8	0/8	3/8	0/8

Table 2

Cases of misinformation in the Index.hr 5G corpus

Subject/ Article no.	Original text in Croatian	Translation into English (by the author)
2	Naravno, ne postoje nikakvi znanstveni dokazi da peta generacija mobilne komunikacije, poznatija kao 5G, izaziva ili pogoršava novu bolest COVID-19 koju izaziva koronavirus SARS-CoV-2. Tom se temom, među ostalima, pozabavio i	There are, naturally, no scientific evidence that the fifth generation of mobile communication, better known as 5G, causes or worsens the new disease COVID-19 [sic] which is caused by the coronavirus SARS-CoV-2. This topic has been discussed,

	nezavisna britanska stranica za provjeru činjenica (fact check) Full Fact.	among others, by the independent British fact-checking website Full Fact.*
5	Hrvati se bune protiv 5G mreže. Ona je opasna po zdravlje kao sušena šunka	Croatians are protesting against the 5G network. It is as adverse to our health as is smoked ham**
6	Jasno, kako to često biva kod takvih stvari, priče o štetnosti 5G mreže su najobičnija nagađanja i nemaju uporišta u znanosti.	Of course, as it often is with these things, the stories about the adverse effects of 5G network are pure guessing, and they have no foundation in science.

Notes. The first two cases of misinformation were cases of erroneous referencing, while the third case was one of denial of the existence of scientific literature on health effects of 5G. * A closer inspection of the referenced hyperlink to the Full Fact article reveals that it doesn't fact-check whether 5G causes or worsens [the symptoms of] COVID-19, but whether it has adverse effects on the immune system which would make one more susceptible to viral, including coronaviral, infections. Additionally, there are at least several studies suggesting the possibility that exposure to man-made electromagnetic fields might lead to immunosuppression and thus increase the risk of opportunistic infections (see Doyon & Johansson 2017 and papers cited therein). ** This claim is based on the fact that the International Agency for Research on Cancer classified radio frequency exposure as possibly cancerogenic (International Agency for Research on Cancer 2013), and the "pseudofact" that smoked ham is also classified as possibly cancerogenic. Interestingly, this pseudofact is not expressed explicitly in the main text, but is implicitly expressed two times, once in the title, and once in a subheading. Firstly, smoked ham is not specifically identified as a (possibly) cancerogenic agent by the IARC. Secondly, processed, and red meat are not in the same category as radio frequency radiation. Thirdly, carcinogenesis is not the only possible adverse effect of radio frequency radiation. Fourthly, it is not clear how the label "possibly cancerogenic" should lead to the implication that radio frequency exposure has no adverse health effects.

Table 3

Cases of a subjective opinion by the author

Subject/ Article no.	Original text in Croatian	Translation into English (by the author)
1	Iako se <u>suluda</u> teorija zavjere protiv 5G mreže proširila cijelim svijetom [...].	Although this <u>silly</u> conspiracy theory against the 5G network has dispersed all over the world [...].
2	<u>Naravno</u> , ne postoje nikakvi znanstveni dokazi da peta generacija mobilne	There are, <u>naturally</u> , no scientific evidence that the fifth generation of mobile

	komunikacije, poznatija kao 5G, izaziva ili pogoršava novu bolest COVID-19 [...].	communication, better known as 5G, causes or worsens the new disease COVID-19 [sic] [...].
3	Subjective opinion not backed by any type of external information.	
4	Internetom kruže <u>lude</u> teorije da je 5G tehnologija uzrokovala koronavirus	<u>Crazy</u> theories about the 5G technology causing the coronavirus [sic] are circling the internet

Table 4

Descriptive data on hyperlinks and visual media

Group/Corpus	Hyperlinks	Visual media
Index.hr 5G	1.750 (3.495)	2.750 (2.493)
Index.hr Science	1.000 (0.535)	1.125 (0.354)
Reliable 5G	2.375 (2.446)	2.500 (2.000)

Notes. The mean values are reported. Standard deviations appear in parentheses.

Group values of hyperlink and visual media frequency are shown in Table 4. Hyperlinks and visual media were detected in all corpora. Articles without hyperlinks were found in all corpora. All articles in all corpora displayed at least one visual medium.

3.1. Comparisons between Index.hr 5G, and reliable 5G articles

Categorical variables – Results of the chi square test are shown in Table 5. There were no significant differences in the number of articles with references between the Index.hr 5G and reliable 5G corpora, with a small-to-moderate ES. Still, the odds ratio analysis showed that Index.hr 5G articles were 4.20 times likelier to contain no references than reliable 5G articles. There were significantly less articles which contained scientific references in the Index.hr 5G

corpus compared to the reliable 5G corpus, with a large ES. Additionally, Index.hr 5G articles were 21.02 times likelier to contain no scientific references compared to reliable 5G articles. The Index.hr 5G corpus also displayed significantly more articles which contained misinformation compared to the reliable 5G corpus, with a moderate-to-large ES. Index.hr 5G articles were 10.78 time likelier to contain misinformation compared to reliable 5G articles. The Index.hr 5G corpus also contained significantly more articles in which the author gave his opinion on the issue, with a large ES. Index.hr 5G articles were 26.73 times likelier to express the author's opinion on the issue compared to reliable 5G articles. Furthermore, the Index.hr 5G corpus contained significantly more articles in which the author's subjective opinion was expressed compared to the reliable 5G corpus, with a large ES. Index.hr 5G articles were 16.95 more likely to include a subjective opinion on the issue compared to reliable 5G articles.

Hyperlinks – Because normality of distribution was violated in the Index.hr 5G group ($p < .001$), and the assumption of homogeneity of variance was not violated ($p = .787$), we compared the two values using the Mann-Whitney U test. Although visual examination of the descriptive data suggested that reliable 5G articles contain slightly more hyperlinks than Index.hr 5G articles, the test failed to reject the null hypothesis ($U = 40.500$, $p = .369$), showing a small ES ($r = 0.266$).

Visual media – Normality of distribution was violated in both the Index.hr ($p = .012$), and the reliable 5G groups ($p = .021$). The assumption of homogeneity of variance was not violated ($p = .612$). Mann-Whitney U test revealed no differences between groups in the number of visual media per article ($U = 31.500$, $p = 1$), with a trivial ES ($r = 0.016$).

Table 5

Results of the chi square tests comparing Index.hr 5G and reliable 5G articles

Variable	Chi square	Cramer's V
References	$X^2 = 1.381, p = .240$	$V = 0.289$
Scientific references*	$X^2 = 6.904, p = .009$	$V = 0.630$
Misinformation*	$X^2 = 4.857, p = .028$	$V = 0.480$
Author's opinion*	$X^2 = 9.290, p = .002$	$V = 0.674$
Subjective opinion*	$X^2 = 6.904, p = .009$	$V = 0.577$

Notes. $df = 1$, $N = 16$, * $p \leq .05$.

3.2. Comparisons between Index.hr 5G, and Index.hr science articles

Categorical variables – Results of the chi square test are shown in Table 6. There were significantly less articles with references in the Index.hr 5G corpus compared to the Index.hr science corpus, with a moderate ES. The odds ratio analysis showed that Index.hr 5G articles were 10.78 times likelier to contain no references than Index.hr science articles. There were no differences between the two corpora in the number of articles with scientific references, with a small ES. Still, Index.hr 5G articles were 4.20 times likelier to contain no scientific references compared to Index.hr science articles. The Index.hr 5G corpus also displayed significantly more articles which contained misinformation compared to the Index.hr science corpus, with a moderate ES. Index.hr 5G articles were 10.78 times likelier to contain misinformation compared to Index.hr science articles. The Index.hr 5G corpus also contained significantly more articles in which the author gave his opinion on the issue compared to the Index.hr science corpus, with a large ES. Index.hr 5G articles were 288.14 times likelier to express the author's opinion on the issue compared to Index.hr science articles. Furthermore, the Index.hr 5G corpus contained significantly more articles in which the author's subjective opinion was expressed compared to the Index.hr

science corpus, with a large ES. Index.hr 5G articles were 16.95 more likely to include a subjective opinion on the issue compared to Index.hr science articles.

Table 6

Results of the chi square tests comparing Index.hr 5G and Index.hr science articles

Variable	Chi square	Cramer's V
References*	$X^2 = 4.857, p = .028$	$V = 0.480$
Scientific references	$X^2 = 1.381, p = .240$	$V = 0.289$
Misinformation*	$X^2 = 4.857, p = .028$	$V = 0.480$
Author's opinion***	$X^2 = 9.290, p < .001$	$V = 1.000$
Subjective opinion**	$X^2 = 6.904, p = .009$	$V = 0.577$

Notes. df = 1, N = 16, * $p \leq .05$, ** $p \leq .01$, *** $p \leq .001$.

Hyperlinks – Normality of distribution was violated in both the Index.hr 5G ($p < .001$), and the Index.hr science corpora ($p = .005$). Assumption of homogeneity of variance was violated as well ($p = .028$). Thus, we compared the two values using the Welch's test. Although visual examination of the descriptive data suggested that Index.hr 5G articles contained slightly more hyperlinks, the test demonstrated no apparent differences between the two corpora [$t(7.327) = 0.600, p = .567$], with a small ES ($d = 0.300$).

Visual media – Normality of distribution was violated in both the Index.hr 5G ($p = .012$), and the Index.hr science corpora ($p < .001$). The assumption of homogeneity of variance was also violated ($p = .004$). Welch's test revealed no significant differences between groups in the number of visual media per article [$t(7.281) = 1.825, p = .109$], but with a large ES ($d = 0.913$). Furthermore, the t-

value was slightly higher when comparing the two corpora in the number of visual media per article, than when comparing them in the number of hyperlinks per article.

4. DISCUSSION

Comparisons of news articles about health effects of 5G published by Index.hr, and news articles about health effects of 5G published by reliable mainstream media revealed that the Index.hr 5G articles compared to articles in the reliable 5G corpus were 26.73 times likelier to express the author's opinion, 21.02 times likelier to have no scientific references, 16.95 times likelier to express a subjective opinion, 10.78 times likelier to contain misinformation, and 4.20 times likelier to contain no references. Only the data concerning the presence of references yielded relatively unclear results. The converging data nevertheless suggest that Index.hr is a less reliable source of information on the health effects of 5G compared to the present corpus of reliable media articles. If we would assume that our sample of reliable articles were a representative sample, we would be in a position to say that Index.hr reports rather unreliably than reliably on the unreliable–reliable continuum.

Comparisons of news articles about health effects of 5G published by Index.hr, and news articles about science (but not 5G) published by Index.hr revealed that the Index.hr 5G articles compared to Index.hr science articles were 288.14 times likelier to express the author's opinion, 16.95 times likelier to express a subjective opinion, 10.78 times likelier to contain no references, 10.78 times likelier to contain misinformation, and 4.20 times likelier to contain no scientific references. Here, only the data concerning the presence of scientific references yielded relatively unclear results.

Problematically, small sample sizes are associated with both false negatives and false positives (Oakes, 2017; Vadillo, Konstantinidis, & Shanks, 2016), while also being associated with overestimated odds ratios (Nemes, Miao Jonasson, Genell, & Steineck, 2009). However, we extracted all articles on health effects of 5G from Index.hr, making this issue insurmountable at the moment. Furthermore, the analyses were conducted without excluding the oldest article in the Index.hr 5G corpus, which displayed notable qualitative differences (presence of scientific references, and expression of an objective, non-polarized opinion) compared to other articles in the corpus. Possibly, this oldest article might be an indicator that a phenomenon occurred within Index.hr between April 8, 2019 and July 20, 2019, which was followed by a presumed switch in the approach to reporting on health effects of 5G.

Nonetheless, the observed differences between the two Index.hr corpora demonstrate that there are both quantitative and qualitative differences within Index.hr in the production of news articles on health effects of 5G compared to the production of other scientific news articles. Compared to the production of general news articles on science, the production of news articles on health effects of 5G is thus characterized by a reduction in referencing, and an increase in misinformation, opinion expression, and opinion subjectivity. The simultaneous increase in misinformation and reduction in referencing, as well as the quality of the observed pieces of misinformation suggest that misinformation doesn't stem from other unreliable sources of information, but that the misinformation is produced within Index.hr. An increase in opinion expression, and opinion subjectivity in the context of misinformation suggests that Index.hr is manipulating the information on health effects of 5G. This is corroborated by the fact that the two types of misinformation identified in the present study included erroneous referencing, and denial of the existence of scientific literature on the topic. Furthermore, all articles on both 5G, and scientific topics were

written by different authors, indicating that this phenomenon is systematic within Index.hr. Additionally, the fact that there were significant differences in the presence of scientific references between the Index.hr 5G, and reliable 5G corpora, but not between the Index.hr 5G, and the Index.hr science corpora, possibly suggests that Index.hr relies less on scientific references in general. Although the present data point to manipulation of information on the health effects of 5G, caution should be warranted due to the small sample size.

We found no significant differences in the raw number of hyperlinks, and visual media between both pairs of corpora. However, the ES for the difference in the number of visual media between the Index.hr 5G, and Index.hr science corpora was large, suggesting that the sample size possibly affected the results of the statistical analyses. It is difficult to interpret this result at the moment. Our mean raw values of hyperlinks and visual media greatly differed from Dhoju et al. (2019). They reported a median of eight hyperlinks for reliable media, while the reliable 5G corpus in the present study had a mean of 2.375 hyperlinks (and a median of 2; not reported in the results section). Furthermore, articles across corpora in our study contained on average between 1.125 and 2.750 visual media, while in the mentioned study articles from both reliable, and unreliable media contained on average around 14 visual media. We suggest that the raw number of hyperlinks may not be a valid measure of media reliability. Additionally, our results are in line with Dhoju et al. (2019) who found no differences between reliable, and unreliable media in the number of visual media per article.

5. LIMITATIONS

Firstly, the sample size is small, as discussed in different parts of the paper. Secondly, the reliability of media for the reliable 5G corpus was determined introspectively by the author. Finally, this study used a very narrow methodological frame. Nevertheless, we find it, in this case at least, effective.

6. CONCLUSION

The present case study investigated whether the Croatian news website Index.hr manipulates information on the health effects of 5G. We constructed one experimental corpus, containing all articles by Index.hr on health effects of 5G, and two control corpora, one with articles about health effects of 5G published by reliable media, and one with articles about science (but not 5G) published by Index.hr. We assessed the presence of references, scientific references, misinformation, opinion expression, and opinion subjectivity. Compared to Index.hr science articles, Index.hr 5G articles were 10.78 times likelier to contain no references, 4.20 times likelier to contain no scientific references, 10.78 times likelier to contain misinformation, 288.14 times likelier to express the author's opinion, and 16.95 times likelier to express a subjective opinion. The simultaneous increase in misinformation and reduction in referencing, as well as the quality of the observed pieces of misinformation suggest that misinformation doesn't stem from other unreliable sources of information, but that the misinformation is produced within Index.hr. An increase in opinion expression, and opinion subjectivity in the context of misinformation suggests that Index.hr is manipulating the information on health effects of 5G. This is corroborated by the fact that the two types of misinformation identified in the present study included erroneous referencing, and denial of the existence of scientific literature on the topic. Furthermore, all articles on both 5G, and scientific topics were written by different authors, indicating that this phenomenon

is systematic within Index.hr. We conclude that our data point to manipulation of information on health effects of 5G by Index.hr. Still, the small sample size warrants a degree of caution.

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