Athens Journal of Health & Medical Sciences – Volume10, Issue 4, December 2023 – Pages 269-286

Linguistic Complexity of Patient Information Leaflets: A Coh-Metrix Analysis

By William Kodom Gyasi[*]

The present study explored linguistic complexity of patient information leaflets based on the Coh-Metrix analytical tool. Using 100 patient information leaflets of seven common ailments in Ghana, the researcher analyzed the lexical and syntactical features of the leaflets to ascertain their linguistic complexity. The results revealed patient information leaflets are lexically dense except the leaflets for dewormer which were written at moderate level. Also, the study revealed that the patient information leaflets were syntactically complex. However, a comparative analysis of the leaflets across ailments revealed no significant difference in the syntactical and lexical densities among the leaflets. The researcher recommends that further studies be conducted in other health information documents to ascertain their linguistic complexity.

Keywords: *readability, lexical density, syntactical complexity, Coh-Metrix, patient information leaflets, health communication*

Introduction

Humans desire good health because it is the best way to live for long. Quality health care delivery requires effective communication between practitioners and patients. Public service announcement through the use of information centres, national media and outdoor media is not new in the Ghanaian society. Information on sanitary practices, hygienic practices and precautionary and preventive measures are communicated through the public service announcements.

Bernhardt (2004) found that the relationship between communication and health has rapidly developed and expanded. Health communication involves strategic dissemination of relevant health information to influence behavioral change among people (Schiavo 2013). Health communication could be done through print, verbal, multimodal and other effective formats. Patient Information leaflets is a print health communication document.

Patient Information Leaflets contain information about the drug or medication from manufacturer to consumer. It is obligatory to put package leaflets in all medicine packages. It is expected read the leaflets to know more about the drug and how to use it well for maximum results. The use of clear and precise language is key in the development of effective and appropriate material.

McLaughlin (1969) defines readability as "the level at which particular individuals find a particular text captivating and understandable." Readability enhances writer's effective communication with readers as well as the level of comprehension of text by a reader. Through the use of readability formulas,

[*]Associate Professor, University of Cape Coast, Ghana.

https://doi.org/10.30958/ajhms.10-4-4 doi=10.30958/ajhms.10-4-4

manufacturers could have an objective idea of the reading ease level of their patients' information leaflets. Since medical terminologies and technical writing are unavoidable in PILs, the need to guard that through readability scores is advisable.

Patients information leaflets is key information document for patients in the absence of health professionals. However, available studies on leaflets have indicated that they are difficult to read and understand. In UK, Williamson et al. (2010) found the readability of patient's information leaflets above patient's comprehension. In Midwestern urban area, Wilson (2008) found that patients' information leaflets were written too high for the less educated adult.

UK again, Bradley et al. (1994) studied the readability of the leaflets of over-the-counter (OTC) drugs and found that reading score is above the mean reading age of the general adult population. Likewise, a study by Auta et al. (2011) and Clerehan et al. (2005) on the readability of patient information leaflets revealed that leaflets were written at a difficult to read level. The only known study in Ghana on PILs is by Gyasi (2013) which was on common malaria drugs used in Ghana. Gyasi (2013) found that the PILs of the drugs were difficult to read.

While his study was based on only malaria information leaflets, there is the need for further studies to consider other common ailment in Ghana information leaflets to ascertain their readability and comprehensibility to patients. This is crucial because issues regarding the use of medicine are a matter of life and death. Moreover, there is no known study in Ghana yet that examined the readability of the patient information leaflets and the comprehensibility difficulties readers face in using the leaflets for relevant information about the drugs they use to treat common ailments.

The purpose of this study is to examine the readability and comprehensibility of Patients Information Leaflets of over-the-counter drugs of seven (7) common illnesses in Ghana. These illnesses are common cold (flu or catarrh), cough, body pains, diarrhoea, heartburns, sleeplessness and constipation. These illnesses are usually treated through the use of over the counter drugs from licensed medicine sellers.

Research Questions

1. Are there statistically significant differences in the lexical density and syntactic complexity of PILs of OTC drugs across illnesses?
2. Do consumers read PILs of OTC drugs and if they do, do they understand what they read?
3. Is there a correlation between the readability of PILs of OTC drugs and consumers response?

Literature Review

Health communication is vital in health care delivery. Effective health communication is important in mitigating diagnostic challenges, side effects of

drugs and overdose of drugs by patients. The use of patient information leaflets in over the counter drugs sales help users of drugs to know what the drugs contain, the directions of use, the precautions, and the side effects of the drugs. As an information tool, PILs will be relevant to patients if the message in the leaflets are understandable to the patients (users). Readability of PILs is one indicator of the level at which readers will succeed in understanding the leaflets. Readability of PILs in previous studies have revealed that PILs are written at the difficult to read level. Gyasi (2013) discovered that common malaria drugs leaflets in Ghana are difficult to read. Likewise, Wilson (2008) discovered that PILs are difficult to read for an average reader in the western world. The current study was therefore of the view that the communication between manufacturers and patient through PILs could be improved through the production of readable PILs. Even though studies have found PILs to difficult to read, there are limited studies on how over the counter drugs leaflets readability scores affect readers understanding of the leaflets. To fill this gap, the researcher sampled 68 PILs of seven common diseases in Ghana and run a readability analysis of the selected leaflets. The researcher used Flesch Kincaid grade level and SMOG readability formula to measure the readability of the leaflets. The grammatical and lexical density of the leaflets were determined through the Coh-metrix index which measures grammatical density and lexical density. Using Shannon and Weaver's Communication Model, the researcher analyzed the results of the study and came out with these findings.

Grammatical Complexity Analysis

The grammatical complexity of the texts was assessed using Coh-Metrix 3.0. Coh-Metrix is a leading theoretically grounded, computational linguistics analysis facility that analyses texts on multiple levels of language and discourse (McNamara et al. 2014). Coh-Metrix 3.0 measures 108 linguistic features.

For the purpose of this study, I considered Coh-Metrix' *syntactic complexity* measure as a fitting measure of grammatical complexity. This approach is not out of line with that used in Martiniello's (2009) study of the linguistic complexity of math tests for English language learners. There appears to be an overlap between the bank of indices used to measure syntactic complexity in Coh-Metrix and those acknowledged by Lourdes (2015, p. 492) as commonly targeted for "quantifications when characterizing" linguistic complexity. In this study, grammatical complexity is approached from the second definition of 'complexity' distilled from the literature by Pallotti (2015, p. 2); this definition is concerned with "processing costs" or difficulties that are "associated with linguistic structures". This approach justifies the use of the *syntactic complexity* measure of the Coh-Metrix facility, because the indices that make up the measure are deemed to be directly or indirectly indicative of the processing load or difficulty that a piece of writing presents to a reader (Dowell et al. 2016, McNamara et al. 2014). In the light of the elusive nature of a definition for grammatical complexity (Rimmer 2006), it may be argued that the measure of that construct in this present work could have encompassed *syntactic pattern density* as measured in Coh-Metrix. While this

argument may have its merits, I nevertheless chose to restrict the operational definition, and therefore the analysis of grammatical complexity in this work to *syntactic complexity* as measured by Coh-Metrix.

The seven individual indices by which Coh-Metrix measures syntactic complexity are:

- Left embeddedness (SYNLE), that is, the number of words before the main verb in a sentence. Coh-Metrix measures the number of words before a main verb in each sentence, and then calculates a mean across the sample text.
- Number of modifiers per noun phrase (SYNNP). Coh-Metrix counts the number of words before the main verb in each sentence, and then calculates the mean across the sample text.
- Minimal Edit Distance (SYNMEDpos), for parts of speech.
- Minimal Edit Distance (SYNMEDwrd), for all words.
- Minimal Edit Distance (SYNMEDlem), for lemmas.
- Sentence Syntax Similarity (SYNSTRUTa), for adjacent sentences.
- Sentence Syntax Similarity (SYNSTRUTt), for all combinations, across paragraphs.

Each of the indices above is a theoretically and conceptually valid way to measure syntactic complexity (McNamara et al. 2014). However, in this work, I employ only the first two indices, that is, left embeddedness (denoted for brevity as SYNNLE) and mean number of modifiers per noun phrase (denoted for brevity as SYNNP). These should be sufficient indication of text complexity and therefore difficulty based on the notion that "[t]he syntax in text tends to be easier to process when there are shorter sentences, few words before the main verb of the main clause, and few words per noun-phrase" (McNamara et al. 2014, p. 70). According to Graesser et al. (2004), difficult syntax often involves dense structures, ungrammatical forms, ambiguity, and the use of embedded constituents. These attributes lend the difficulty to the processing and comprehension of complex syntax (Perfetti et al. 2005).

The syntactic complexity scores reported in this study are interpreted according to normative scores published in the Appendix B of the book "Automated evaluation of text and discourse with Coh-Metrix" (McNamara et al. 2014).

To create these norms, the author analyzed a subset of a large corpus of texts created by the Touchstone Applied Science Associates (TASA), Inc. The total TASA corpus includes 9 genres consisting of 119,627 paragraphs taken from 37,651 samples. The norms are provided for the three largest domains represented in TASA: language arts, social studies, and science texts. To do so, [the authors] randomly chose 100 passages from each of the 3 genres and each of13 grade levels, for a total of 3,900 passages. Grade level in the TASA corpus is indexed by the Degrees of Reading Power, which is a readability measure that includes word- and sentence-level characteristics. As can be observed in the table, DRP is highly correlated with the Flesch Reading Ease and Flesch-Kincaid Grade Level

measures of readability. To simplify the data analysis and presentation, DRP levels were translated to their corresponding grade-level estimates and then collapsed according to the grade bands used within the Common Core State Standards: grades K to 1, 2 to 3, 4 to 5, 6 to 8, 9 to 10, and 11 and higher. Each grade level within each genre was represented by 100 passages. Because the Common Core grade bands include different numbers of grade levels per band (e.g., 2–3 includes two grades, 6–8 includes three grades), there are different numbers of passages represented for each grade band (McNamara et al. 2014, p. 253).

Apart from descriptive indices, the norms published in the Appendix B of the aforementioned book provide normative values that can be used to compare other texts in the corresponding genre. Because PILs are published in the field of medical field, they fall under the science genre. Therefore, the syntactic complexity scores for these PILs were rightly compared to the norms in the science genre in order to arrive at conclusions on their suitable grade levels.

Text Selection for Grammatical Complexity Analyses

For the sake of uniformity, I selected those same parts of the PILs for grammatical complexity analysis as I did for the readability and lexical density analyses. However, in pre-processing text samples for analysis, I was guided by Dowell et al. (2016). Accordingly, I adopted the following guidelines.

1. If there was not good reason to delete any part of the sampled text, I left it in. The principle behind this was to present texts for analysis that were as close as possible to what the authors intended. Unlike in the case for readability analyses, I found no work that recommended or even suggested that punctuations, bulleted points, etc. could throw off Coh-Metrix measures. Therefore, I left these in the texts.
2. I ensured consistency in the treatment of selected texts. This means that for any modification(s) I made in any one text, I made sure to make same modification(s) in all other texts.

Data Analysis

IBM SPSS® Statistics version 20 was used to conduct both descriptive and inferential statistical analyses of the data. Firstly, the data organised in the MS Excel worksheet were copied and pasted in a pre-coded worksheet in SPSS.

Secondly, simple descriptive statistics were conducted in order to organise and summarise the characteristics of the sampled texts (Tavakoli 2012) in terms of their readability scores, their sentence and word characteristics, their lexical density scores, and their grammatical complexity scores. The information generated included maximum values, minimum values, Means, and Standard Deviations. This information was presented in tables in the Results chapter.

Thirdly, in order to make a choice between parametric and non-parametric inferential statistics tests, I conducted the Shapiro-Wilk test of normality. Parametric tests of significance require that the distribution of the sample scores be normal or near normal. This requirement is especially important where, as in this work, the researcher has to work with small sample sizes (Tavakoli 2012). The Shapiro-Wilk test was chosen because it is suitable for sample sizes less than 2000. Another requirement of parametric tests is the symmetry of the distributions, or the homogeneity of variance, among the various groups under study. I conducted Levene's test of homogeneity of variance.

In fourth place, I conducted a parametric Analysis of Variance procedure, to test the statistical significance of differences, if any, among the readability, lexical density, and grammatical complexity scores of the PILs.

Research Design

The nature of this study indicated that a non-experimental descriptive approach was the appropriate design. In a non-experiment study, such as this one, there is neither controlling for nor manipulation of some phenomenon of interest and then measuring the effect or outcome of such control or manipulation , (Bhattacherjee 2012; Cresswell, 2009). Descriptive research rather involves making observations of a phenomenon of interest and recording these observations as they are presented (Tavakoli 2012). In this work, observations of the reading difficulty levels of the CMI/PILs were made via online readability testing, and the quantitative scores were recorded. The means of the readability scores of the groups were compared; but the comparison did not preclude the study from being descriptive (Tavakoli 2012).

CMI/PILs Description

Seven groups of CMI/PILs were tested for reading difficulty. The documents were grouped according to the ailments or conditions for which their respective medicines were indicated. The medicines fell under these types: appetite stimulants, cold and flu medicines, cough preparations, dewormers, gastrointestinal reflux relievers, haematinics, and pain medication.

Each leaflet was published by the manufacturer of the respective medicine. The leaflets came in a variety of font styles and sizes, document lengths, font colours, and quality of paper. For each document, the publishers had organised the information into specific rhetorical sections, or moves, with appropriate headings. The leaflets varied in the number of these sections that they contained. The commonest headings included *composition* and *pharmacological information* (sometimes presented as *pharmacological action*, *pharmacodynamics* and *pharmacokinetics*, or simply *actions*). Other common sections were *indications*, *contra-indications*, *dosage and administration*, *drug* (and *food*) *interactions*, *side effects*, *warnings and precautions*, usage in *pregnancy and lactation*, symptoms

and treatment of *overdosage*, *storage* instructions, *presentation* of the medicine, and manufacturer information. In a small number of leaflets, there were sections that covered their respective medicines' effect on driving and operating machinery. All CMI/PILs were observed to have *shelf life* information, and also dates of publication and or revision of the document.

In a small number of leaflets, it was observed that the publishers had deliberately endeavoured to explain the sections rather than just give them titles. For example, in the leaflet for Rhinathiol® Expectorant Carbocisteine 5% Syrup for Adults, rather than simply state 'indications', that section is titled "WHAT (sic) Rhinathiol Expectorant Carbocisteine 5% syrup for adults IS AND WHAT IT IS TAKEN FOR (sic)". In the same document, "breast-feeding" is used instead of the commoner "lactation". Another example of this case is the packet leaflet for Vermox® 20mg/ml oral suspension. In this case, instead of "presentation", that section of the document is titled "What Vermox suspension looks like and contents of the pack". Further in this case, the usually distinct *composition* section is situated under a section titled "further information", where it is broken into "active substance" instead of "active ingredients", and "the other ingredients" instead of "excipients". It was observed that documents that employed such simplification of expression generally opened with an index of the various sections or moves in the document.

Sampling Techniques

Leaflet Collection and Selection

The package leaflets were conveniently sampled. With proper permission, and the help of a certified pharmacist, the researcher collected package leaflets from patients who bought medication from the OPD Pharmacy of the Cape Coast Teaching Hospital.

Over the collection period, a total of 100 were collected. However, after sorting it was found that some of the leaflets were the same, hence the researcher used 68 leaflets. The extra leaflets were culled from the collection.

Each document was scanned into a jpeg file at a high dot-per-inch setting using a hand-held SkyPix TSN410 Handyscan scanner. The scanned documents were individually converted to editable text by means of ABBYY Screenshot reader, an optical character recognition (OCR) software.

Text Selection

Blocks of text were selected from each document for readability analysis. The text selection was criterion-based. Criterion-based sampling, also known as judgmental sampling, is a non-probability process wherein cases sampled are selected on the basis of the researcher's typicality, the researcher's judgment, or otherwise on predetermined criteria (Tavakoli 2012). A primary criterion for selecting text was based on the findings of Raynor et al. (2007) that the parts of

medicine information leaflets that were most likely to be read were, in that order, side effects, administration, and indication. A three-decade old study had shown that the items on a packet leaflet most likely to be recalled by patients were directions for use and side effects or adverse reactions (Morris et al. 1977, Auta et al. 2011). The side effects, administration, and indications sections respectively provide information on possible adverse reactions to the medicine, how and when to take the medicine, and what conditions or ailments the medicine is intended for. In keeping with the finding of Raynor et al. (2007), I selected the following sections for inclusion in sampled text: *Indications*, *Contra-indications*, *Adverse reactions*, *Warnings and special precautions*, *Overdosage and treatment*, *Dosage*, and *Pregnancy and lactation*. Where available, texts from sections such as *special populations* were also included in the readability analyses. Based on my subjective judgment, I excluded sections such as *pharmacological actions* and *pharmacokinetics* from the analyses; these routinely contained many technical jargons and appeared to have been written for the benefit of health professionals and not the average patient.

In cognizance of the fact that bulleted lists, tables, equations and headings were not among the materials used to develop the formulas (Schriver 2015), I cleaned the sampled texts to remove headings, and to replace contractions, abbreviations, elisions, and initialisms with their full forms. For in instance, "etc." was replaced by "and so on"; "%" was replaced with "percent"; and "mg" was replaced with "milligram(s)".

Readability Analysis

Each final sample was analysed for readability using the online calculator at https://www.readabilityformulas.com. While the calculator returned readability scores from eight different indexes, I only recorded scores for SMOG and Flesch-Kincaid. Other data I recorded were: word count of sampled text, average number of words per sentence, average number of syllables per word, and percentage of multisyllabic words (≥ 3 syllables).

Results of the Study

Lexical Density of the PILs of the Seven Groups of OTC Medicines

Table 1 presents a quantitative description of the lexical densities of the seven groups of PILs tested in this study. In this study, Ure's redefinition of lexical density was employed. According to the definition, lexical density is a ratio of lexical items to grammatical items (Ure 1971) expressed as a percentage. This means that the lexical density values in Table 9 are percentages of words in sampled texts that have lexical or meaning-bearing value.

Table 1. *Quantitative Description of Lexical Density of PILs*

	N	Minimum	Maximum	Mean	Std. Deviation
	Statistic	Statistic	Statistic	Statistic	Statistic
Appetite Stimulants	11	50.87	72.78	59.8809	7.17752
Cold and Flu medicines	7	46.29	84.21	61.0314	12.59833
Cough preparations	9	45.65	76.14	64.9522	8.92367
Dewormers	9	37.97	62.69	51.9467	7.52005
Gastrointestinal reflux relievers	7	50.80	63.34	56.6771	4.70945
Haematinics	7	45.25	71.90	57.9500	10.02754
Pain Medication	17	40.61	69.83	56.6565	9.94186

As seen from Table 1, the appetite stimulant package inserts scored a mean lexical density of 59.8809 (SD= 7.17752). The highest mean lexical density score was recorded for the PILs that accompanied over-the-counter cough medicines (Mean= 64.9522, SD= 8.92367). At 51.9467 (SD= 7.52005), the PILs accompanying the dewormers scored the lowest mean lexical density. Perhaps this can be explained by the fact some PILs in the dewormer group scored as low as 37.97 of lexical density. Meanwhile, the cold and flu medicines information leaflets recorded the widest variations in their lexical density scores with a standard deviation of 12.59833 for a mean of 61.0314.

Because lexical items are the information components of a sentence, a text with higher lexical density has more information, and therefore carries more meaning, than one with lower lexical density (Johansson 2008). The concept of lexical density is related to the notion that the greater the information load of a text, the greater that text's demand on working memory, and therefore, the more difficult that text is to understand and recall. On the other hand, the lower the lexical item proportion of the text, the lower the lexical density, the lower the text's demand on working memory, and the easier the text is to understand and recall (Ramadhan et al. 2017). Spoken text has lower lexical density relative to written text (Ure 1971). This suggests that written text is generally more difficult to process and recall than spoken text.

According to a categorization by Sholichatun (2011), there are three levels of lexical density for written texts: high (60-70%), medium (50-60%), and low (40-50%). Guillén Galve (1998) found that while lexical density of everyday written text might average 40%, scientific writing might have lexical densities as high as 55-75%. Against these considerations, the PILs tested generally have medium to high lexical densities. In fact, the 'Maximum' statistic shows that in every group of PILs there were those with very high lexical densities, with some in the cold and flu medicine group going as high as over 80%. According to the mean percentages recorded in Table 9, the PILs for the appetite stimulants, the cold and flu medicines, and the cough preparations have high lexical densities mostly. This means that they generally will offer the greatest processing load to working memory among the PILs tested. The implication is that they will be generally difficult to understand and recall. PILs in the other groups should present medium challenges to the average reader.

Generally, though, it appears that all texts tested in this study could present the average reader with significant cognitive load as they try to process the information offered on the package inserts. This finding seems to support the results from the readability formulas that indicated that the PILs were generally above the reading and comprehension abilities of the average patient. The generally high lexical densities could be construed as semantic noise. This is because the generally high cognitive loads they require for processing could potentially defeat the communicative transaction between the pharmaceutical providers (senders) and the majority of readers (receivers). Perhaps the pharmaceutical companies have generally failed to encode their information in forms that are considerate of many in their target audience. It should be noted that even individuals with higher reading levels have been found to prefer information that is written at lower levels as it is easier to comprehend and takes less time to read (Wilson 2008). Therefore, encoding package insert information at an appropriate lexical density (more orality) should not present advanced readers with much cognitive difficulty. However, encoding medicine leaflet information at inappropriate lexical densities (in this case too little orality) could be disadvantageous to average readers.

Comparison of Lexical Density of PILs of the Seven Groups of OTC Medicines

Effort was made to test for statistically significant differences among lexical density scores for the various groups. This was done by means of the inferential statistical procedure known as Analysis of Variance (ANOVA). The data sets fulfilled the assumptions required for a parametric comparison of means (see Table 2).

Table 2. *Analysis of Variance of Lexical Density Scores*

		Sum of Squares	df	Mean Square	F	Sig.
lexical density	Between Groups	906.385	6	151.064	1.859	0.103
	Within Groups	4874.771	60	81.246		
	Total	5781.157	66			

At the $p<0.05$ level, there were no significant differences in the lexical scores among the seven groups of PILs [$F(6, 60)= 1.859$, $p= 0.103$] (see Table 2 above). This result means that, statistically speaking, each PIL should present the average reader with about the same processing challenge as any of the other PILs tested.

The lexical densities of the PILs tested in this study are generally high. The potential implication of these lapses in communication is that patients may not fully benefit from information regarding their medications that could have been useful.

Syntactic Complexity of the PILs of the Seven Groups of OTC Medicines

Grammatical complexity or syntactic complexity is a measure of how complex or dense the grammar used in a piece of text is. Measuring grammatical

complexity involves examining the set of strings in a grammatical structure. In this study, grammatical complexity was approached from one of the definitions of 'complexity' distilled from the literature by Pallotti (2015, p. 2); this definition is concerned with "processing costs" or difficulties that are "associated with linguistic structures". The syntactic complexity measure (of the Coh-Metrix facility) that was used in this study is considered to be directly or indirectly related to the processing difficulty a text presents to a reader (Dowell et al. 2016; McNamara et al. 2014). In this work, the indices of syntactic complexity measured were *left embeddedness (the number of words before the main verb in a sentence)* (denoted for brevity as SYNNLE), and *number of modifiers per noun phrase* (denoted for brevity as SYNNP). These are sufficient indicators of text complexity and therefore difficulty because "[t]he syntax in text tends to be easier to process when there are shorter sentences, few words before the main verb of the main clause, and few words per noun-phrase" (McNamara et al. 2014, p. 70).

The syntactic complexity scores reported are interpreted according to normative scores (hereafter sometimes referred to as 'norms') published in the Appendix B of the book "Automated evaluation of text and discourse with Coh-Metrix" (McNamara et al. 2014). Apart from descriptive indices, the norms published in the Appendix B of the aforementioned book provide normative values that can be used to compare other texts in the corresponding genre. Because PILs are published in the field of medical field, they fall under the science genre. Therefore, the syntactic complexity scores for these PILs were rightly compared to the norms in the science genre in order to arrive at conclusions on their suitable grade levels. Tables 12 to 18 present the summarised syntactic complexity scores of the various groups of PILs.

Table 3. *Quantitative Description of the Syntactic complexity of Appetite Stimulant PILs*

	N	Minimum	Maximum	Mean	Std. Deviation
left embeddedness; words before main verb	11	0.565	4.667	2.199	1.398
number of modifiers per noun phrase	11	0.745	1.087	0.900	0.105

As Table 3 shows, the mean SYNNLE for the appetite stimulants PILs was 2.199 (SD=1.398). This score maps unto approximately Grades 1 to 3 on the norms table. The SYNNP score (Mean= 0.900, SD= 0.105), however, placed the texts at approximately Grades 6 to 9. It appears that the two indices vary widely on the grade levels for which the appetite stimulant PILs were suitable. Generally, though, it appears that SYNNP placed the texts closer to the readability levels indicated by the SMOG and Flesch-Kincaid indices.

The scores mean that the texts in the appetite stimulant PILs generally did not have many words before main verbs in their sentences. This should present readers with lower processing challenges. However, this could be negated by the relatively high number of modifiers per noun phrase. Still, at Grades 6 to 9, the texts should be suitable for the average formally educated adult.

Table 4. *Quantitative Description of Syntactic Complexity of Cold and Flu Medicine PILs*

	N	Minimum	Maximum	Mean	Std. Deviation
left embeddedness; words before main verb	7	0.909	3.655	2.032	0.920
number of modifiers per noun phrase	7	0.717	1.109	0.964	0.133

SYNNLE for the package leaflets from cold and flu medicines was 2.032 (SD= 0.920) (see Table 4). This placed the texts at Grades 1 to 2 on the norms table. SYNNP was 0.964 (SD= 0.133), placing the texts at Grades 10 to 11. Again, there appears to be a wide variation between the two indices concerning text's grade-level placement. The relatively low SNNLE should make the texts easier to process for the average adult reader. However, the relatively high SYNNP places the text about a grade or two above the 8th-Grade recommended reading difficulty levels (Cutts 2013).

Table 5. *Quantitative Description of Syntactic Complexity of Cough Preparation PILs*

	N	Minimum	Maximum	Mean	Std. Deviation
left embeddedness; words before maein verb	9	0.605	2.733	1.743	0.786
number of modifiers per noun phrase	9	0.667	1.426	0.876	0.248

Table 5 shows that the mean SYNNLE for the cough preparation packet inserts was 1.743 (SD= 0.786). This suggests that the text should be easy for most readers to process, the text being placed at the pre-school to Grade 1 level. SYNNP (Mean= 0.876, SD= 0.248), on the other hand, suggests that the texts from these package inserts are similar to typical science texts for Grades 5 to 8 on average.

The mean lexical density of the cough preparation leaflets (see Table 2) showed that these PILs were highly informative or descriptive. They would therefore require high cognitive processing for understanding and recall. However, such cognitive load challenges may be tempered by the relatively low average number of words before main verbs and appropriate number of modifiers per noun phrase.

Table 6. *Quantitative Description of Syntactic Complexity of Dewormer PILs*

	N	Minimum	Maximum	Mean	Std. Deviation
left embeddedness; words before main verb	9	1.212	6.529	3.490	1.771
number of modifiers per noun phrase	9	0.867	1.104	0.992	0.070

Dewormers PILs scored the lowest mean lexical density (see Table 2). This means that, among the groups of package leaflets studied, they generally offered

the least challenge to cognitive processing. Still, the readability indices suggested that they were very difficult to read. According to the norms table, however, the dewormer PILs were, on average, similar to Grades 5 to 6 science texts in terms of the mean number of words before main verbs (Mean= 3.490, SD= 1.771) (see Table 6). If it is assumed that the average reader has the cognitive processing capacity of an 8th Grader, then the texts from the dewormers should present easy processing costs to the average reader. In terms of SYNNP (Mean= 0.992, SD= 0.070), the dewormer texts were generally placed at Grade 11 and above. This may too high for an average reader to process comfortably.

Table 7. *Quantitative Description of Syntactic Complexity of GIT Reflux Reliever PILs*

	N	Minimum	Maximum	Mean	Std. Deviation
left embeddedness; words before main verb	8	1.097	4.571	2.618	1.128
number of modifiers per noun phrase	8	0.807	1.022	0.917	0.065

As can be seen in Table 16, SYNNLE for the packet inserts from the GIT reflux reliever medicines was 2.618 (SD= 1.128). On the norms table, this placed the texts at Grades 2 to 3. This means that those PILs should present about as much cognitive load as science texts for Grades 2 to 3. SYNNP, however, placed the texts between Grades 8 and 9 (Mean= 0.917, SD= 0.065), or just within the abilities of the average reader according to readability recommendations (Cutts 2013). The GIT reflux reliever PILs should therefore be easy to process by the average reader. In contrast, the readability formulas suggested that these texts were very difficult to read and suited for university level readers, while the mean lexical density indicated that they should present medium processing difficulties (Sholichatun 2011).

Table 8. *Quantitative Description of Syntactic Complexity of Haematinics PILs*

	N	Minimum	Maximum	Mean	Std. Deviation
left embeddedness; words before main verb	7	1.520	3.591	2.871	0.725
number of modifiers per noun phrase	7	0.695	1.149	0.910	0.157

Per the norms table, the haematinic PILs have the left embeddedness (SYNNLE) typical of Grades 3 to 4 science texts (Mean= 2.871, SD= 0.725) (see Table 8). However, the norms suggest that the haematinics PILs generally have number of modifiers per noun phrase (SYNNP) that is typical of 8th to 9th Grade science texts. In either case, the syntactic complexity of the texts generally should be easy to process by the average reader, that is, if it assumed that the average reader has the aptitude of an 8th-Grader.

In terms of lexical density, the heamatinics PILs generally scored high enough to be typical of academic/scientific writing (see Table 1). The readability consensus concerning this group of PILs was that they were very difficult to read.

Nevertheless, the syntactic complexity indices appear to show that, structure-wise, these PILs are suited to cognitive facilities of basic school level readers.

Table 9. *Quantitative Description of Syntactic Complexity of Pain Medicine PILs*

	N	Minimum	Maximum	Mean	Std. Deviation
left embeddedness; words before main verb	16	0.600	4.731	2.497	1.391
number of modifiers per noun phrase	16	0.798	1.298	1.067	0.139

Table 9 shows that, on average, pain medicine PILs had 2.497 words before a main verb in typical sentences. That is about three words before a main verb in typical sentence. The standard deviation of 1.391 suggests that sentences may have deviated from the typical words-before-main-verb count by one word or so. Referring to the Coh-Metrix norms table, the mean figure placed the pain medicine PILs at the level of Grade 1 at least, and Grade 2 at most. However, the *Maximum* statistic suggests that some of the PILs in this group had syntactic complexity typical of science texts for 9th to 10th Grade. On the other hand, SYNNP placed the texts of the PILs at Grade 11 and beyond (Mean= 1.067, SD= 0.139).

The pain medication PILs were on average suitable for Grade 14 (university level) according to the readability indices. Concerning lexical density, they were found to be quite dense (see Table 2) and therefore would generally present medium to high processing loads to the average reader. The SYNNP score seems to agree with the processing load suggested by the lexical density score. However, these difficulties are not further enhanced by a large average number of words before main verb.

It appears that, in terms of syntactic complexity, the texts of the PILs were generally within the cognitive processing abilities of basic school readers. This would suggest that in terms of structure, the PILs (or more specifically, the portions of the PILs tested) generally would not present high cognitive costs to readers. Table 9 presents a comparison of the syntactic complexity scores for the seven groups of PILs tested.

Table 10. *Comparison of Syntactic Complexity of 7 Groups of PILs*

		Sum of Squares	df	Mean Square	F	Sig.
SYNNLE	Between Groups	17.578	6	2.930	1.836	0.107
	Within Groups	95.730	60	1.595		
	Total	113.308	66			
SYNNP	Between Groups	0.327	6	0.055	2.697	0.022
	Within Groups	1.214	60	0.020		
	Total	1.542	66			

At the $p< 0.05$ level, there were no statistically significant differences between seven groups of PILs in terms of the mean number of words before main verb in a sentence [$F(6, 60)= 1.836$, $p= 0.107$] (see Table 10). However, there was a statistically significant difference between some groups of PILs at the $p<0.05$ level

where number of modifiers per noun phrase was concerned; [F(6, 60)= 2.697, p= 0.022].

The result from the readability and Coh-Metrix indices indicated that patients of the PILs will face some difficulties when they are using PILs for relevant information. The researcher conducted a mini interview with twenty (20) participants on one to one basis to ascertain whether they read PILs, the level of difficulty the face and the reasons that their reading of PILs. The participants were 7 senior high school students, 9 first degree holders, 2 second degree holders and 1 MBA and 1 post diploma holders. The responses these participants were insightful in that the 12 of the participants read the PILs and the remaining 8 admitted they do not read PILs. The 12 participants who read the PILs submitted that they do that to know information about the drug's dosage, side effect, time to take and indications. Out of the 12 readers of PILs, 7 participants stated difficult terminologies as the cause of their lack of understanding of the PILs. The remaining 5 who understood the PILs were the tertiary participants whose educational level might have influence their comprehension of the text. On the other hand, the participants who did not read the PILs cited time constraints, already knowledge about the drugs and difficulty in understanding the PILs as reasons for their lack of readership of PILs. It is succinct therefore, patients read PILs and the reasons for their reading of PILs is to know the dosage, side effects, time of taken, expiry dates of drugs and many other relevant information that are captured in PILs. However, their understanding of the PILs is mostly hindered due to the technical terms that are used in the PILs by manufacturers. Moreover, one major cause of the lack of readership by those who did not read the PILs is the lack of understanding of the PILs. In the light of this, the researcher argues that the readability and Coh-Metrix scores were valid in that readers who had not acquired the required level of education (college level) found the PILs as very difficult to read and understand. Their main reasons for this was the difficult terms used in the PILs which implies that the prediction of the lexical density and grammatical density scores were reflecting the users experience with the PILs text.

Based on the Shannon and Weaver communication model, the researcher can make sense of the result in that the major that hinder effective communication between PILs writers (manufacturers) and the target readers (patients) is semantic noise. The patients did not complain about the materials, font and other mechanical variables, rather an overwhelming majority cited wordiness and one cited lengthiness as the causes of their lack of understanding of the PILs. It therefore implies that, for manufacturers to increase message fidelity of their PILs, there is the need to reconsider the wording and technical terms used in composing PILs so that patients can find them useful for their information needs when they are using drugs. This is much relevant in the Ghanaian setting in as sense that all the interviewees indicated that they do not buy drugs with prescription. This means that their major source of reliable information concerning the drug in order to avoid catastrophic occurrence is the PILs of those drugs. If the PILs are therefore not readable nor lexically and grammatically friendly to patients, the possibility of recording the same casualties that prompted the addition of PILs will be inevitable. Therefore, manufacturers of drugs should give keen attention to the readability of

their PILs in order to ensure effective health communication with patients of common ailments studied in this research.

Conclusion and Recommendations

The findings of this study, therefore, demonstrate that deliberate effort is required in order to produce written leaflets that are suitable for their target audiences. The evidence from consumers shows that readers are most likely to be bored by the content of leaflets if the leaflets are not readable to them. The manufacturers could also inculcate the use of readability formulae and Coh-Metrix as tools to objectively test the suitability of the leaflets before circulation. The manufacturers could consider using the Plain Language Thesaurus compiled by the Centre for Disease Control and Prevention's National Centre for Health Marketing (Vanderbilt Health.com).

In sum, health is a matter of life and death, hence any communication about health issues should be effective and understandable to audience. Readability and Coh-Metrix are vital quantitative objective tools for predicting the extent to which a text will be easy to read and understand by potential audience. Therefore, there is need to derive compliance of medical documents to the plain language recommendations especially Patient Information Leaflets. The researcher recommends a survey study on the patients readership of PILs and the possible reasons and challenges they encounter. Such a study will help to discover the usefulness of the PILs to patients and the urgency for writer of PILs to consider readability as tool to achieving effective health communication with their users. The researcher recommends further researches that will examine large health documents readability such as brochures, booklets and many other health documents.

References

Auta A, Shakur D, Banwat SB, Dayom DW (2011) Readability of medicine information leaflet of anti-malarial in Nigeria. *Tropical Journal of Pharmaceutical Research* 10(5): 63–65.

Bernhardt JM (2004). Communication at the care of effective public health. *American Journal of Public Health* 91(2): 2051–2053.

Bhattacherjee A (2012) *Social science research: principles, methods, and practices.* 2nd Edition. Available at: http://scholarcommons.us f.edu/oa _textboo ks.

Bradley B, Singleton M, Po ALW (1994) Readability of patient information leaflets on over-the - counter (OTC) medicines. *Journal of Clinical Pharmacy and Therapeutics* 19(1): 7–5.

Clerehan R, Buchbinder R, Moodie J (2005) A linguistic framework for assessing the quality of written patient information: its use in assessing methotrexate information for rheumatoid arthritis. *Heath Education Research, Volume* 20(3): 334–344.

Cutts M (2013) *Oxford guide to plain English*. 4th Edition. Volume 53. Oxford: Oxford University Press.

Dowell NMM, Graesser AC, Cai Z (2016) Language and discourse analysis with Coh-Metrix: applications from educational material to learning environments at scale. *Journal of Learning Analytics* 3(3): 72–95

Graesser AC, McNamara DS, Louwerse MM, Cai Z (2004) Coh-Metrix: analysis of text on cohesion and language. *Behavior Research Methods, Instruments, and Computers* 36(2): 193–202.

Guillén Galve I (1998) The textual interplay of grammatical metaphor on the nominalizations occurring in written medical English. *Journal of Pragmatics* 30(3): 363–385.

Gyasi KW (2013) Readability and health communication: an analysis of the readability of commonly used malaria drugs information on leaflet in cape coast, Ghana. *Journal of Research and Method in Evaluation (IOSR-JRME)* 2(4): 17–25.

Johansson V (2008) Lexical diversity and lexical density in speech and writing: a developmental perspective. *Working Papers* 53: 61–79.

Lourdes O (2015) Syntactic complexity in L2 writing: Progress and Expansion. *Journal of Second Language Writing* 29(Sep): 82–94.

Martiniello M (2009) Linguistic complexity, schematic representations, and differential item functioning for English language learners in math tests. *Educational Assessment* 14(3–4): 160–179.

McLaughlin (1969) SMOG grading – A new readability formula. *Journal of Reading* 12(8): 639–646.

McNamara DS, Graesser AC, McCarthy PM, Cai Z (2014) *Automated evaluation of text and discourse with Coh-Metrix*. New York, NY: Cambridge University Press.

Morris LA, Mazis M, Gordon E (1977) A survey of the effects of oral contraceptive patient information. *Journal of the American Medical Association* 238(23): 2504–2508.

Pallotti G (2015) A simple view of linguistic complexity. *Second Language Research* 31(1): 117–134.

Perfetti CA, Landi N, Oakhill J (2005) The acquisition of reading comprehension skill. In MJ Snowling, C Hulme (eds.), *The Science of Reading: A Handbook*, 227–247. Malden, MA: Blackwell.

Ramadhan MR (2017) *Lexical density and grammatical intricacy in written and spoken texts*. Unpublished Master Thesis. Medan, Indonesia: Universitas Sumatera Utara.

Raynor DK, Blenkinsopp A, Knapp P, Grime J, Nicolson DJ, Pollock K, et al. (2007) A systematic review of quantitative and qualitative research on the role and effectiveness of written information available to patients about individual medicines. *Health Technology Assessment* 11(5): 1–60.

Rimmer WM (2006) Syntactic complexity measures and their relationship to L2 proficiency: a research synthesis of College-level L2 writing. *Applied Linguistics* 24(4): 492–518.

Schiavo R (2013) *Health communication: from theory to practice*. 2nd Edition. San Francisco: Jossey-Bass, an imprint of Wiley.

Sholichatun S (2011) *Content analysis of reading materials in 'English on Sky' 15 textbook for Junior High School*. Undergraduate Thesis. Walisongo Institutional 16 Repository.

Tavakoli H (2012) *A dictionary of research methodology and statistics in applied linguistics*. Tehran: Rahnamā.

Ure J (1971) Lexical density and register differentiation. *Contemporary Educational Psychology* 5: 96–104.

Williamson JM, Martin AG (2010) Analysis of patient information leaflets provided by a district general hospital by the Flesch and Flesch-Kincaid method. *International Journal of Clinical Practice* 64(13): 1824–1831.

Wilson M (2008) Readability and patient education materials used for low-income populations. *Clinical Nurse Specialist* 23(1): 33–40.

Wilson M (2009) Readability and patient education materials used for low-income populations. *Clinical Nurse Specialist: The Journal for Advanced Nursing Practice* 23(1): 33–40.