

Time series analysis of government information about COVID-19 on social media and the number of new cases during the first 6 months of the pandemic: the Brazil case

Análise de série temporal de informações do governo sobre COVID-19 nas redes sociais e o número de novos casos durante os primeiros 6 meses da pandemia: o caso do Brasil

Análisis de series de tiempo de la información del gobierno sobre COVID-19 en las redes sociales y el número de nuevos casos durante los primeros 6 meses de la pandemia: el caso de Brasil

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Abstract

This retrospective study sought to assess the association between the evolution of the COVID-19 pandemic in Brazil and the quality of educational materials published in the official profiles of Brazilian government health agencies on Instagram. Posts about COVID-19, published between January 31 and August 15, 2021, were selected, dated, quantified and classified according to their content by three researchers. Public's engagement was calculated by the number of likes, comments and views. The quality of the educational posts was assessed by two trained and calibrated researchers (Kappa intra and inter-examiners, $k=0.96$ and $k=0.92$, respectively), using the Brazilian version of the Clear Communication Index (BR-CDC-CCI), the number of new COVID-19 cases was collected using the COVID-19 epidemic calculator provided by PAHO at <https://covid-calc.org/>. The relationship between the evolution of the COVID-19 indicator and the quality of educational posts was calculated using the statistical model of a fortnightly time series. On average, educational posts reached 6.4 in the BR-CDC-CCI score (median = 6.5). In the multiple model adjusted for the amount of educational posts and public engagement, it was observed that for each increase of one point in the BR-CDC-CCI score, there was a reduction of 327,864 new cases of Covid-19 ($p < 0.001$). It was concluded that there was a relationship between the low quality of posts and the greater number of new cases of the disease, indicating the need for greater attention from Brazilian

government agencies with the quality of information made available on social networks to help control the COVID-19 pandemic.

Keywords: COVID-19; Health communication; Health education; Access to information; Social networking.

Resumo

Este estudo retrospectivo buscou avaliar a associação entre a evolução da pandemia de COVID-19 no Brasil e a qualidade dos materiais educativos publicados nos perfis oficiais dos órgãos governamentais de saúde brasileiros no Instagram. As postagens sobre COVID-19, publicadas entre 31 de janeiro e 15 de agosto de 2021, foram selecionadas, datadas, quantificadas e classificadas de acordo com seu conteúdo por três pesquisadoras. O engajamento do público foi calculado pelo número de curtidas, comentários e visualizações. A qualidade das postagens educativas foi avaliada por duas pesquisadoras treinadas e calibradas (Kappa intra e inter-examinadores, $k=0.96$ e $k=0.92$, respectivamente), utilizando a versão brasileira do Índice de Comunicação Clara (BR-CDC-CCI), o número de casos novos do COVID-19 foi coletado através da calculadora epidêmica Covid-19 fornecida pela OPAS, no site <https://covid-calc.org/>. A relação entre a evolução do indicador da COVID-19 e a qualidade das postagens educativas foi calculada através do modelo estatístico de uma série temporal quinzenal. Em média, as postagens educativas alcançaram 6,4 no escore BR-CDC-CCI (mediana = 6,5). No modelo múltiplo ajustado pela quantidade de publicações disponibilizadas e engajamento do público, observou-se que a cada aumento de um ponto no escore BR-CDC-CCI, houve uma redução de 327.864 novos casos de Covid-19 ($p < 0,001$). Concluiu-se que houve relação entre a baixa qualidade das postagens e o maior número de novos casos da doença, assinalando a necessidade de maior atenção por parte de órgãos governamentais brasileiros com a qualidade das informações disponibilizadas nas redes sociais para auxiliar no controle da pandemia de COVID-19.

Palavras-chave: COVID-19; Comunicação em saúde; Educação em saúde; Acesso à informação de Saúde; Rede social.

Resumen

Este estudio retrospectivo buscó evaluar la asociación entre la evolución de la pandemia COVID-19 en Brasil y la calidad de los materiales educativos publicados en Instagram de las agencias de salud del gobierno brasileño. Las publicaciones sobre COVID-19, entre el 31 de enero y el 15 de agosto de 2021, fueron seleccionadas, fechadas, cuantificadas y clasificadas según su contenido por tres investigadores. La participación de la audiencia se calculó por la cantidad de me gusta, comentarios y vistas. La calidad de las publicaciones educativas fue evaluada por dos investigadores capacitados y calibrados (Kappa intra e inter-examinadores, $k=0.96$ y $k=0.92$, respectivamente), utilizando la versión brasileña del Clear Communication Index (BR-CDC-CCI), El número de casos nuevos de COVID-19 se recopiló en el sitio web <https://covid-calc.org/>. La asociación entre la evolución del indicador COVID-19 y la calidad de las publicaciones educativas se calculó mediante el modelo estadístico de una serie temporal quinzenal. En promedio, publicaciones educativas alcanzaron 6,4 en la puntuación BR-CDC-CCI (mediana = 6,5). En el modelo múltiple ajustado por la cantidad de publicaciones y la participación de la audiencia, se observó que por cada aumento de un punto en la puntuación BR-CDC-CCI, hubo una reducción de 327,864 nuevos casos ($p < 0,001$). Se concluye que existía una relación entre la baja calidad de publicaciones educativas y el mayor número de nuevos casos. Las agencias de salud del gobierno brasileño deben estar atentas de la calidad de información disponible en las redes sociales para ayudar a controlar la pandemia de COVID-19.

Palabras clave: COVID-19, Comunicación en salud; Educación en salud; Acceso a la información; Red social.

1. Introduction

Since the end of 2019, the world has been on constant alert due to the COVID-19 pandemic, and global society has been undergoing an unprecedented rupture. The easy transmission of SARS-CoV-2 made its fast dissemination throughout the world possible, causing deaths and severe conditions of morbidity. All of this has resulted in an overload on health systems, requiring emergency public action. Efforts throughout the world have been implemented so that effective therapeutic alternatives, beyond the vaccine, could be made accessible to the general public. Since there were no available vaccines in the early months of the pandemic, and considering that there is no proven antiviral treatment, health authorities have been strongly recommending the adoption of measures of individual protection and social distancing as the most important means through which to contain the disease. It could be presumed that individual behavior collectively influences the pandemic's evolution. However, for these measures, as well as any proposed preventive therapy, to be successful, it is necessary for the population to adhere to the measures.

This adherence must also be related to how informed the population is about the disease and how confident/safe they feel about this knowledge for their own self-care (Centers for Disease Control and Prevention, 2009; Centers for Disease Control and Prevention, 2019; McClure et al., 2016).

In contemporary culture, changes in the ways individuals are seeking information about health care are becoming ever-increasingly evident. Social medias are considered accessible platforms and capable of being used in the promotion, communication, and intervention of health literacy (Roberts et al., 2017, Levin-Zamir & Bertschi, 2018). In contrast with pandemics in history, such as the Spanish flu in 1918, the COVID-19 pandemic is spreading through a connected world, in which practically all individuals are connected to one another through a mobile phone in the palm of their hands. Due to restrictive measures of social distancing, people depend heavily on the maintenance of connectivity by using global digital social networks, both for social interaction as well as for access and sharing of information about the virus (Limaye et al., 2020; Roberts et al., 2017). Governmental agencies have been using social media to inform their actions, advise citizens, as well as interact with the population (Pang et al., 2021).

However, social media, although practical, accessible, and economical, can also offer an inconvenience that is as harmful and contagious as the virus itself. As they are based on a wide range of sources, many of which with no necessary technical-professional alignment, they can end up transmitting “disinformation” (Daraz et al., 2018; Loeb et al., 2020). Scholars describe the current period as “an era of fake news” in which disinformation, generated intentionally or not, spreads quickly. Although it affects all areas, disinformation presents specific problems in the field of health, where it can delay or even hinder effective measures and, in some cases, threaten the lives of individuals (Wojtowicz, 2020). When used properly, governmental social media can work as a tool to control rumors, provide regular updates, and promote coherence within the community in public health crises, such as that being faced nowadays. It is important that Medicine Evidence Based principles guide the health communication to assure the best evidence on preventive measures and treatments reach the target population.

Three aspects are considered essential to upgrade social media from a mere disseminator of disinformation to a promotor of health (Schillinger et al., 2020). The first is the clarity of language. The second refers to the source of information and to who is disclosing it. It is important to remember that the public authorities are the most interested parties in the disclosure of reliable information and with the greatest scientific evidence, given that the adherence to prevention programs and therapies impact the evolution of the disease in the population under its auspices. The third aspect to be considered is the information capacity of engagement of citizens, signaling how the governmental actions are embraced by the population (Pang et al., 2021; Schillinger et al., 2020). Understanding these aspects is necessary to comprehend the role of the social media of official governmental agencies in the pandemic evolution.

In this context, it is important to understand how the online communication about COVID-19 took place between the Brazilian government and the population at an important moment, when the adherence to health advice was essential to guaranteeing individual and community safety against the virus, and to evaluate its association with the pandemic evolution.

Therefore, this study had the aim to evaluated, quantitatively and qualitatively, the content published on the social media platform, Instagram, by Brazilian governmental agencies in confronting COVID-19, the engagement of the population with these publications and its association with the number of new cases of the disease in the first six months of the pandemic.

2. Methodology

2.1 Type of study

A retrospective study was conducted, in which two data groups were confronted: a) the quantity and quality of the posts content related to the COVID-19 pandemic published on social media from Brazilian governmental agencies and b) the evolution of the number cases of the diseases. The data from the present research are a part of a broader study, begun on January 31, 2020 and is still ongoing, which seeks to analyze the relationship between the content regarding COVID-19 posted on the social media of three spheres of the Brazilian government and official indicators of the evolution of the pandemic in the country (number of new cases, deaths, and social isolation). The latest indicators will be presented in this article in the sense of contextualization, but they have not been explored in the analyses until this moment.

This study presents the results from the first six months of data collection, referent to the period between January 31, 2020, and August 12, 2020. The initial mark for data collection corresponds to the first day after the decree of a state of emergency issued by the World Health Organization (WHO).

2.2 Data collection

2.2.1 Information sources

In this study, it was decided to collect data regarding official communications on health posted on Instagram, the researches verified that there was a great overlapping of content concerning COVID-19 when comparing the profiles of the Brazilian Ministry of Health (MH) and the National Health Surveillance Agency (ANVISA, in Portuguese) on this social media network and on their official websites. Instagram discloses contents with images and short texts, allowing for people to recover old posts with their respective dates and, with this, construct a historical series of posts. Currently, Instagram has 69 million users in Brazil and 1.2 billion users worldwide (<https://pt.slideshare.net/DataReportal/digital-2021-july-global-statshot-report-v02/>, accessed on December 5, 2020).

The indicators referent to the pandemic evolution (deaths by COVID-19, new COVID-19 cases, and lethality) were extracted from the Pan-American Health Organization (PAHO) (<https://ciis.fmrp.usp.br/covid19/estado-br-mapa/>, accessed on October 8, 2020). The PAHO has made available free information consolidated and provided by states, capitals, and the Federal District of Brasilia in a practical and continuous manner since February 2020. Information on social isolation was extracted from a specialized company site, which is consulted through official state agencies – Inloco (<https://mapabrasileirodacovid.inloco.com.br/pt/> accessed on October 8, 2020).

2.2.2 Criteria for the selection of social media posts

Posts on COVID-19 geared toward the general population, published on the official profiles of the Brazilian MH (@minsaude) and ANVISA (@anvisaoficial) on Instagram were eligible. Posts that were not related to COVID-19 and that did not have the general population as its target public, as well as posts referent to health campaigns for other diseases, were excluded.

2.2.3 Data extraction and classification of the posts

The posts were recorded, dated, named and classified as: educational posts on COVID-19 signs and symptoms, educational posts on COVID-19 prevention, epidemiological bulletins, decrees concerning measures to combat the disease,

governmental actions in health, and governmental actions in the economy. The engagement achieved by the posts, represented by the number of likes, comments, and views of the posts, was also recorded.

2.2.4 Quality analysis

The educational posts (COVID-19 signs and symptoms and prevention) were saved, both images and subtitles, for quality analysis, using the Brazilian version of the Center of Disease Control Clear Communication Index (BR-CDC-CCI) (Marinho et al., 2020). The CDC-CCI consists of 20 scored items that generate a final score (0 to 10 points). The instrument evaluated the clarity of the information and the public's understanding, considering the main message and the call to action, as well as the way in which recommendations of behavior, numbers, and risks are addressed in the materials. To evaluate short messages, such as posts on social media, the original authors proposed a modified version, adopted in this study, which corresponds to 13 of the 20 scored items. In results interpretation, the materials that present scores equal to or higher than 9 (percentage score $\geq 90\%$) are considered adequate for use in health communication.

The training and calibration for the use of this instrument was conducted by the researcher responsible for the validation of the Brazilian version of CDC-CCI, (gold standard). Two researchers examined 11 posts, and their results were compared, reaching an agreement considered excellent (Kappa Cohen intra and inter-examiners, $k=0.96$ and $k=0.92$, respectively).

2.3 Statistical analysis

First, the descriptive analysis of the variables was conducted, and the data were placed in fortnight groups ("Fortn1" to "Fortn13"), from January 31, 2020, to August 12, 2020. For the quality analysis of the posts, the average of the BR-CDC-CCI scores of the educational posts recorded in each fortnight group was calculated. The association between the evolution of COVID-19 indicator (number of new cases) and the quality of the educational posts was found by applying the statistical models of the fortnight time series.

A times series regression model was used to analyze the data, whose formula is given by: $y_t = \beta_0 + \beta_1 x_{1t} + \beta_2 x_{2t} + \dots + \beta_K x_{Kt} + \epsilon_t$, $\epsilon_t \text{ i.i.d } N(0, \sigma^2)$. y_t is a times series of interest (outcome), $t = 1, 2, \dots, n$ observations. x_{kt} is the k th covariate at time t or explanatory series with $k = 1, 2, \dots, K$ covariates. β_k is the k th coefficient of the regression model. ϵ_t is the random error of the model. The estimated equation for this model is defined as: $\hat{y}_t = b_0 + b_1 x_{1t} + b_2 x_{2t} + \dots + b_K x_{Kt}$, in which b_k is the k th estimated coefficient of the model with $k = 1, 2, \dots, K$. The selection of the covariables was performed using the stepwise procedure, considering both the p -value of the covariable and the Variance Inflation Factor (VIF). In case of collinearity, the variable of greater interest according to the theoretical model was selected. In addition to the usual scatter plots, normality (Shapiro-Wilk), heteroscedasticity (ARCH), and self-correlation (Ljung-Box) tests were performed on the residues. For some observations, it was necessary to make a simple imputation by applying the same value. These analyses were performed with R statistical software (R Core Team, 2020).

The association between the evolution of the COVID-19 indicator (number of new cases) and the quality of the educational posts was found by applying the statistical models of the fortnight time series (Shumway & Stoffer, 2010). Naturally, as the regression linear, we can use the regression time series models to quantify the (cross) autocorrelation and associate two or more time series with due care. Therefore, we used the regression models described below (see Shumway & Stoffer, 2010, Chapter 2). This approach is common in time series analysis. For a successful example of this model application in the context of dentistry data, see de Melo Cunha et al. (2015).

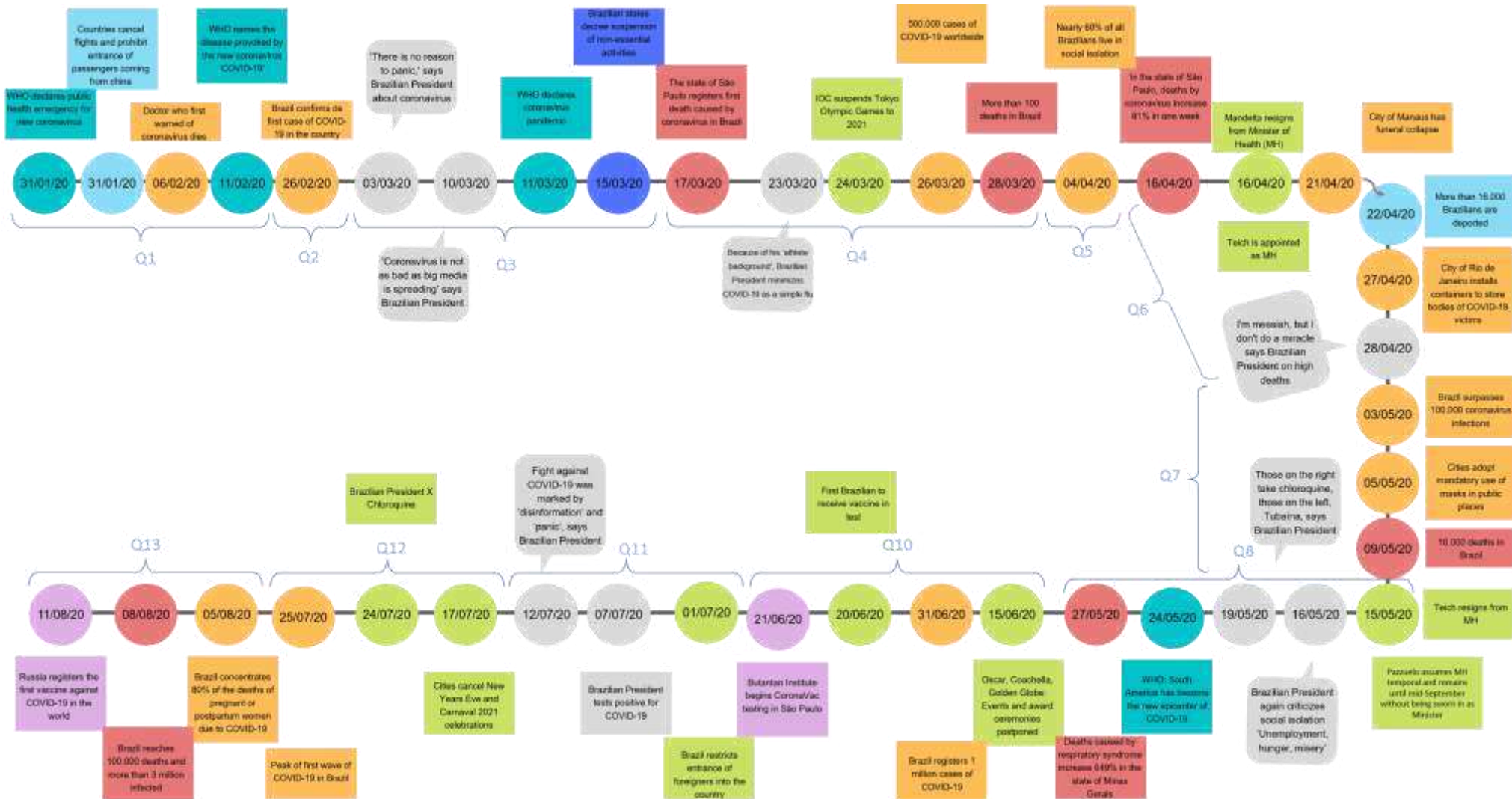
3. Results

Figure 1 contextualizes the evolution of the six first months of the pandemic in Brazil as reported in the headlines of the country's mass communication vehicles during the period.

The first case of COVID-19 in Brazil was recorded in the second fortnight (Fortn2), and as of the fourth fortnight (Fortn4), the number of cases increased expressively, as shown in Figure 2-A. At the end of the thirteenth fortnight (Fortn13) there were already 681,594 new cases of the disease in the country. The mark of 100,000 cases was reached in the seventh fortnight (Fortn7) (Figure 1). As regards the number of deaths, an exponential growth was also found during the analyzed period, from the recording of 1,000 deaths in the fifth fortnight (Fortn5) to the recording of 15,000 deaths in the eleventh fortnight (Fortn11). As regards the lethality, the sixth fortnight (Fortn6) presented the highest value at 7.31. The fourth and fifth fortnights (Fortn4 and Fortn5) showed the highest social isolation index, reaching 48.5%. Despite the continuous increase in the number of new cases, social isolation was reduced over time (Table 1) (Figure 2-A).

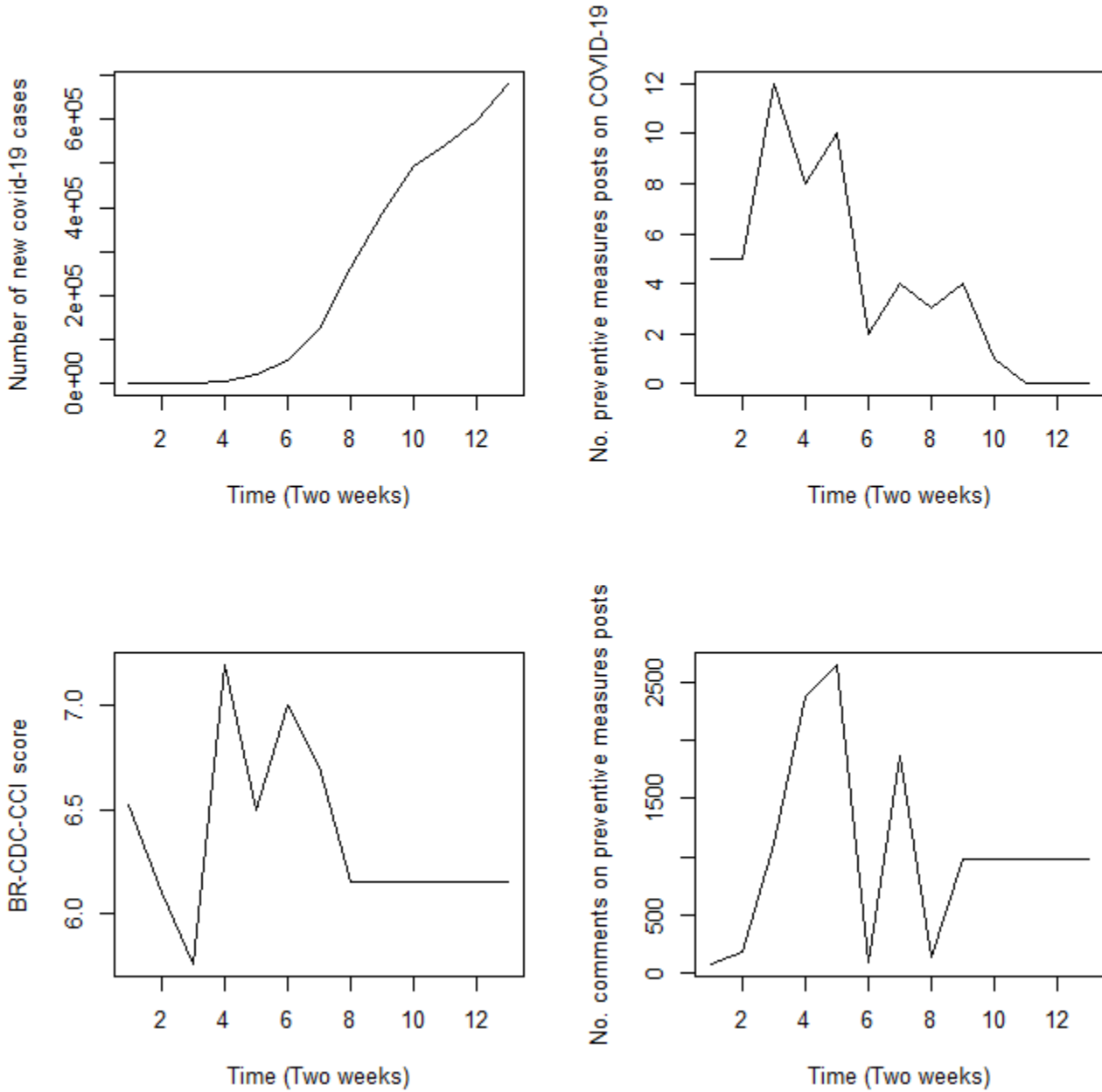
During the six first months of the pandemic, 899 posts about COVID-19 were reported on the official profiles of the Brazilian MH and ANVISA. Of this total, 60 had an educational content, with only six posts being about the signs and symptoms of the disease and 54 about individual protective care, 148 corresponded to epidemiological bulletins, one made a reference to an official decree, 673 reported governmental actions for health, 24 were warnings of "fake news", and there was no report of governmental actions for the economy (Table 1).

Figure 1: Timeline with the main headlines of mass communication in Brazil between January 31, 2020 and August 12, 2020.



Source: Authors.

Figure 2: Graph representation of the fortnight time series between January 31, 2020 and August 12, 2020. The variables are number of new cases (A), number of posts with educational messages about individual preventive care (B), BR-CDC-CCI score (C), and number of comments on posts with educational messages about individual preventive care (D).



Source: Authors.

Table 1: Distribution and descriptive measures of the evolution of COVID-19 indicators and of posts on Brazilian government social media (profiles of the Brazilian Ministry of Health @minsaude and the National Health Surveillance Agency @anvisaoficial on Instagram) of about disease during the first six months of the pandemic.

	Fn1	Fn2	Fn3	Fn4	Fn5	Fn6	Fn7	Fn8	Fn9	Fn10	Fn11	Fn12	Fn13	μ	σ	CV	25	50	75	m	M
C	0	2	160	4417	20683	54423	123480	262001	385348	493629	540824	598224	681594	243445	262034.59	0.08	2288.50	123480	517226.50	0	681594
D	0	0	0	159	1373	3981	8486	13879	14842	14902	15211	15706	15662	8015.46	7146.59	0.89	79.50	8486	15056.50	0	15706
L	0	0	0	3.59	6.63	7.31	6.87	5.29	3.85	2.87	2.81	2.62	2.29	3.39	2.56	0.75	1.15	2.87	5.96	0	7.31
I	27.67	31.70	30.36	48.16	48.53	45.93	44.06	43.79	41.12	40.52	40.78	40.26	38.74	40.12	6.60	0.10	35.22	40.78	45	27.67	48.53
T	64	39	51	111	104	92	97	69	56	62	71	41	42	69,15	24.64	0.36	46.50	64	94.50	39	111
S	1	1	1	2	1	0	0	0	0	0	0	0	0	0.46	0.66	1.43	0	0	1	0	2
P	5	5	12	8	10	2	4	3	4	1	0	0	0	4.15	3.87	0.93	0.50	4	5	0	12
SP	6	6	13	10	11	2	4	3	4	1	0	0	0	4.62	4.39	0.95	0.50	4	8	0	13
B	6.52	6.10	5.75	7.20	6.50	7	6.71	6.15	6.15	-	-	-	-	6.45	0.47	0.07	6.13	6.50	6.86	5.75	7.20
q	0	0	0	1	0	0	0	0	0	-	-	-	-	0.11	0.33	3.02	0	0	0	0	1
p	0	0	0	16.60	0	0	0	0	0	-	-	-	-	1.84	5.53	3	0	0	0	0	16.60
E	0	2	4	9	13	14	15	14	11	25	24	17	0	11.38	8.23	0.72	3	13	16	0	25
d	0	0	0	1	0	0	0	0	0	0	0	0	0	0.08	0.28	3.46	0	0	0	0	1
H	58	31	35	91	80	76	78	52	41	36	47	34	42	53.92	20.62	0.38	35.50	47	77	31	91
F	11	1	2	4	2	3	0	0	1	0	0	0	0	1.85	3.05	1.65	0	1	2.50	0	11
e	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	0	0	0	0	0
LF	2539	4247	-	137919	72200	15300	-	-	55200	-	-	-	-	47900.83	52484.60	1.10	3820	35250	88629.75	2539	137919
CoF	986	60	-	914	2389	436	-	-	180	-	-	-	-	827.50	852.35	1.03	150	675	1336.75	60	2389
LS	2868	-	44	32000	10000	-	-	-	-	-	-	-	-	11228	14467.84	1.29	750	6434	26500	44	32000
CoS	20	-	0	587	136	-	-	-	-	-	-	-	-	185.75	274.14	1.48	5	78	474,25	0	587
LP	9722	19606	-	152400	85127	4322	81805	11466	40200	-	-	-	-	50581	52019.26	1.03	10158	29903	84296.50	4322	152400
CoP	73	189	-	2376	2652	86	1870	134	975	-	-	-	-	1044.38	1099.78	1.05	98	582	2249,50	73	2652
TL	60476	123941	252254	1526498	1286061	806311	910807	701954	362450	351733	253803	174668	141021	534767.46	473590.27	0.89	157844,50	351733	858559	60476	1526498
TCo	1507	3322	6519	21147	38316	31484	28600	46329	15463	15347	8152	4529	3422	17241.31	14820.01	0.86	3975,50	15347	30042	1507	46329
TV	18	15	14	16	17	19	25	20	22	15	25	14	17	18.23	3.81	209.05	15	17.00	21.00	14	25

TVw	225728	592224	645579	1524669	3025694	1931669	1950850	1123026	952142	455900	694163	380100	411900	1070280.31	822352.45	0.77	433900	694163.00	1728169.00	225728	3025694
TVCo	502	1680	1780	4846	15623	7327	85504	5974	5938	1012	3945	841	929	10453.92	22925.30	2.19	970.50	3945.00	6650.50	502	85504

C: new cases; D: new deaths; L: lethality; I: social isolation; T: total posts; S: Posts about signs and symptoms; P: Posts about preventive care; SP: Posts about signs and symptoms and preventive care; B: BR-CDC-CCI; q: Posts that reached quality; p: Percentage of posts that reached quality; E: Posts about epidemiological bulletin; d: Posts about decrees; H: Posts about government actions for health; F: Posts about fake news; e: Posts about government actions for the economy; LF: Likes fake news; CoF: Comments fake news; CS: Likes signs and symptoms; CoS: Comments signs and symptoms; LP: Likes preventive care; CoP: Comments preventive care; TL: Total likes; TCo: Total comments; TV: Total videos; TVw: Total views; TVCo: Total of comments on videos; Fn1 to Fn13: Fn = Fortnight; μ : average; σ : standard deviation; CV: coefficient of variation; 25, 50, and 75: quartiles 1, 2, and 3; m: minimum; M: maximum.
 Source: Authors.

Table 1 showed that the greater number of posts of educational content occurred in the first few fortnights, with a peak during Fortn3, and diminished abruptly after Fortn5, given that, as of Fortn10, no post of educational content was published. The percentage of posts with educational content, which were submitted to qualitative analysis, as regards the total number of posts in each fortnight over time was of 9.4% (Fortn1), 15.4% (Fortn2), 25.8% (Fortn3), 9.0% (Fortn4), 10.6% (Fortn5), 20.2% (Fortn6), 4.1% (Fortn7), 4.4% (Fortn8), and 7.1% (Fortn9). On average, the posts of educational content reached 6.4 in the BR-CDC-CCI score (median = 6.5) (Table 1). The only post that reached the score of 9 during the entire period of data collection was recorded in Fortn4 (Figure 1-C).

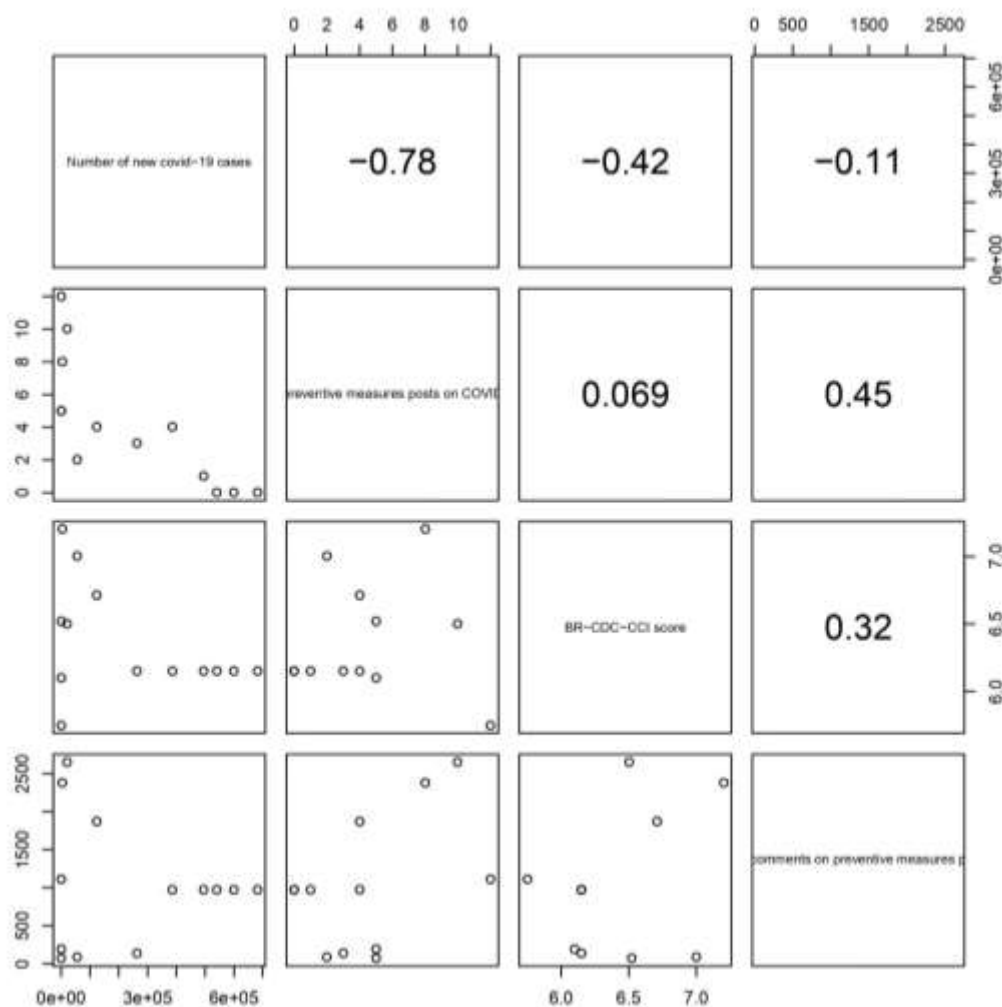
The posts of educational content received the greatest user engagement in Fortn4 (Table 1) (Figure 2-D), and this engagement diminished during the period of this study. Nevertheless, the greatest engagement did not occur with educational messages, but rather with posts that proposed to refute fake news, which presented, on average, 47,900 likes per fortnight, reaching more than 34,000 likes in a single post in Fortn4 (Table 1). The posts in video format also had a broad outreach, reaching nearly 1 million views on average per fortnight (Table 1).

Figure 3 presents the bivariate analysis between the outcome of the number of new cases and the variables included in the multiple time series model. The number of new cases was significantly greater in the periods in which there was a greater number of governmental posts about individual preventive care ($r = -0.78$) and in which the quality of the educational messages was worse ($r = -0.42$). In addition, there was a significant correlation between the number of new cases and the number of comments on posts with educational messages about individual preventive care ($r = -0.11$). By contrast, there was a positive correlation, although weak, between the quality of the posts of educational content, the number of posts about individual preventive care ($r = 0.069$), and the number of comments on these posts ($r = 0.32$).

In the multiple time series model, the variables of the number of posts about individual preventive care, the quality of the posts (BR-CDC-CCI), and the number of comments on the posts about individual preventive care were statistically associated with the number of new cases of COVID-19 throughout the 13 fortnights. The most significant variable was the number of posts about preventive care. In terms of the estimated coefficients, the quality of the posts (BR-CDC-CCI score) was what most impacted the predicted values of the number of new cases (Table 2).

After the adjustment for the quantity of preventive care posts published and the respective public engagement, an inverse association could be observed between the quality of the educational materials and the number of new cases over time. With each increase by one point in the BR-CDC-CCI score (quality of posts of educational content), there was a reduction of 327,864 new cases ($p < 0.001$), as can be seen in Table 2. The model was validated by the diagnostic analysis and was capable of explaining 88% of the variability of the data concerning new cases during the evaluated period. The analysis of the residues revealed no indications of the violation of the original assumptions.

Figure 1: Bivariate analyses (scatter plots and Pearson correlation coefficients – r) between the number of new cases and the variables included in the multiple model (number of posts with educational messages about individual preventive care, BR-CDC-CCI score, and number of comments on posts with educational messages about individual preventive care).



Source: Authors.

Table 2: Multiple time series model (unit of time considered: fortnight) for the variable number of new cases of COVID-19 disease during the first six months of the pandemic.

	Estimate	Std Error	t-test	p-value
Number of preventive measures posts on COVID-19	-65281.59	7533.75	-8.67	< 0.001
BR-CDC-CCI score	-327864.19	67461.93	-4.86	< 0.001
Number of comments on preventive measure posts on COVID-19	152.18	36.48	4.17	0.002

Multiple R -squared:0.9119; Adjusted R -squared: 0.8826. Source: Authors.

4. Discussion

The analysis of the Instagram posts of the official profiles of the Brazilian MH and ANVISA in the first months of the pandemic showed that the quantity and quality of the educational content about the prevention of COVID-19, as well as the engagement of users with these posts, had an impact on the number of new cases of the disease. Although evaluate health literacy level of the ones who had read the posts was not the aim of this study, it could be assumed that the clear the information, the better understanding and adoption of preventive measures. These results reinforce the idea that the

improvement of the quality and quantity of educational content in governmental social media can foment the adoption of favorable habits towards controlling the disease, since it not only makes it possible to inform with greater assertiveness, but it also tends to annul trivial false and malicious information in the current scenario of Brazil.

A pandemic, especially when caused by a new virus, induces feelings of uncertainty, fear, and anxiety. To mitigate the panic and encourage adequate behavioral actions, good communication is essential. Unfortunately, as seen in the results obtained through this study, the material published by Brazilian federal agencies was flawed and poor in quality. Only one of all the posts published on Instagram during the analyzed period reached the minimum score to be considered adequate in the qualitative analysis. Moreover, it is important to highlight that there was also a lack of regularity in providing content, with posts of educational content concentrated only in the initial fortnights of the pandemic. The data reveal that they were discontinued as of Fortn10, at a moment in which the cases and deaths continued to rise. As the data was collected in the first months of the pandemic, it was expected that an increase in the number of cases over time would occur. However, the continuity of the posts with preventive care messages should have been guaranteed so as to reinforce the importance of these measures, considering a population that was already tired and possibly unmotivated to adopt such measures (Park et al. 2020).

The fact that there was a greater user engagement with posts on preventive care content exactly during the periods with the highest number of cases may reflect a greater concern on the part of the population due to a worse epidemiological scenario. By contrast, this greater interaction may also have occurred due to doubts and controversies triggered by these posts, because of their poor quality or because they contradicted the population's expectations, who therefore did not feel safe in adopting the restrictive measures needed to control the pandemic. Despite being a new disease with a rather unclear pathology, controlling its transmission through preventive measures is unquestionable (Limaye et al., 2020; Wojtowicz, 2020). After the initial reluctance to recognize the condition of the pandemic by some Heads of State (<https://g1.globo.com/politica/noticia/2020/04/28/e-dai-lamento-quer-que-eu-faca-o-que-diz-bolsonaro-sobre-mortes-por-coronavirus-no-brasil.ghtml> , accessed on April 28, 2020), the proportions reached by the disease proved to be clear and the health information issued by the public entities became a necessary means through which to contain the disease.

The greater capacity to understand health issues is related to the greater adherence to the favorable behaviors towards health care in a variety of publics (Fleary et al., 2018; Geboers et al., 2016; Liu et al., 2015). Conversely, the greater the difficulty in comprehension, the greater the vulnerability in health care. This vulnerability is worsened when the health information is distributed in a biased manner or with intentions unrelated to the wellbeing of the citizen. In this context, it could be highlighted the current, massive dissemination of false and misleading information on social media, which has generated negative effects on health and incited international discussions about the relationship among social media, communication, and politics (Wardle & Derakhshan, 2017; WHO, 2020). Consequently, the question of the difficulty of understanding health information has become a relevant object of study worldwide. The BR-CDC-CCI establishes that educational materials in health need to be drafted, based on the assumption that the population has a low level of comprehension, and the language needs to be formulated in accordance with these levels. The index also establishes that, in addition to being understandable, educational materials must clearly indicate to the reader how to behave in a way that is favorable to health, recognizing the risks and benefits arising from this behavior (Marinho et al., 2020).

However, the quantity and quality of educational posts about COVID-19 in the two profiles analyzed is an example that demonstrate an inability of the public entities to use this promising communication resource for the common good. Social media can be excellent tools to aid in administrative acts (Limaye et al., 2020). However, for this to happen in the field of health, the information needs to be well-developed, since evidence shows that literacy rates in health are low (Sørensen et al., 2015). This situation has proven to be of utmost importance in countries such as Brazil, where the number of functional illiterates is high, part of whom are assiduous users of social networks. In the United States, for example, the clear disclosure

of information issues by public entities is mandatory and, in 2010, the Plain Writing Act was passed with this very purpose. Consequently, the public health sectors in that country took it upon themselves to adapt their health communication to meet the stipulations set forth in the law (Centers for Disease Control and Prevention, 2010; United States Government, 2010). It is understood that a public entity needs to be aware of its role as a representative of a power that, *a priori* “emanates from the people” (Brazil, 1988), and must be aligned with this conduct. Access to information is also one of the pillars of Brazilian Public Administration and the non-compliance with this prerogative configures Administrative Misconduct. In April 2021, a Parliamentary Committee of Inquiry was set up to investigate the Brazilian Federal Government’s actions to control the pandemic. Within the data presented, what stands out is the investment of approximately \$50 million spent by the Department of Communication, focused primarily on the disclosure of medications with no scientific evidence for early treatment (Takla & Jeevaratnam, 2020).

The first mass communication campaign in Brazil, focused on vaccination, was launched in December 2020, and no additional effort to disclose preventive measures to control the second wave of the disease was made. New indications of the poor use of public funds and strategies that run against the recommendations of international health organizations have appeared constantly. It is important to highlight that the first official statement of the President of the Republic, which proved to be misaligned with the scientific evidence and divergent from the role of a maximum leader of the nation, took place only in the third fortnight, when the first death due to the COVID-19 was reported in the country, considering that at the end of the same fortnight, there were already more than 100 deaths. In July 2021, one and a half years after the issuance of the decree of a state of emergency by the WHO, Brazil ranks second in the world in the number of deaths, behind only the USA, according to Johns Hopkins University.

The flaws in communication observed in the Brazilian government’s social media in this study have come up against another aggravating factor in the current historical context: the dissemination of information that is decontextualized with science, spread at a speed unimaginable in previous pandemics (Roberts et al., 2017; Wojtowicz, 2020). Public and technical administrators in health seem unable to have the same capacity to draft attractive content as those created and driven by the authors of “fake news”. New fields of knowledge need to be better used by health professionals, within the educational process, as well as by public entities, as a means through which to compensate this unfavorable condition (Roberts et al., 2017; Wojtowicz, 2020).

This study has its strong points and limitations. The limitations include the flaws in the recording of the evolution of COVID-19 indicators, since the Brazilian MH itself does not provide an official disclosure of the data on new cases and deaths. The fact that Brazil is a country of continental proportions and that it did not adopt a unified conduct at the national level regarding measures to combat the pandemic, given that this final decision-making power was allotted to the municipal and state public agencies, made it difficult to include these factors within this study. On the other hand, this study made use of the best available sources during the data collection period, with official records for these indicators, at the same time that it adopted strict criteria in data collection and analysis of the governmental communications, with an experienced and trained team, and by making use of validated instruments.

Despite the limitations recognized above, the results of this study are robust enough to reinforce the importance of public agents’ communication in a rapid, precise, empathetic, and consistent manner with the local population regarding COVID-19, preferably in a unified manner, to create an environment of credibility and trust. We emphasize that further studies must be conducted to better understand the contribution of the information quality factor in the evolution of the COVID-19 pandemic. In another study design, evaluate the health literacy level and contextual information of the population who had access to educative post could help to explain how this information impact their behaviour.

Brazilian governmental health agencies should pay closer attention to the quality of information made available on social media to aid COVID-19 pandemic control. With the perspective that the pandemic will still extend for some time and that new communication challenges will arise, including questions related to vaccination and treatment options, many lessons can be learned from this study's results. Based on the affirmation of the influence that educational materials made available on governmental social media can have in controlling the COVID-19 pandemic, governmental administrators will thus be able to adapt their communication strategies, thereby improving the quality and comprehension of their content, and with this contribute to a greater autonomy of the population in the adoption of behaviors that are compatible with individual and collective health care.

5. Conclusion

The results of this study showed that there was a relationship between the low quality of educative posts on Brazilian governmental health agencies Instagram profiles and the greater number of new cases of the COVID-19. This fact indicates the need for better attention from Brazilian government agencies with the quality of information made available on social networks to help control the COVID-19 pandemic.

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