

Diabetes in the News: Readability Analysis of Malaysian Diabetes Corpus

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Abstract

Background: This paper describes a study to evaluate the readability scores of Malaysian newspaper articles meant to create awareness of diabetes among the public. In contrast to patient-specific sources of information, mass media may potentially reach healthy people and help them avoid becoming part of the diabetes statistics. The study selected relevant samples from the Malaysian Diabetes Corpus and used an online tool to score and display their readability using Flesch Kinkaid Reading Ease (FKRE) as the main indicator.

Result: The average readability for the materials is low at 49.6 FKRE, which may impede the uptake of information contained in the articles. Trend analysis reveals that there is not much variability in the years covered by the corpus with the articles from 2016 scoring better than other years. Feature analysis of articles with the best and worst readability indicates that medical practitioners may not be the best spokesperson to reach the public. It also indicates that simple sentence structures could help improve readability.

Conclusion: There is still much room for improvements in attaining good public health literacy through mass media communication. Public health and media practitioners should be vigilant of the language aspects of their writing when reaching out to the public.

Background

Readability is an important issue in the dissemination of public health materials. Better readability often leads to better retention of knowledge and better overall health literacy. This in turn translates into overall better outcomes in the sphere of public health: better health-related awareness and knowledge, less hospitalisations and better adherence to medications and health-related recommendations. For chronic diseases such as diabetes mellitus, limited health literacy among patients and their families will lead to a higher burden of care (Caruso et al., 2017). Liu et al. (2020) define health literacy as the “ability of an individual to obtain and translate knowledge and information to maintain and improve health in a way that is appropriate to the individual and system contexts”. It is within the first step of ‘obtain and translate knowledge and information’ that readability plays a critical role within the overall framework of health literacy.

Health literacy among Malaysians has been rated as poor (Ministry of Health, 2019; Jaafar et al, 2021), and so it is not surprising that poor motivation towards personal health responsibility may be associated with Malaysians living with diabetes. Every 1 in 4 Malaysians has been diagnosed with diabetes, out of which, close to 10% of these patients were not aware of their own condition until they had their blood sample screened for diabetes parameters (Ministry of Health, 2019). Uncontrolled diabetes can lead to various health complications and the rising numbers of Malaysians suffering from diabetes is worrying; an estimated total annual cost of USD 600 million is reported to have been expended to manage this disease (Ganasegeran et al., 2020).

Acknowledging the importance of population health literacy in efforts to curb chronic diseases such as diabetes, Malaysia has agreed to be a signatory to the Shanghai declaration endorsing health literacy as a critical determinant of health (WHO, 2017). Nevertheless, Malaysia has yet to strengthen a wider adoption and commitment in efforts to improve health literacy among Malaysians. Conversely, health literacy research and practice is still in its early stages with only a few Malaysian studies published in this subject (Abdullah et al., 2020). Improvements in health literacy of Malaysians can provide real hope for the country to halt the disturbingly rapid rise of diabetes among its population and subsequently reduce its burden on healthcare systems and communities.

Readability and Readability Formulas

Readability as a field of research has a long history that goes back to the early 1900s. The educational psychologist Edward Thorndike published his book, *The Teacher's Word Book*, in 1921 and introduced the idea of using mathematics as a lens to look at language ease-of-use and understanding (Thorndike, 1921). The following years saw an escalation in the use of mathematics for that purpose, notably due to the shift for more quantification in education. This includes works by Zipf in 1935 (which later became known as Zipf Law) and Flesch's book in 1955 (Hall, 1956). Flesch's efforts are known to us today as the Flesch-Kincaid Grade Level, a readability formula built into the ubiquitous Microsoft Word software.

A prominent result of these efforts to make communication better and textual materials easier to understand or read comes in the form of readability formulas, albeit they are not without controversies (DuBay, 2004). The discussion regarding those issues however is beyond the scope of this article. Dale and Chall (1995, p. 80) defined readability as "The total (including all the interactions) of all those elements within a given piece of printed material that affect the success a group of readers have [sic] with it. The success is the extent to which they understand it, read it at an optimal speed, and find it interesting." From the purely mathematical view of things, the last criteria proposed by Dale and Chall (1995) may be impossible to calculate in any material. Albright et al. (1996, p. 139) defined readability as "the determination by systematic formulae of the reading comprehension level a person must have to understand written materials". Later, McInnes and Haglund (2011, p. 175) gave a simpler definition of readability as a "measure of the ease with which a passage of text can be read". The fact that there are varied definitions of the term is hardly surprising as DuBay (2004) estimated that in the 1980s alone, there were about 200 readability formulas in use, each based on its own definition and principles regarding readability. Regardless, readability formulas are the only available tools to quickly and economically assess the "ease with which a passage of text can be read" McInnes and Haglund (2011, p. 175).

Previous Readability Studies on Health-Related Materials

Various studies have looked at the readability of materials related to diabetes and health literacy in general. Overland et al. (1993) studied 85 subjects with diabetes and how they read and comprehend different reading grades of health information. The researchers found that lowering the readability barriers improved patients' ability to understand the materials. Aguilera et al. (2010) studied the

readability of 81 patient education materials on diabetes and concluded that the majority were not effective in reaching their audience because of the high readability barriers despite these materials being targeted for patients already living with diabetes.

At the turn of the century, more people turn to the internet as the source of information, and this includes health-related information (McCaw, McGlade & McElnay 2014). Bernard et al. (2018) used specific search terms on three different search engines to simulate typical scenarios of patients looking for information on diabetes. The researchers zoomed in to 42 websites and evaluated the readability of the information contained within these sites. They concluded that the readability, in general, was higher than the average American reading level. McInnes and Haglund (2011) carried out a similar study and came up with a similar conclusion: the readability of the information needed to be vastly improved. Research of similar nature have been carried out in different languages as well, for example, Korean (Chin & Choi, 2014), Persian (Azami & Moazami, 2018, Ahmadzadeh et al., 2014) and Spanish (Rodriguez & Singh, 2018). At the other end of the difficulty spectrum, Smith and co-workers (2017) evaluated the readability of diabetes-related medical journal articles for the layperson. Not unexpectedly, they concluded that most of the articles would be beyond a layperson's level of comprehension and suggested a suitable summary section to be included for the general public in medical journals.

In summary, all the aforementioned research have two things in common. First, they concluded that readability is indeed a problem. Secondly, they refer to scenarios involving people living with diabetes. While targeting patients with diabetes is crucial, there are members of the public who are diabetes-free and among these are those with considerable risk of getting diabetes in the future. This portion of the population would rarely interact with materials specific to, and designed for, people with diabetes. The most logical avenue to reach them for the purpose of creating better awareness of the problem is through the mass media, where they expect to interact with 'common, everyday' materials. However, this potent vector of approach would be handicapped if the readability of the materials falls below what is suitable for public consumption.

In view of the value and reach of the mass media, this study aimed to evaluate if the readability of the sample data (newspaper articles) from the Malaysian Diabetes Corpus (MyDC) falls within the acceptable range for the public. The materials were chosen as they are publicly available newspaper articles. The layperson is deemed more likely to read these newspaper articles compared to diabetes-related information that are provided in educational pamphlets or websites. In short, these 'mass-media' materials usually have more reach than diabetes-related information put out by specific governmental bodies and NGOs. The study sought to answer the following questions:

1. What is the average readability of the overall materials?
2. What are the patterns for the readability of the materials in the years covered by MyDC?
3. What are the features of the articles that ranked best and worst for readability?

Methodology

The methodology of this study involved three components: (1) selection of articles (2) selection of best calculation method to measure article readability, and (3) analysis of the features of three articles ranked as the best and worst for readability.

Selection of articles

The corpus used in this study is the Malaysian Diabetes Corpus which is meant to monitor the linguistic trends surrounding the word 'diabetes'. The corpus was drawn from a popular and established Malaysian English newspaper. The collection of the corpus covered articles published from the years 2013 to 2018 and the inclusion criteria was articles related to awareness regarding diabetes. The rationale behind this is that the articles must be relevant to people without diabetes as the intent was to study the readability of articles that could create awareness regarding diabetes among the healthy population. Articles excluded from the selection were sports or similar events organised by NGOs or governmental bodies, articles specifically for people with diabetes, articles regarding local issues such as passing away of notables and product releases and promotions related to diabetes.

Selection of best methods to calculate the articles' readability

The readability calculations were carried out using an online tool available at <https://www.webfx.com/tools/read-able/> by feeding the articles one by one and recording the data manually. Automated readability scoring tools are deemed accurate compared to hand calculations (McInnes & Haglund, 2011). The formulas available from the online tool are Flesch Kincaid Reading Ease (FKRE), Flesch Kincaid Grade Level (FKGL), Gunning Fog Score (GFS), SMOG Index, Coleman Liau Index (CLI) and Automated Reading Index (ARI).

The Flesch Kincaid Grade Level and the Flesch Kincaid Reading Ease were initially developed for the US military for use in its training manuals and related publications in 1975 (Kincaid et al., 1975). The FKRE evaluates readability in terms of percentile scores where higher scores indicate better readability. The FKGL, on the other hand, represents readability in terms of US school system grade levels. The grading system is given in Table 1.

Table 1
Grading System and School Levels (Flesch 1979)

Score (FKRE)	School Level (FKGL)	Notes
100.00–90.00	5th grade	Very easy to read. Easily understood by an average 11-year-old student.
90.0–80.0	6th grade	Easy to read. Conversational English for consumers.
80.0–70.0	7th grade	Fairly easy to read.
70.0–60.0	8th & 9th grade	Plain English. Easily understood by 13- to 15-year-old students.
60.0–50.0	10th to 12th grade	Fairly difficult to read.
50.0–30.0	College	Difficult to read.
30.0–10.0	College graduate	Very difficult to read. Best understood by university graduates.
10.0–0.0	Professional	Extremely difficult to read. Best understood by university graduates.

The Gunning Fog Score (sometimes Gunning Fog Index) was developed in 1952 (DuBoy, 2004) and has been updated and improved several times since then. It also uses the grade system to indicate readability and the scoring system is shown in Table 2.

Table 2
The Gunning Fog Score (DuBoy, 2004)

Gunning Fog Index	Reading Level by Grade
17	College graduate
16	College senior
15	College junior
14	College sophomore
13	College freshman
12	High school senior
11	High school junior
10	High school sophomore
9	High school freshman
8	Eighth grade
7	Seventh grade
6	Sixth grade

The SMOG (Simple Measure of Gobbledygook) Index was developed in 1969 to simplify the process of calculating readability (McLaughlin, 1969). It is known for its simplicity and lends itself well to calculations by hand as well as computers. It is also the favoured tool for assessing the readability of healthcare materials, with one research claiming it to be the 'gold standard' for their purpose (Fitzsimmons et al, 2010).

The Coleman Liau Index (CLI) and the Automated Reading Index (ARI) differ from the other formulas described above by making use of character count in a word instead of detecting the syllables contained within the word. This makes them faster for computers when compared to syllabic-focused formulas, although not necessarily more accurate. The output is still in the forms of grade levels.

In this study, the steps taken to process the data were: (1) calculate the correlation between FKRE and the syllabic-oriented formulas; and (2) calculate the correlation between FKRE and the character-focused formulas. The two steps described above would illustrate whether a strong correlation between the FKRE and the other formulas exists. Table 3 shows a strong negative correlation between the FKRE and the other formulas regardless of whether the formulas are syllabic-oriented or character-oriented. The negative correlation can be explained by the fact that the easier the text (higher FKRE value), the lower the text's grade (lower grade values). This helped to establish FKRE as a viable yardstick to use in readability measurement for the dataset.

Table 3
Correlation between FKRE and the formulas

	Flesch Kincaid Reading Ease
Flesch Kincaid Reading Ease	1
Flesch Kincaid Grade Level	-0.926910804
Gunning Fog Score	-0.83681993
SMOG Index	-0.917094037
Coleman Liau Index	-0.793461497
ARI	-0.845043078

Feature analysis of the three best and worst articles for readability

Two language experts described the features of the articles independently and their descriptions were tagged and compared to each other. The initial agreement between the two sets of description was 84%. These descriptions were presented, cross-checked, and a consensus was reached between the raters.

Data analysis

Data entry and analysis was performed using Microsoft Excel to calculate the descriptive statistics and correlation analysis.

Results

At the time of writing, MyDC has 212 articles with a total of 134024 tokens (words) and 10904-word types (different words) which are presented in Table 4. The final sample comprised a total of 74 articles which met the selection criteria.

Table 4
Number of Articles Included from Year 2013 to 2018

Year	Articles	Tokens (words)	Token Types
2013	13	11819	2300
2014	14	12745	2767
2015	12	10642	2191
2016	10	5514	1453
2017	8	5216	1492
2018	17	10833	2350
Total	74	56769	6122 (unique words)

Readability of the articles

The Kurtosis and Skewness values in addition to the close values for Mean and Median displayed in Table 5 suggest that the data is consistent with a normal distribution. Therefore, we can use the Mean as the best measure of central tendency for the FKRE values of the dataset. The Mean of 49.6 matches the category of 'fairly difficult to read' to 'difficult to read' based on the interpretation in Table 1, requiring Grade 12 and above to understand and not within the category of 'plain English' (60-70 range).

Table 5
Descriptive Statistics of the Flesh
Kincaid Reading Ease (FKRE) Score

<i>Flesch Kincaid Reading Ease</i>	
Mean	49.67
Standard Error	1.04
Median	50.15
Mode	66.90
Standard Deviation	8.92
Sample Variance	79.58
Kurtosis	-0.19
Skewness	0.01
Range	42.90
Minimum	25.60
Maximum	68.50
Sum	3675.70
Count	74
Confidence Level (95.0%)	2.07

Patterns of the readability of the articles

Figure 1 shows that in general there is not much variability in terms of FKRE values for the years measured. The range of 45 to 56 still puts the average readability of the materials in the “fairly difficult to read” to “difficult to read” category.

Features of the best and worst samples for readability

The three best and three worst scoring articles (based on FKRE) were analysed by the raters. The features of the six articles are illustrated in Table 6 for comparison. The best ranked articles had been written in a conversational manner, with the use of simple active sentences as the most prevalent feature. Two out of three of the best articles involved laypersons talking about healthy lifestyle and diabetes. In contrast, the worst ranked articles contain features normally associated with low readability and comprehensibility, namely the use of dense passive sentences, numeric values, jargons, lengthy sentences, as well as chemical names and numbers. Additionally, two out of three of the worst articles involved professional health workers talking about diabetes.

Table 6
Features of the Three Best and Three Worst Scoring Articles

Best Articles	
Name	Features
Best 1	(1) Reported and Direct Speech (2) Subject: Dieticians (3) Text features: Conversational, Simple active sentences
Best 2	(1) Letter to the Editor (2) Subject: None, Citizen Writer (3) Text features: Simple active sentences
Best 3	(1) Reported and Direct Speech (2) Subject: Local Actress (3) Text features: Conversational, Simple active sentences
Worst Articles	
Name	Features
Worst 1	(1) Research Report (2) Subject: Reporting of DAWN2 research findings (3) Text features: Dense passive sentences, numeric values, jargons
Worst 2	(1) Reported and Direct Speech (2) Subject: NGOs and medical doctors (3) Text features: Conversational, explanatory, lengthy sentences, jargons
Worst 3	(1) Reported and Direct Speech (2) Subject: Nutritionist (3) Text features: Passive sentences mixed with direct speech reporting, high density of chemical names and numbers

Discussion

As a monitor corpus, the size, and dimensions of the Malaysian Diabetes Corpus are expected to grow with time, depending on available resources. Currently, the corpus is drawn from a popular and established Malaysian English newspaper and this may limit the representativeness of the study findings. Further, the numbers are relatively small for a corpus. However, the small sample size is not considered a

cause for major concern as MyDC is a specialised corpus and is not meant to be used as a reference corpus like the British National Corpus, for example.

The average readability score calculated in this study was 49.6, and to put it in perspective, this value may be compared with the oft-cited readability value of Reader's Digest which is 65, and New York Times which is 52. Clearly, there is a general indication that the newspaper articles within the corpus may be too difficult for the average reader. Research has also pointed out that newspaper articles have different readability values based on content types. Flaounas et al. (2013) described a massive-scale readability analysis of English newspaper articles from 99 countries and ranked 'Sports' and 'Arts' at the top with a score of 54 and 48, respectively. They listed 16 content types, but unfortunately, 'Health' is not among them. However, they also included an Average score for all which stands at 42. The Mean score for the dataset in this study is higher (better readability) than the average readability of materials used in their study. This fact can be viewed positively but in a cautious manner as the readability is still below what is desirable if the objective is to create awareness about diabetes among the public.

With regards to the patterns of the articles' readability seen over the years as captured in this study, the range of 45-56 is considered consistent, suggesting that the articles are in the difficult to read category. The variance itself is not significant enough to provide any interesting discussion because of the low general readability of the materials. Furthermore, there were no recorded phenomenon or events during the years covered to indicate any factors that may have been responsible for the slight variations. However, the results show slightly higher numbers than the average put forth by Flaounas et al. (2013) and at least for the Year 2016, the average score is better (55.93) than the best average (54 for Sports) discovered in their study.

Calculations for readability are mathematical approximates that evaluate the 'readability' of a piece of text quantitatively. As a strictly quantitative method, it yields usable information when covering large numbers of articles but is very limited in its abilities to drill down into the features of individual articles. The third research question is meant to enrich our understanding of what makes a text more readable to the layperson in a more qualitative manner.

The best ranked articles seem to share similar textual features. They were written in a conversational manner, with heavy use of simple active sentences. This helps with readability scores as active sentences normally result in words with fewer syllables and are well-known to be simpler than their passive counterparts. The problems posed by heavy use of passive sentence constructions to readability is well known and has been strongly criticised by John O'Hayre (1966). He came up with the Lensear Write Formula that factors in the use of active versus passive sentence constructions in evaluating readability. Although he meant it for government employees at the time, his words are still insightful for medical and public health practitioners today: "We know we can't write simple, straightforward English without a lot of effort, so we automatically fall back on our technical jargon where we feel safest; this kind of writing is easiest for us to do" (O'Hayre, 1966, p. 27).

Also notable is the fact that two out of the three subjects are not medical or healthcare personnel. This may suggest that the layperson may be better articulated to convey information to the public. Medical experts may find it difficult at times to 'speak plainly' as their 'normal' language may already include terms or styles common to their professions (i.e., medical jargon). This is not a new problem. For example, in the field of e-learning, an instructional designer normally sits in between the subject matter expert (SME) and the learner. The instructional designer's task is to redesign and reformat the knowledge from the SME into something easier and 'consumable' for the learner. Writers for the mass media as well as medical personnel communicating with the public via mass media should be aware that efforts must be made to simplify the language as much as possible.

The article 'Worst 1' has an FKRE score of only 25, making it the least readable in the dataset. It is a report of a scientific study and thus, this finding is not surprising. However, the newspaper is meant to be read by the public, which means that low readability is not desirable. Smith, Buchanan and McDonald's (2017) suggestion that medical publications should include a lay person summary for each article could be of immense value in such cases. Additionally, research reports that are of significance to the public would do well with a 'press release' version that can incorporate readability enhancements to make it easy for news outlets to publish.

Conclusion

The evaluation of the sample data from MyDC shows that the readability of online newspaper articles meant to create awareness of diabetes among the public falls short of the acceptable ranges for easy reading. The average readability score of 49.6 FKRE, while ahead of the average in Flaounas et al. (2013) of 42, still leaves much room for improvements. This indicates that public health experts should reach out and discuss the potential improvements in terms of readability with stakeholders within the mass media. It is possible that media practitioners are not aware of the potential of their medium to improve the diabetes situation. Flawed they may be, but readability formulas are currently the most readily available quantification tool available for public health experts and mass media practitioners to ensure materials on diabetes reach the public in a more effective manner. In Malaysia, English is the second language, with Malay as the national language while various vernaculars are also being used by the different ethnic groups that make up the population. This adds a further dimension to public health efforts in Malaysia. It is therefore prudent that Malaysian public health practitioners consider the language aspects in formulating and coordinating their efforts to combat diabetes.

Declarations

Ethics approval and consent to participate

There were no human subjects associated in the preparation of this manuscript and therefore no consent it required. We were granted the permission and ethics approval to conduct this study by the Institution

Review Board (XXX PPI/111/8/JEP-2020-150) as this study did not violate any ethical guidelines or regulations.

Consent for publication

Not applicable.

Availability of data and materials

The datasets used and analysed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

AH and TNM designed the study. AH and AJ were responsible for the acquisition and analysis of data and have drafted the work. TNM, HR, AFA and NAJ substantively revised the manuscript. All authors were responsible for interpretation of data, have approved the submitted version of the manuscript and agreed both to be personally accountable for the author's own contributions and the resolution documented in the literature.

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Authors' information

AH and AJ are social science researchers with background in English language and literacy; TNM and HR are dental public health specialists with interest in public diabetes education, NAJ is a dietitian involved

in clinical diabetes counselling, and AFAA is a family medicine specialist who manages patients with diabetes and conducts research in diabetes and oral health.

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Figures

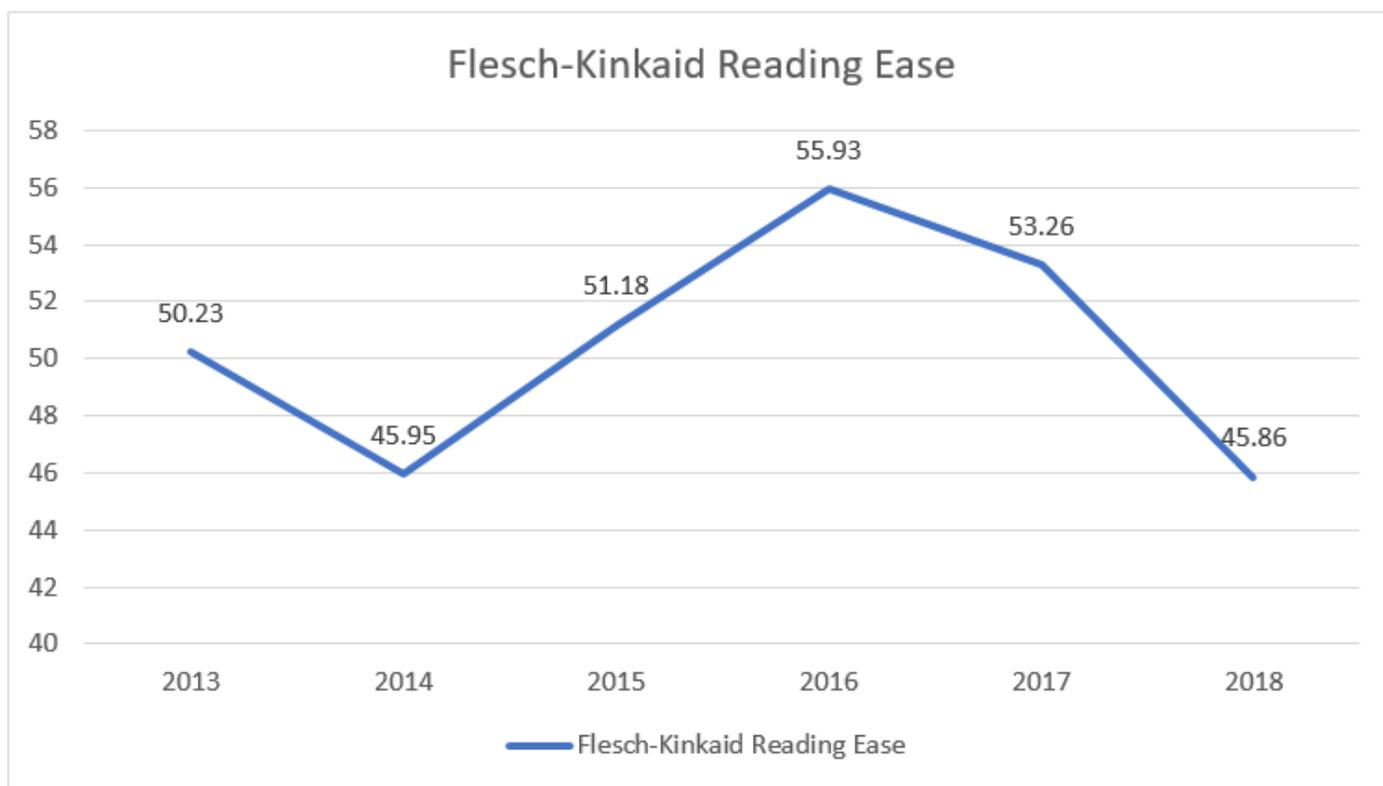


Figure 1

Trends of FKRE scores 2013-2018 The Flesch-Kinkaid Reading Ease scores for years 2013 to 2018 are shown as the blue curve.