THE READABILITY OF ONLINE HEALTH INFOGRAPHICS ON CDC AND WHO: A CROSS-SECTIONAL STUDY

Ren HUANG[1], **Xuejuan FU**[1] **and Wei GAN**[1]
[1]Guangdong University of Technology, China

ABSTRACT
Effective communication of health information involves clear messaging to ensure that readers comprehend and can easily apply behavioral recommendations. Infographics that are combinations of text and pictures have been widely used as an effective form to convey information in public health and nutrition. The current study aims at exploring the readability of public health infographics online to determine whether they meet recommended guidelines, especially health infographics on government websites by public health agencies such as the Centers for Disease Control and Prevention and the World Health Organization. Online health infographics from graphic page on the CDC website and WHO website were included in the research. The traditional readability formulas like Flesch Reading Ease, Flesch-Kincaid Grade Level and The SMOG Index which focused on textual features and formulas considered cognitive factors like ATOS, New Dale-Chall and Coh-Metrix were used to test the infographics readability. We compared the readability of online health infographics with general guidelines. The results demonstrated that most infographics from the CDC and WHO exceed the general guideline. Meanwhile, online health infographics in WHO have better performance on readability formulars that focus on textural features and cognitive factors compared with CDC. Based on these results, the health infographics from the CDC and WHO which are prominence in public health communication are not easily readable and understandable for individuals attempting to use the online health information to make the health decision and engagement. It is also insights the well-designed health infographics should be mindful more than the visual aesthetics but also the textural features and cognitive factors to improve the information readability.

Keywords: Readability, Health Infographics, Online Health, WHO, CDC

1 INTRODUCTION

The Internet has become a popular source of health information with increasing public seeking and learning health information on it. About 4.5% of all searches on the Internet are for health-related information.[1] There are more than 100,000 health-related websites worldwide and this number is increasing rapidly. With diffusion of the Internet, more patients looking for health related information online before taking their physicians.[2] With the online health information available and accessible to diverse online populations in terms of race, age, and educational attainment,[3] the readability of the online health materials needs more considerable. Online health information is effective if it is readable and understandable by its users.

Infographics which are combinations of text, numbers, charts and pictures have been widely used as an effective form to convey information in public health and nutrition.[4] The infographics allow for transforming complex health information into a visual, attractive, didactic and shareable format.[5] Well designed infographics are helpful in health communication, particularly for the audience with low health literacy.[6] This form of presenting information has been shown to be not only preferred by 80% of clinicians when compared to text articles but also helpful to people with low health literacy and numeracy skills.[7]

Health materials should be designed to facilitate public to obtain and understand especially for individuals with limited health literacy. The National Center for Education Statistics performed the assessment of reading level among Americans found that the typical American reads between 7th and 8th grade level.[8] In England, about 16% of adults in Northern Ireland and England reading level

beneath an individual aged 5 to 7 years.[9]In Canada, approximately 48% of Canadians literacy levels below the high school.[10] As the result, health professionals recommend that materials for the general public, particularly in emergencies, be readable at the 6th grade reading level to have maximum impacted.[11] General guidance on the recommended reading level of publicly available health information suggests that material should not exceed a grade 5–8 reading level, or that of an 11- to 12-year-old.[12] If people cannot read and understand health information, they may be less likely to act or change their behavior.[13]

Consider number of publics have limited literacy level that below 8th-grade level and increasing infographics are utilized on health-related websites, the criteria of existing infographics need more formal evaluation to optimize the infographic design. However, most infographics evaluation focused on the visual attractiveness and graphical elements[14] that text readability are lack. The current study aims at exploring the readability of public health infographics online to determine whether they meet recommended guidelines, especially health infographics on government websites by public health agencies such as the Centers for Disease Control and Prevention (CDC) and the World Health Organization (WHO) which are grounded in their prominence and global reach in public health communication.

2 MATERIALS AND METHODS

2.1 Infographics search and text process

We collected the health infographics from graphic page on CDC website[15] and WHO website[16], which contained 51 infographics from CDC and 75 infographics from WHO. Both organizations represent authoritative sources of public health information, making them ideal case studies for investigating the effectiveness of infographics in conveying complex health messages to diverse populations. The materials collection was completed on 11 September 2023 and subsequent updates on the website were not included in the study.

The infographics text was extracted from each infographic and re-entered into the txt format document. We removed all the hyperlinks and citations on the infographics that were irrelevant to the health communication.

2.2 Readability assessments

We conducted 6 readability tests which 3 tests focused on the textual features and 3 tests focused on the cognitive factors to ensure a comprehensive representation. Those traditional readability tests that focused on the textual features such as letters, syllables, words and sentences features were the Flesch-Kincaid Reading Ease (FRE), Flesch-Kincaid Grade Level (FKGL) and the Simple Measure of Gobbledygook (SMOG). The FRE score focused on word and sentence length. A higher score indicates a higher readability level. The FKGL score is focused on the complexity of the words in a sentence and the syllables in a word, a higher score indicates the materials require a higher grade level to comprehension. The SMOG formular estimates the years of education a person needs to have completed to understand a written text, higher SMOG score implies that the text is more challenging for young people. We used an online readability calculator to conduct the traditional readability tests. [17]

The traditional formulas as mentioned before focused on the textual features that could potentially result in a good readability score to a nonsense text. To consider the cognitive factors, we also included the Coh-metrix, Advantage-TASA openStandard for Readability (ATOS) and new Dale-Chall formular which consider the cognitive factors as cognitive-structural elements, semantic units and syntactic structures complexity.[18] The Coh-Metrix provides measures of text easability and readability. It provides component profiles of text easability on five different dimensions: narrativity, syntactic simplicity, word concreteness, refrential cohension, and deep cohesion. The material was easy to understand with higher Coh-Metrix score. ATOS formular confirmed as a valid and reliable text complexity measure for the Common Core Standards. ATOS scores are often associated with specific grade levels, and a higher ATOS score implies that the text is more challenging for students at lower grade levels. The New Dale-Chall Readability Formula is based on difficult words and average sentence length and can also capture syntactic complexity and word familiarity. The higher the score, the lower the difficulty of reading the text.

We conducted 6 readability tests online and then analyzed the infographics' readability compared with general guidelines. We also explored the readability differences between the CDC and WHO. All analyses were conducted using R version 4.3.1. [19]

3 RESULTS

We analyzed the infographics texts characteristics which included the count of words, sentences and syllables between CDC and WHO. The mean score, standard deviation, t values, and p values were calculating different aspects of infographics as shown in Table 1. Infographics on CDC have more words (MCDC = 166.98, SDCDC = 112.43), sentences (MCDC = 15.39, SDCDC = 10.34) and syllables (MCDC = 292.80, SDCDC = 199.30) compared with infographics on WHO (words: MWHO = 60.13, SDWHO = 78.15; sentences: MWHO = 5.87, SDWHO = 8.88; syllables: MWHO = 94.20, SDWHO = 109.49) significantly.

Table 1. Online health infographics textual features between CDC and WHO

	CDC		WHO		
	Mean	SD	Mean	SD	*t*
Total words	166.98	112.43	60.13	78.15	5.89^{***}
Unique words	107.65	60.52	43.73	42.48	6.53^{***}
Total sentences	15.39	10.34	5.87	8.88	5.37^{***}
Total syllables	292.80	199.30	94.20	109.49	6.48^{***}

Note. $^{*}p < .05$, $^{**}p < .01$, $^{***}p < 0.001$.

We compared the readability of CDC and WHO through the FKGL, SMOG, FRE, ATOS and New Dale-Chall formulas with the general guidance. Consider the different general guideline, such as NIH's recommended 6th–7th grade level for health materials, reading level of publicly available health information suggests that material should not exceed a grade 5–8 reading level, or that of an 11- to 12-year-old. We adopted the readability that exceeds the 8th grade as difficult to read. Through analysis the frequency exceeded 8th grade (as shown in Table 2) through different formulas, 72.94% of the infographics from the CDC exceeded the guidelines, and 45.79% of the infographics from the WHO exceeded the guidelines on average.

Table 2. The frequency of infographics readability of CDC and WHO exceed the general guidance

	CDC	WHO
Flesch-Kincaid Grade Level (>8 Grade)	62.75%	44.00%
The SMOG Index (>8 Grade)	49.02%	25.33%
Flesch Reading Ease (< 60)	78.43%	46.67%
ATOS (>8 Grade)	84.31%	41.33%
New Dale-Chall (>8 Grade)	90.20%	71.64%
Average	72.94%	45.79%

We then compared the readability of CDC and WHO infographics, and the results are shown in Table 3. For the readability formula focused on the textual features like FRE, FKGL, SMOG, the infographics from WHO have a lower FKGL score, lower SMOG score and higher FRE score. The results demonstrated that the infographics from WHO were easier to read compared with CDC. For the readability formula focused on cognitive factors like ATOS, New Dale-Chall, and Coh-Metrix, the infographics from WHO have a lower ATOS score, higher New Dale-Chall score compared with CDC which consistent with the traditional formula results. The infographics from WHO were easier to understood. In Coh-Metrix analysis, infographics from WHO have higher narrativity and deep cohesion score and higher refrential cohension score compared with CDC significantly. The higher narrativity score means the information in WHO more familiar to the reader. The higher deep cohesion score means the texts have more causal and intentional connectives to help reader to understand the information. The higher refrential cohension score means the texts was easier to process since there are more connections that tie the ideas together for the reader. However, the synactic simplicity score and word concreteness score did not show significant differences.

Table 3. The readability differences between CDC and WHO.

Readability Formular	CDC		WHO		
	Mean	SD	Mean	SD	*t*
Flesch Reading Ease score	45.29	18.98	56.35	19.99	-3.14**
Flesch-Kincaid Grade Level	10.08	3.79	8.44	3.57	2.43*
The SMOG Index	8.78	2.92	7.73	2.70	2.04*
ATOS	9.77	2.11	7.85	5.02	5.74***
New Dale-Chall	21.39	11.41	28.68	12.38	-3.40***
Coh-Metrix					
Narrativity	9.82	10.17	25.31	28.23	-4.35***
Synactic Simplicity	64.6	24.35	55.93	31.63	1.74
Word Concreteness	83.6	18.87	81.39	29.23	0.52
Refrential Cohension	43.84	38.13	61.64	33.70	-2.69**
Deep Cohesion	25.43	28.48	52.51	38.45	-4.54***

Note. * $p < .05$, ** $p < .01$, *** $p < 0.001$.

4 DISCUSSIONS

In the contemporary era of recurring and global health crises—ranging from pandemics such as COVID-19 to emerging infectious diseases and chronic public health emergencies—the importance of health communication has become increasingly pronounced. From communication theory perspective, readability is conceptualized as a message encoding strategy that determines how effectively information is transmitted and understood within a given context.[20] Information design that represents a multidisciplinary and multidimensional field addresses complex communication challenges across diverse cultural and global contexts. [21] Within information design theory, readability is more than a measure of linguistic simplicity, it is a core element of information design that integrate content, form, and audience cognition. Infographics as the prevalent form of information design that combine texts and images are a powerful tool to making complex information easier to understand and communicate. Well-designed infographics could improve the clarity and efficiency of communication. The information designer has to consider the readability of text, as well as the readability of pictures, and the readability of layout[22] to prevent the poor readability lead to misinformation and may have a detrimental effect on health.

The use of infographics is an increasingly common technique to convey information in a variety of medical settings, such as hospitals, clinics, and teaching institutions.[23] The current research explored the readability of health informatics from CDC and WHO, which are prominent in the world wide to publish the health information. We found that a lot of infographics from the CDC and WHO exceed the general guidelines for readability. Both the CDC and WHO have amount infographics above the average readability level. Online health infographics in the CDC and WHO has a readability level that is inappropriate for public use. Through the texture feature analysis, we found that the WHO have less words, fewer sentences, and have more causal and intentional connectives readability formula like FRE, FKGL, SMOG. The infographics from WHO were easier to read compared with those from the CDC, even though both organizations have many infographics exceed the general guidelines. Furthermore, the readability calculated through ATOS, New Dale-Chall, and Coh-Metrix formulas which consider the cognitive factors and support the infographics from WHO was easier to understand. Specifically, WHO infographics have more narrative texts, more causal and intentional connectives, and more connections to the reader. The readability formular results could assist the information designer to optimize information sets that are well suited for the intended receivers especially for the lower health literacy publics. Likewise, simplify the health materials from texture feature and cognitive factor, such as words, sentences and more causal and connectives to improve the infographics readability.

There are some limitations for the current study. As readability of visual components are excluded the assessment, evaluation the picture readability such as icons, charts and color remain an important direction for future research. Some studies have demonstrated that the infographics have limited colors and fonts, and logical alignment prioritizing key elements could simplify complex concepts and improve applicable for the health educators.[24] More than individual readability of visual elements and text contents, the relationship between text readability and graphics/visuals also needs more exploration, as

text-visual interplay in the infographics.[25] The integration of these text and visual components into a infographic through the holistic perspective is crucial.

5 CONCLUSIONS

The current study analyzed the online health infographics on the CDC and WHO that found the readability level is inappropriate for limited health literacy skill publics' reading and understand. The readability of the health infographics should concentrate on textual features and cognitive factors which improve readability and understandability. Meanwhile, information designer creating health related infographics should have thoughtful and strategic considerations of various design elements such color, icons and typography, more than visual aesthetic and appeal but also the text readability and understandability to address the needs of public health communication efforts.

As infographic design progresses through ongoing interdisciplinary exploration, the current study aspires to inform future research trajectories and foster continued innovation at the intersection of information design and health communication.

ETHICAL APPROVAL

Not required. The use of publicly available data is determined not to be human subjects research by the institutional review board at Guangdong University of Technology.

FUNDINGS

This research was funded by the Guangdong Office of Philosophy and Social Science (GD24XTS03), Research Project of Humanities and Social Sciences of the Ministry of Education (Grant No. 23YJA760026), 2024Guangdong Philosophy and Social Science Foundation Regular Project (Grant No. 2024GZGJ53).

COMPETING INTERESTS

None declared.

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