UiT The Arctic University of Norway

Faculty of Health Sciences- Department of Pharmacy

Medicine articles on English Wikipedia: Quantifying the presence of pharmaceutical industry edits and analyzing their content.

Cross-sectional design, content analysis, and a network analysis of editors across articles.

Asia Jadgal

Master's Thesis in Pharmacy, May 2022

Supervisor- Dr. Kristian Svendsen, Associate Professor at UiT-The Artic University of Norway.

Acknowledgments

Abstract

Today, Wikipedia has developed into a prominent source for health queries to the vast public. Over the years, some studies have been performed to understand what the webpage can and cannot offer. However, the current literature lacks knowledge of how the pharmaceutical industry is present in Wikipedia's medicine articles.

The immediate objective of this research was to quantify the presence of the pharmaceutical industry and find factors associated with such presence, through a cross-sectional design. Moreover, this study aimed to analyze the content written by the industry, through an inductive approach to content analysis. Further, it was aimed to study the connections within the editorial team through network analysis. The articles were randomly selected, and the newest Covid-19 medicines authorized in Europe were also included.

This was the first study to analyze the editors of the pharmaceutical companies and their content in such detail: The key findings of this research show that the pharmaceutical industry is present in Wikipedia's medicine articles, although the presence is small. Also, no factors were associated with such presence. The content written by the industry was mainly promotional; however, there was no malintent or misinformation behind the edits. Lastly, it was observed that regardless of affiliation, the articles shared more than one editor. Many editors kept recurring in different articles, suggesting, a lack of anarchy in these articles.

For Wikipedia, the pharmaceutical industry is an unwanted presence, as it goes against the webpage's conflict-of-interest guidelines, which need to be addressed by the community. Furthermore, the results of this research add nuance to the debate regarding Wikipedia's usability.

Table of Contents

List of tables

List of figures

1 Background

Wikipedia is the largest encyclopedia online. Today, it has become the most accessed resource for health information. With the vastness of the internet, Wikipedia has become the source of health information by over 50%-70% of physicians. The web page has even played a role in education and clinical decisions [1]. People preferring digital means of learning have become their own cohort, called the "Net Generation." Using the internet to educate oneself has become increasingly normal [2]. Therefore, using Wikipedia as a source of health information is nothing new for both consumers and medical professionals[3].

Despite being a prominent resource for health information, there is an obvious risk of credibility. Meaning, it is uncertain whether the information can be trusted. Since everyone with internet access can log on and edit articles to their liking, Wikipedia struggles with the balance of giving this free access to editors and being credible at the same time[4, 5]. Precisely who those editors are, and their intention behind editing health articles, have been a subject for research in recent years [6]. However, with the limited research, it is not easy to fully understand who edits health related articles. Furthermore, we know very little about the interest that lies at the corporation level. It is unknown to what extent the pharmaceutical industry edits medicine articles on Wikipedia.

In 2014, the American Food and Drug Administration (**FDA**) suggested that companies correct misinformation about their product on the internet and on social media. This would be beneficial to hinder illegitimate claims and conspiracies from gaining ground on the internet [7]. Whether this would mean that pharmaceutical companies have increased their activity on Wikipedia, and whether their edits are educational or misinformation, has yet to be analyzed. In 2015, a pilot study detected a small presence of pharmaceutical industry on medicine articles on English Wikipedia [8]. This thesis aims to quantify the presence of the pharmaceutical industry with a larger sample and understand the editors' connections to each other in the community of editors, using a network graph. The thesis also aims to understand the context of the company's presence by performing a content analysis of the edits done by the industry.

2 Introduction

Wikipedia is a massive online resource of medical information [3]. It was created in 2001 and has evolved a lot since then. The name itself, comes from the Hawaiian word wiki, meaning "quick", which is an indication of how fast the encyclopedia can be accessed. Wikipedia's goal for itself is to create a world where knowledge is freely accessed by anyone. The English Wikipedia project is supported by Wikimedia Foundation. The foundation's job is to control servers, develop software, and help Wikimedia projects. The actual content contributions, however, are reliant upon volunteering editors, which are often called Wikipedians [9].

Over the years, Wikipedia has had a stigma attached to it. There has been a residing prejudice among academics on using Wikipedia. Some of the reasons for that are related to people thinking it's a anarchy, and that the webpage is not to be trusted [10]. However, in 2005, a paradigm-shift happened, where *Nature* Compared Wikipedia to Encyclopedia Britannica. The results showed there was no difference in number of errors found in either encyclopedia [11]. Making Wikipedia seem more trustworthy.

Wikipedia has in recent years been collaborating with the biomedical community. Several universities, medical institutes, and academic publishers have formed temporary partnerships with Wikipedia. The partnerships are beneficial for the webpage, by getting improved content. Likewise, the partnering organization also benefits by increasing awareness and impact, because of Wikipedia's huge readership. [12]

One example of such collaboration is Cochrane. This is a global network that performs systematic reviews on topics related to health. The aim of the collaboration has been to keep articles evidence-based and up-to-date, since its start in 2012. Cochrane has even recruited a "Wikipedian in residence" that gives advice [13]. Such collaborations give Wikipedia contributions of editor that might not otherwise have edited Wikipedia. This also increases the quality of the medical content, which benefits public health [4].

2.1 Usability of Wikipedia

Although numerous studies have evaluated the medical content on Wikipedia, only a few have evaluated the pharmacology content. There has been a divergence of opinion amongst those who have, on whether the content is valid or not for professionals, students, and healthcare consumers. *Kraenbring et al. 2014* compared the pharmacology entries on Wikipedia with standard textbooks, finding that Wikipedia articles could be used as a comprehensive and accurate source for undergraduate medical education[14]. Moreover, *Kupferberg et al. 2011* assessed the pharmacological information of different statin groups. They also found that the drug information was generally accurate. However, it was also concluded that Wikipedia could not be used as the only source for information by health care professionals[15].

By contrast, there have also been empirical studies that spurn the usability of pharmacological content for students. For example, *Lavsa et al. 2011,* studied the reliability of Wikipedia's medicine content for pharmacy students. The accuracy, completeness, and referencing of medicine information were compared to the manufacturer's package insert of the 20 most frequently prescribed drugs. The findings revealed that the medicine information on Wikipedia did not provide consistently referenced, accurate and complete information. It was concluded that students should actively be encouraged to use more credible resources. [16]

Clauson et al. 2008, compared the completeness and accuracy of drug information in Wikipedia with Medline Drug Reference (**MDR**). In total, eight categories of drug information were assessed. They found that Wikipedia could not provide as much drug information compared with MDR. In all, it was found that Wikipedia could only answer 40% of the questions related to drugs, compared to MDR which could answer 80%. Thus, it was concluded that Wikipedia had a narrower scope. When it comes to accuracy it was found that the content did not have any factual errors, rather it contained errors of omission. Further suggesting that it cannot be the only source of drug information when making decisions. However, they did not deny that it is helpful, but somewhat incomplete, suggesting that more work had to be done if Wikipedia wanted to gain authority. [17]

2.2 Editors of health articles on Wikipedia

Those who edit Wikipedia are called Wikipedians. *Kuznetsov (2006)* described that Wikipedians are motivated by five value systems. These are altruism, community, reciprocity, autonomy, and reputation. Creating a Wikipedia account creates a sense of identity. This creates a form of reputation, and many Wikipedians link their previous work, allowing others to see the contributions one has made. Wikipedians can also nominate each other for Wikipedia awards, that provide recognition from other users in the community. [18]

In 2012, *Faric & Potts* carried a cross-sectional study to characterize individuals' motivations for contributing to health content on English Wikipedia. 32 Wikipedians completed a questionnaire, and 17 got interviewed. They found out that the Wikipedians who edited health-related articles had a shared goal of using their skill to improve Wikipedia. In addition, they were motivated by their want to help. They also wanted to educate themselves by editing. Some felt a sense of responsibility to contribute. Many got a sense of personal fulfillment. In general, they were favorable to the idea of a free and accessible Wikipedia. [6]

Having responsibility as a motivation varied depending on what view attitude one had toward Wikipedia. For example, one physician recognized the scale of Wikipedia and wanted to contribute to high-quality health information for patients that used the webpage as a source of information. In addition, they wanted to help give potential users accurate health-related material. [6]

To some editors, editing gave them a chance to learn new material. To many, this was a frequent initial motivation to join Wikipedia. Many found new and updated knowledge on the said topic by contributing. Moreover, acquiring new knowledge gave them a better understanding. Contributing can also be motivated by personal fulfilment. Some found it relaxing by doing it as a hobby, and others engaging and rewarding to contribute to something positive. [6]

However, the participants also reported having negative experiences with Wikipedia. The common negative experience was the negativity they received within the community. For example, they reported experiencing rude and aggressive behavior. Hostility was mainly occurring when one added content that someone else thought was incomplete or should have

been added a certain way. Bad experiences led to demotivation, and some felt discouraged to continue contributing for some time. [6]

2.3 Content policies and aims of health-related articles

Since its launch, Wikipedia has evolved a lot, defining guidelines and policies to increase content quality. When it comes to content guidelines, Wikipedia has three core values [19]. Firstly, the editor must have a neutral point of view. Therefore, the policy states that the content must be represented relatively without bias [20]. Secondly, it is not allowed with original research. This implies that the content provided in the article must come from a published and reliable secondary or tertiary source [21]. Lastly, the reader must verify the information provided in the article, meaning that correct references must be in place. Verifiability is essential because it reassures the reader that the content is reliable [22].

2.3.1 Wikipedia's writing style of medical content

The writing style of Wikipedia's health articles is quite different from the standard peer-reviewed medical literature. Wikipedia has a manual that describes what medicine- related articles should look like in terms of writing style. This is because the writing style of the article content should be aligned with Wikipedia's goals. Since Wikipedia aims to give a birds-eye-view, the writing style should reflect that. Therefore, it's quite important in medicine article, that no primary sources are used. This is because no personal views of a study should be given. Rather, only give information of what other published sources have said about that topic should be included. Furthermore, the goal is not to become a manual, therefore "how-to" steps are not encouraged. This way Wikipedia avoids becoming a primary resource, but rather stick to the encyclopedias goal, of attaining the birds-eye-view. [23]

Moreover, the medicine articles are suggested to follow templates, info boxes, and content suggestions of what topics should be covered. The topics are following, medical use, contraindications, adverse effects, overdose, interactions, pharmacology, chemistry, manufacturing, history, society and culture, legal status, recreational use, economics, brand names, research, veterinary. Some of these topics can be broken down to even more sections. However, this list is supposed to give an overall picture of what all articles should try to imitate. So that all medicine articles on Wikipedia are coherent with each other. [23]

2.3.2 Conflict of interest and paid editing

To make the content be written with a neutral point of view, Wikipedia has a conflict-of-interest (**COI**) policy. Neutral point of view entails that topic is written fairly without any bias. The COI policy states that anyone with a conflict of interest must disclose their affiliation. In addition, anyone with an affiliation, as a rule of thumb, should only edit those articles where they do not have a COI. With this, Wikipedia ensures neutral content. [24]

COI editing involves editing content about oneself or any other with a personal relationship, such as an employer, friend, or family. COI is discouraged from protecting the object of the topic, whether it be about a person, company, or item. [24]

Another type of COI is paid editing. A paid editor gets financial gains for contributing to a topic. This type of editing is highly discouraged because it risks Wikipedia becoming a place for marketing. And therefore, strongly against the webpage's ideal for itself. Wikimedia Foundation has therefore laid out rules for paid editing. Firstly, the editor must disclose their affiliation. Secondly, the editor is discouraged from writing on the topic. Thirdly, any edits they want to do on the article should go through another user. Finally, the paid editor should ideally ask another user on the article with no COI to review and write the content. In addition, the editor must not review affected articles or create an article directly. [24]

2.4 Community culture - Avoiding Anarchy

Media Wiki software has made it easy to edit by lowering the barriers. One can edit through their web browsers without registering as a member [25]. Despite the effort of increasing number of contributors, the active contributors to Wikipedia's medical content are significantly few. *Heilman et al.2015* looked at the number of editors of medical content. They found that the number of editors has decreased five years pre- 2015. A few factors were listed that could explain this trend. Firstly, the stricter policy and reference requirement could discourage some editors. Secondly, there is residing xenophobia, where the community can sometimes be unwelcoming to new users. This can be due to suspicion that new users may contribute to vandalism or that their edits are incomplete [3].

To hinder biased or illegitimate contributions, Wikipedia has a revert functionality. Those who use this functionality are called *reverts*. To revert an edit means that the article goes back to its previous state. Any other editor on the webpage can revert the article when someone makes an inappropriate edit. Reverts help fix mistakes, vandalism and enforce Wikipedia guidelines and quality. Although the intention of reverts is good, they can sometimes be damaging. [26]

One of the ways these reverts can track new edits to an article is to become a *Watcher*. A watcher is someone who has created a watchlist. For instance, a logged user can include an article to their watchlist, making them a custodian of that article. They would then get a notification every time a new edit is made to that specific article. If the edit is faulty or informal, they can revert the edit. [27]

Anonymous editors do not have a recognized identity on Wikipedia, which can be a point of discrimination. They can be perceived as outsiders [28]. Furthermore, Halfaker et al. 2011 found that reverts are very demotivating to users, where their effect reduces the workforce of contributors. This could be why Wikipedia faces newcomer low retention, where new or unrecognized editors are being chased away [26].

However, the net sum of the reverts has been positive. Where the overall quality of the pages has increased. This demonstrates that Wikipedia is more driven by guidelines and quality, being far less anarchic than most people think. [26]

2.4.1 Administrators, bureaucrats, and privileges

Having a user account comes with some automatic privileges. One of those is having the Internet protocol (**Ip**)-address hidden. Although everyone can register and get access to editing Wikipedia—not all get granted higher access. Some privileges are determined by age and editing history of the user, while others must be requested [29]. *Figure 1* illustrates some of user rights that must be requested on Wikipedia.

Some get promoted to access all user rights. These users are administrators (**admins**). Admins have advanced tools in hand to perform their responsibility. Their tools include the ability to rename pages, protect - and unprotect pages, block - and unblock user accounts and Ip-addresses, edit pages that are protected, etc. There is no employer and employee dynamic between Wikimedia Foundation and administrators. The administrators are volunteers, and there are no requirements or obligations for any admin to use any of their tools [30].

On English Wikipedia, any user can request to become an admin. The community must have trust and confidence in the user to be accepted. This can be achieved through nomination. Any registered user can vote, and each editor will be assessed. However, to get votes, one should be an active contributor. One should generally be familiar with Wikipedia and its rules and policies, understand the practices in the comminutes and be a regular contributor. In addition, any COI should be disclosed. The discussion for an editor to be upgraded to admin is through a discussion within the community. The discussion takes seven days, and the editors cannot ask more than two questions to each nominee. Thereafter, an uninvolved bureaucrat determines if there is more than 75% consensus among the community to upgrade the user to an admin. [30]

Likewise, one can also request to become a bureaucrat. A bureaucrat can add different types of users to become a part of the administration, account creators, reviewers, and other groups. They can also add users into the bureaucratic group. They are bound to work in the community's interest. Further, their actions should reflect the community's wishes [31]. To become a bureaucrat, one must go through a similar process of becoming an admin- request and be assessed [32]. Usually, only those with considerable trust from the community get upgraded to this position. So far, there are only 20 bureaucrats on Wikipedia [33].

However, not every active contributor becomes an admin or a bureaucrat; there are still other access levels one can achieve. For instance, one can request to be a member of the autopatrolled group [29]. Autopatrolled is a user-right, where a user can create a page that automatically gets labelled as "reviewed". Typically, when an editor without this user-right creates an article, it becomes a part of the unreviewed list. The article must be manually reviewed to become marked as "reviewed" and "patrolled". However, suppose someone with the autopatrolled user right creates a page. In that case, the article automatically gets marked as "reviewed" and "patrolled." To get the autopatrolled right, one must request it from an administrator. The administrator only grants this user- right to a trusted editor. The editor must be regular at creating articles and be familiar with Wikipedia's policies and not breach essential guidelines [34].

Another example of a user right is extended-confirmed. This is a user right that allows editors to edit pages that are only open to a few people. This is because some pages on Wikipedia are *protected*. Meaning, that not all editors can edit them. Although the goal is to give the public open editing access, administrators are sometimes forced to make the articles "protected." Usually, this is used by the admin group when a situation has occurred that cannot be fixed by simply blocking users. Depending on the level of protection an article has, only those with specific user rights can edit. The level of protection can range from only admin access, different user rights access, and no protection at all. [35]

Aside from humans, also bots are present on the webpage. A Bot is software programmed to execute decisions without humans. These were implemented in Wikipedia to support the encyclopedia. They do specific tasks such as undo vandalism, correct spelling mistakes, identify copyright problems, and others[36]. They adapt to the context they find themselves in[36]. In 2014 it was estimated that the bots completed around 15% of the edits on all languages on Wikipedia[37]. They are essential contributors to the website.

Can add and remove administrators and other users

Bureaucrat

Has access to all the user rights Wikipedia offers, except the bureaucratic ones.

Administrator

Can create a page without being it being approved by other members

Autopatrolled

Can edit pages that are locked, where only people with this user-right or higher can edit.

Extended confirmed

Figure 1 Some of Wikipedia's user rights and their description

2.4.2 Edit wars

Because of its nature, Wikipedia invites all types of people to edit the articles, giving the webpage diversity[38]. Diversity is a positive attribute to any collaborative work [39]. However, diverse opinions can lead to arguments and division amongst the contributors. When huge differences occur, it becomes difficult to reach a consensus among the editors [40].

One example of a normal disagreement is someone's nationality and ethnicity. For instance, there has been conflict regarding the famous composer Frederic Chopin. Whether he is Polish or French, or a both, is often discussed. Another example is Jennifer Aniston, famous actor, on whether she is considered Greek-American, English-American, or only American. [41]

The situation becomes messier if editors keep contradicting each other. For instance, if they keep going back and forth with their preferred version of the content, especially when they keep deleting others [42]. If the situation cannot be deescalated, it becomes an *edit war*. This dynamic is especially problematic if it becomes a part of a power play [43]. The preferred way to handle disputes among editors is through good faith. One should assume the other editor has no malicious intent towards the article or Wikipedia. Furthermore, common courtesy, politeness, and civility should also be applied in the discussion between editors. Ideally, the editors should negotiate and compromise or propose a truce [44].

Administrators of the specific Project group help resolving edit wars. Administrators must put in time and effort to handle these conflicts. The arising conflict can be handled through working for consensus between the parties, building policies, and coordination [44]. However, this can take much time. It has been observed that around 40% of all edits involve indirect conflict resolution activities [45].

If things cannot be settled, then other measures are taken. Often, the administrators must ban users, or block them for some time [46]. Admins can also "Protect" a page, where only few users with higher access are allowed to edit the article [47].

2.5 WikiProject Pharmacology

English Wikipedia has different Project groups. Each group covers a specific topic. As the name suggests, the editors of WikiProject pharmacology have a common interest in pharmacology-related articles. However, it is not only medicines included in the project-group's scope. Also, any article related to pharmacology or pharmacy are included [48]. For instance, articles about Eli Lilly, water fluoridation, enzyme inhibitor, and epidural administration, which are not medicines, though they are related to pharmacy and pharmacology [49].

Today, WikiProject Pharmacology consists of 14 737 articles. The contributors are encouraged to include articles in the group. Any contributor can label an article as of interest to the project group [48]. This is done by putting a specific template banner on the articles talk page [50].

However, not all articles that get the project's label automatically get assessed. WikiProject Pharmacology has its assessment department. The department's goal is to assess the articles and assign them a value. To get an article assessed, one must list the article on the "section for assessment request" so that other members can change the rating of an article. The ratings are subjective and rely on the user's opinion of the article. [51]

Anyone is free to rate the articles. One can simply select the suited grade and add the template of a specific grade with the project's banner on the article's talk page. Although the rating is subjective, each grade has documented criteria. [51]

Since WikiProject Pharmacology uses a Wiki version 1.0 assessment program, the criteria for each grade are documented. Using Wiki 1.0 assessment for editorial teamwork gives the group a structural-based categorization of articles. Every project group has its version of the Wiki assessment table [52]. The table is divided into two main categories: Importance and Quality, which are further divided into different subcategories. [51].

For Importance, the subcategories are Top, High, Mid, and Low importance. Furthermore, the Importance category, which distinguishes between top to low importance, is meant to estimate the subject's popularity. For example, if the subject topic is crucial for that field, it may be assigned "Top Importance". However, the rating is not meant to determine the

inherent value of an article, instead guide the reader of what subject has achieved international notability in that field. [51]

For Quality, some subcategories are related to content [51], and others that are administrative categories [52]. The subcategories related to content quality that WikiProject Pharmacology uses are: Featured article (**FA**), Featured list (**FL**), Class A, Good Article (**GA**), Class B, Class C, Start, and Stub. [51]

Table 1 neatly describes the various subcategories of content quality, and total number of articles in each, as of 13.01.2022. The quality ranks start from the highest rank, followed by lower ranks in order. [51]

Table 1 WikiProject Pharmacology articles by quality from 13.01.2022.

Quality	Total articles	Percent	Attributes according to Wiki 1.0 assessment
FA[a]	13	0.08%	The article is considered the best of what Wikipedia has to offer. It gets to be featured on the project group's front page. The article is complete, neutral, accurate, contains good sources, and is only changed when new information is available.
FL[b]	1	0.006%	The article is on the featured list of the best article- list on the group's front page. The article must be helpful, complete, accurate, and neutral.
GA[c]	42	0.3%	The article must be useful to almost all people. Should not contain obvious problems. However, compared to an FL article, the article could be weak/missing in some areas.
B	507	3%	Mostly complete, without significant problems. The article may require some more work. The reader should not be left wanting more, however, a researcher may find it incomplete.
C	986	7%	The article is sufficient but is missing some necessary substance. The sources have to be reliable but may contain primary sources. The article needs more secondary/tertiary sources. The article is perceived as a casual read and does not give a complete picture of the topic.
Start	3603	24%	The article is not yet complete. It contains varying degrees of reliability. For the reader, the article is perceived of use but not enough. The article needs to improve on the content, writing style, and add more reliable sources.
Stub	6973	47%	The article depicts the topis; however, the content is rather incomplete. The article can at times be irrelevant or incomprehensible. For the reader, some articles can be so short that they only provide a dictionary definition of the topic. Suggestion for the article to be upgraded are: the article must have more content, and sources, and be more meaningful to the reader.

[a]*FA: Featured Article* [b] *FL: Featured List* [c] *GA: Good Article. [51]*

2.6 Earlier detection of pharmaceutical companies on English Wikipedia

There has been reported suspicion regarding edits carried out by the pharmaceutical industry by Wikipedians themselves. In an article by The Atlantic, Doctor James Heilman found a dubious edit on Wikipedia, making him investigate its intention. The problematic edit was on the article about kyphoplasty [53]. This procedure is a common treatment when someone breaks their spine, along with vertebroplasty [54]. However, vertebroplasty was found to be no better than placebo [55]. Since both have been found equal in effect, there has been skepticism if any of them are any good [56]. Nevertheless, Dr. Heilman found that the entry that initially said that the effectiveness of the treatment was "controversial" got changed to "well documented and studied"[53]: A statement that was not backed by recent research[54-56].

An edit like this would be beneficial to Medtronic, which in 2007 purchased the company that makes kyphoplasty kits. Dr. Heilman later found that the user who made the edit was Kim Schelble, whom Medtronic employed. This made him more suspicious on the edits made about treatment entries on different articles. To his testimony, this was the most aggressive edit carried out by a pharmaceutical company for their promotion. [53]

Further, because of his excellent reputation in the community, he admits that pharmaceutical companies like IMS Health, GlaxoSmithKline, and Alexion, have reached out to him for advice on editing medical content on Wikipedia. Although he rejected the offer, the proposal itself indicates that pharmaceutical companies might as well be reaching out to other Wikipedians for advice. [53]

Although Wikipedia has clear policies against COI editing, the only natural protection the webpage has is its volunteering Wikipedians. They seem to be quite adamant about upholding the quality of the article and therefore also guard the article quite closely. Hence, making them quite suspicious of new edits and quick to use the revert functionality. [26]

Exactly who edits medicine articles on English Wikipedia, was examined in a pilot study done by *Svendsen & Skancke*. Twenty articles were analyzed, where 10 were the top 10

bestselling medicines. The rest of the 10 was the recently approved medicine in 2015 on the European market. [8]

Interestingly, they found no evidence of the edits made by pharmaceutical companies of the top ten bestselling medicines. This was explained by a large number of editors present in the articles. Many editors were suggested to have a limiting effect of misinformation spread by pharmaceutical companies. [8]

By contrast, the newest medicines had more evidence of edits made by pharmaceutical companies in their articles. Although they found the edits more significant, the content was not classified as misinformation. However, according to Wikipedia's guidelines, they found that the industry edits were made by registered users who did not disclose conflict of interest, which would be considered a breach of policy. [8]

Since this was a pilot study with a limited number of articles, the findings are not definite. However, it was able to detect a pattern in which an article with a higher concentration of editors had fewer traces of the pharmaceutical industry. [8]

On the other side, the potential for misinformation about medicines by independent third party can increase in the age of social media. In 2014, the American Food and Drug Administration (**FDA**) gave out guidance to hinder the spread of misinformation about medicines on the internet. The FDA suggested that companies should volunteer to correct misinformation about their product on the internet. This was to promote public health, since a lot of people seek the internet for their health queries. It was determined beneficial for public health if companies corrected independent third-party information that may be misleading and harmful. The FDA stated that if a company decides to correct misinformation, it would not be faulted for meeting standard regulatory requirements regarding labeling. However, it would object if the firm would use non-truthful information to contradict the already existing misinformation. And would not be exempt from complying with the FDA's requirements related to advertisement [7] . To which extent the companies followed the FDA's suggestion is not known. However, they possess numerous studies on their product, to which they can contradict any misinformation spread on the internet, and on Wikipedia. And if it did, a lot of people would benefit.

3 Aims of the thesis

Today, we have very little quantitative evidence on the presence of pharmaceutical companies on English Wikipedia. Motivated by the gaps in my knowledge I' be studying the presence of the pharmaceutical industry on English Wikipedia's medicine articles. The main objectives of the project are following:

- To identify editors with an affiliation to the pharmaceutical industry
- To find predictors for pharmaceutical edits on a medicine article.
- To perform a content analysis of any edits done by pharmaceutical companies.
- To perform a network analysis of all editors across the included articles to gain a better understanding of the connections in the editorial team.

4 Methods and materials

4.1 Study design

The chosen methodology for this project is a mixed-methods approach. The project is divided into two parts: a qualitative- and quantitative analysis. The quantitative part imitates a cross-sectional design. Where the data collection was done to get a snapshot of the articles in one moment, and to find factors associated with pharmaceutical company edits. Moreover, a network analysis was used to better describe the editor's connection to each other in the editorial team.

The qualitative part of the project is a content analysis of the findings. Here, the edits made by the pharmaceutical industry were reviewed and analyzed. Themes were identified from the content analysis, to better understand the contributions from the pharmaceutical industry. Rest of the method chapter will give a further in-depth description of the execution of this project.

4.2 Literature on the topic

Since this thesis aims to research the presence of pharmaceutical companies on Wikipedia's medicine articles, very few studies were at my disposal. The foundation of the theory relied upon previous research done on Wikipedia's health and medical articles. Literature search engines such as PubMed, Medline, and Google scholar (for a wider search) were used. Broad and comprehensive keywords were used, such as- Wikipedia AND Pharmacology/ Pharmacy/ Pharmaceutical company/ Evidence-based medicine/ Medical education/ Health Information systems/ Information networks/ Drug Information service/ Health promotion/ information-seeking behavior/ Medical information/ Medicine student/Pharmacy student/ Usability/ Bias/ Conflict of interest. This literature search gave an overview of the topic regarding Wikipedia's usage in medical research, medical professions, pharmaceutical industry, academia, students, and other health settings. However, to get insight in Wikipedia's own guidelines and policies, information from Wikipedia's own pages had to be used. These pages were not article pages, but rather manual type articles describing the various processes within the English Wikipedia. The articles are written by the English Wikipedia community, to give clarity on community practices, principles, conflicts, and how to make English Wikipedia more reliable [57].

4.3 Inclusion and exclusion strategy

4.3.1 Pilot

Before the selection of articles, 10 medicine articles were analyzed in a pilot project to lay out a strategy for the rest of the data collection. Here it was assessed whether articles belonging to Stub-and Start class contained enough substance to be analyzed and included. Further, the variables of article and the editor analysis were determined, as summarized in *table 2* and *table 3* (see chapter 4.4*)*. It was checked what data from the article and the editor statistics page could be collected. Moreover, it was decided how many articles and editors should be included. All articles in the in the pilot were chosen randomly, making it possible to continue with the random selection later in the study.

4.3.2 Selection of articles

The articles selected for this project are from WikiProject Pharmacology. Although, the articles vary from any topic related to pharmacology and pharmacy, only medicine articles were included for this project. The included articles ranged from the four most frequent quality grades in the project group: Class- B, C, Start, and Stub. 100 articles were randomly selected, in which 25 articles were from each Quality class. In addition, the newest Covid-19 medicines authorized for use in the European market were also included.

4.3.3 Selection of editors

The editors included in the analysis mainly were derived from the chosen articles. For every article selected, a maximum of 21 editors were chosen. These editors were: the first editor of the article, and all editors from the articles top 20 list. The top 20 list is a list of the 20 editors with the biggest contributions to the article in terms of number of characters added and deleted. In addition, some editors that did not directly edit the article page, but edited the article's talk page, and were found to have an affiliation, were also included in the analysis (see chapter 4.4).

4.3.4 Classifying editors with an affiliation to the pharmaceutical industry

To classify editors with an affiliation, enough evidence had to be collected. Sometimes that evidence could easily be objective, whilst other times subjective judgments had to be used.

Objective evidence relied upon a direct declaration of affiliation. That is, when an editor declared its affiliation, or the Ip-address was directly linked to the pharmaceutical companies' server. Resulting in no doubt that the editor had an affiliation. However, subjectivity was used when an editor did not declare an affiliation, or the Ip-address did not give out any direct evidence. Then the editor's edit history was used to assess the affiliation status. A repetitive pattern of promotion to one company over time, was an indicator of affiliation.

The steps for collecting evidence of affiliation were following: Firstly, the article's talk pages were reviewed. This is because, if an editor would follow the guidelines of Wikipedia regarding COI, then the editor is allowed to make suggestion to the article's talk page without directly editing the actual article page. Therefore, the article's talk page was used to identify editors with an affiliation that only made suggestions and were not part of the editor list of an article.

After this, the 21 editors that edited the included articles got checked for affiliation. To check for affiliation of the 21 editors, the steps differed on whether the editor was a registered user or anonymous (editing behind Ip-address). For a registered user, the user page of the editor was reviewed. If someone has an affiliation, it should be declared on this page. Further, the talk-page for each editor is a place of discussion, where other community members can discuss edits or anything suspicious regarding conflict of interest. Therefore, an editor got categorized with "affiliation to a pharmaceutical company", when the user declared it on its talk-page, or if clear evidence of COI was presented by other members on the users talk-page.

For unregistered users with no talk-pages, an Ip-check was performed. If the Ip-address was linked to a server of a pharmaceutical company, it got categorized as pharmaceutical edit. Further, the edit history of the Ip-address was checked for suspicious activity. For example, if it was apparent that the editor had a pattern of promoting the same pharmaceutical company in previous edits, the editor got assigned an affiliation.

However, if the suspicion was more of an assumption without strong evidence, then the editor was in a grey area. For instance, if an editor did not declare affiliation, or had no repetitive pattern of promotion in edit history. Moreover, if no one in the community or an admin did not express any suspicion, or if there was no clear consensus in the community regarding the editor's affiliation, then good faith was assumed. Therefore, the editor would not be categorized as a "editor with an affiliation". However, suspected editors in a "grey area" were reviewed with my supervisor for a second opinion. From that, the final decision of categorizing took place.

4.4 Data collection for the quantitative part

The data was collected between November 2021 and February 2022. Data entries were manually derived from the statistical tools of Wikipedia, called Xtools. The variables from the articles and their explanation are summarized in table 1. Further variables from the editor information are the summarized in table 2.

The data was collected using XTools, a statistical tool provided by MediaWiki software. It is designed to handle large servers such as Wikipedia. The benefit of using XTools, is that it neatly summarizes the data of the page statistics, history, edit counter, and much more. [58]

For the article analysis: the "page statistics" within XTools was used to collect the data on variables such as: Quality, length of article, total edits, total editors, total watchers, number of Ip-addresses, total bot edits, total reverted edits, age of article, first edit (byte), total references, Importance, total major edits. Further, the "Pageviews" statistic within XTools, was used to get data on daily average of the article.

However, XTools is in some instances limited. It is unable to show the exact number of watchers of an article if the number is below 30. For this reason, any article with less than 30 watcher is in grouped as "<30". [58]

For the editor analysis, the "Edit counter" within XTools was used. The Edit Counter provides detailed statistics on a registered user [59]. The Edit Counter was used to collect data on age of the user account, live edits, deleted edits, total edits, total pages edited, total pages initiated, number of times blocked. To collect data about the user account for a specific

article, the "Top edits" statistics within XTools was used. This gave information about total edits the user had made to the specific article, and number of edits that had been reverted in the specific article.

Another limitation Xtools has, is its inability to show detailed statistics of the editor if the user has done more than 600,000 edits [58]. In those cases, the Edit Counter will only show the total (approximate) number of edits and user-rights the editor has [60]. For this reason, editors with more than 600,000 are excluded from the analysis, after it is reviewed that they do not have an affiliation with a pharmaceutical company.

If a user is anonymous, meaning the editor is unregistered, then only the Ip-address of the editor is available. Although, data on variables such as number of edits to the article, and number of reverted edits to the article were available from the "Top Edits" statistic, everything else is unavailable for an unregistered user. For more information about the Ip-address, a Ip-address check was performed. The Ip-check was done by using a free online Ip-check tool from WhatIsMyIPAddress.com. Typically, the service provides the geolocation of the Ip-address, and the organization the Ip-address is linked to. For instance, if someone edits from a company computer, the company's server will appear. However, if a person edits from a private computer, only the internet provider will be shown. This was utilized, to check if the Ip-address was linked to a pharmaceutical company.

Table 2 Variables included in the article analysis, alongside with the variable explanation.

Variables for article analysis

Variable	Explanation
Quality	The quality grade of an article assigned by the community. The range of quality classes are B, C, Start, and Stub. This is a categorical variable.
Length of article (byte)	The total number of characters an article contains.
Total edits	The total number of edits that has been made in the article.
Total editors	Total number of editors the article has.
Total watchers	Total number of watchers an article currently has. A watcher is someone who gets notified every time there is a new change to the article [27] . Since XTools show all number below 30 watchers, as "<30", this variable has been divided into these groups: <30, <100, <200, <500, and >500.
Number of Ip-addresses	Total number of edits done by unregistered users, who only have a Ip-address attached to their edit.
Total Bot edits	Total number of Bot edits to the article. Bots are software that do tasks without humans, such as: undo vandalism, correct spelling mistakes, identify copyright problems and other [36].
Total reverted edits	Total number of reverted edits performed on the article.
Age of article	Age of the article.
First edit (byte)	How large the first edit of the article is.
Total references	Total number of citations in an article.
Importance	Importance is category from Wiki 1.0 assessment, which ranges from: high, mid, low and unassessed. [51]
Total major edits	Total number of major edits done to an article.
Daily average	Daily average number of visitors to the article.

Table 3 Variables for the editor analysis with its explanation.

Variables for editor analysis

Variable	Explanation
Is the user anonymous?	If the editor edits behind an Ip address, then it as coded 1, if the editor is a registered user it is coded as 0.
Age of account	A registered user will have history of the time of registration. This is used to determine the age of the account.
Live edits	The number of live edits a registered account has is the number of edits a user has done in total.
Deleted edits	The number of deleted edits says how many edits the editor has deleted.
Total edits	Edits of a registered user in total.
Pages edited	The total number of Wikipedia pages a registered user has edited on.
Pages created	The total number of Wikipedia pages a user has initiated.
Blocked	Number of times a user has been blocked by others with authority in its lifetime.
Total edits to the selected article	The total number of edits a user has done to the selected article.
Number of reverts in the article	The total times the edits of the user have been reverted by other editors of the selected article.
Autopatrolled	This is a user right that allows an editor to create an article without it being approved by other community members [34]. If the editor has been promoted to autopatrolled user-rights, then it is coded as 1, if not it is coded as 0
Extended confirmed user	This is a user right that gives the authority to edit pages protected to a certain level, where only people with extended confirmed user right or higher can edit the page [35] . If an editor has been promoted to have extended confirmed user right, then it is coded as 1, if not then it is coded as 0.
Affiliation	If the user has any affiliation to a pharmaceutical company (see chapter 4.3.4), then it is coded 1, if not it is coded 0.
Affiliation guidelines breached	When an identified user with an affiliation, has breached Wikipedia's COI-guidelines, then it is coded 1, if not, it is coded 0.

4.5 Statistical analysis

Stata.17 was used to perform statistical analysis. To check for differences between the two groups, affiliation and non-affiliation, a Chi squared test were used for categorical variables. A two tailed student's t tests were used to compare continuous variables. The significant level was set to $p < 0.05$. Further, a multivariate analysis was performed using binary logistic regression to predict the chance of an article having an affiliation. The model was checked for correlation between variables. If that was the case, then one of the variables was removed from the regression model.

4.6 Network analysis

A network graph is based on nodes connected to each other through links/edges. A node represents the object of interest. Meanwhile, the edge represents the connection between each node [61].

All editors that had contributed to the articles were included as raw data. The "page statistics" program withing XTools was used to collect data on the editors for each article. In this project, the nodes represent the articles included. Moreover, the edges are the editors that have been present in more than one article.

The software tool Gephi was used to visualize the network graph. To differentiate between the nodes, all articles with an affiliation were colored pink, and articles without affiliation were colored green.

A network graph can give important network measures. For this project density and average degree were measured. Density of a graph ranges from 0 to 1, where 1 is highly dense graph. This measure is useful to understand how crowded the network is [62]. In this project a dense graph would mean the articles have editors in common. Further the average degree, can give insight as to how many articles each article share one or more editor with.

4.7 Content analysis

4.7.1 Data collection

Textual data got collected after all pharmaceutical edits were identified. This was possible using the "Top Edit" program from Xtools, where all edits made by the specific user were shown in chronological order. The text from the editors with an affiliation was collected and used for the content analysis. The included text was mainly from the medicine article, however, sometimes the article's talk page, and the users own user page got included.

4.7.2 Author's preunderstanding

The text was analyzed by me, a female graduating student from the Master of Pharmacy Program at The Arctic University of Tromsø. I have no conflict-of- interest or affiliation to an organization. This analysis was done as a part of my master's thesis for my graduate degree. In general, I have used Wikipedia throughout my life to quickly get general information on a topic. However, I have never actively contributed to the webpage, nor had any registered user. Throughout the project, I have held a neutral stance on any kind of involvement of the pharmaceutical industry on Wikipedia. In addition, I have no personal interest in presenting the results in anyone's favor.

4.7.3 Analysis

The raw data was organized by edits of each individual editor. The content was then reviewed to derive codes. Since this area of research is quite new, an inductive approach for the content analysis was used to examine the raw data. Therefore, codes were inductively derived from the data. Through a repeated examination, the codes were finalized. From these codes, the emergence of themes occurred. A flat coding frame was used, by giving all the codes the same importance. Therefore, similar codes were grouped together to form a theme.

The coding was done manually, because the text document was small, and edits per editor were not large.

4.8 Ethical considerations

The data required in this project were derived from Xtools. For the article analysis, no sensitive information was required. However, the editor analysis requires information about the editor's username or Ip-address. Since this project did not offer consent to the editors, their username or Ip-address will not be disclosed. To protect the editors with an affiliation in the content analysis, only a basic description of the editor will be given. The editors with an affiliation will be given pseudonyms, such as editor 1, editor 2, and so on, to protect their identity. Only information such as whether the editor contributed anonymously, what company the editor is promoting, and the editor's textual contribution to Wikipedia, will be included.

5 Results

5.1 Study sample

WikiProject pharmacology contains 14,737 articles in total. However, not all of them are medicine articles. It is unknown how many of the 14,737 articles are medicine articles. This is because the Project group does not have an individual template to differentiate between the topics.

Of those 14,737, 100 medicine articles were randomly selected. Moreover, the only seven medicines have been approved for covid-19 by the EMA, as of 18.02.2022 were included. . Resulting in the inclusion of total 107 articles. From every article, a maximum of 21 editors were included, were the article creator, and the top 20 editors were included, as seen in the flow chart for the article and editor inclusion in *figure 2*.

In total 2,059 editors were observed from combining the first editor and the top 20 editors (if the article had at least 20 editors) from all 107 articles. However, 73 editors got excluded, resulting in the total of 1,986 editors included in the editor analysis. The 73 editors excluded were excluded because Xtools does not show statistics for editors who've made more than 600,000 edits meaning that data on variables such as: total number of edits, live edits, deleted edits, reverted edits, created pages, and times blocked were missing. However, before the exclusion, their history and talk page got reviewed to make sure that they did not have any affiliation.
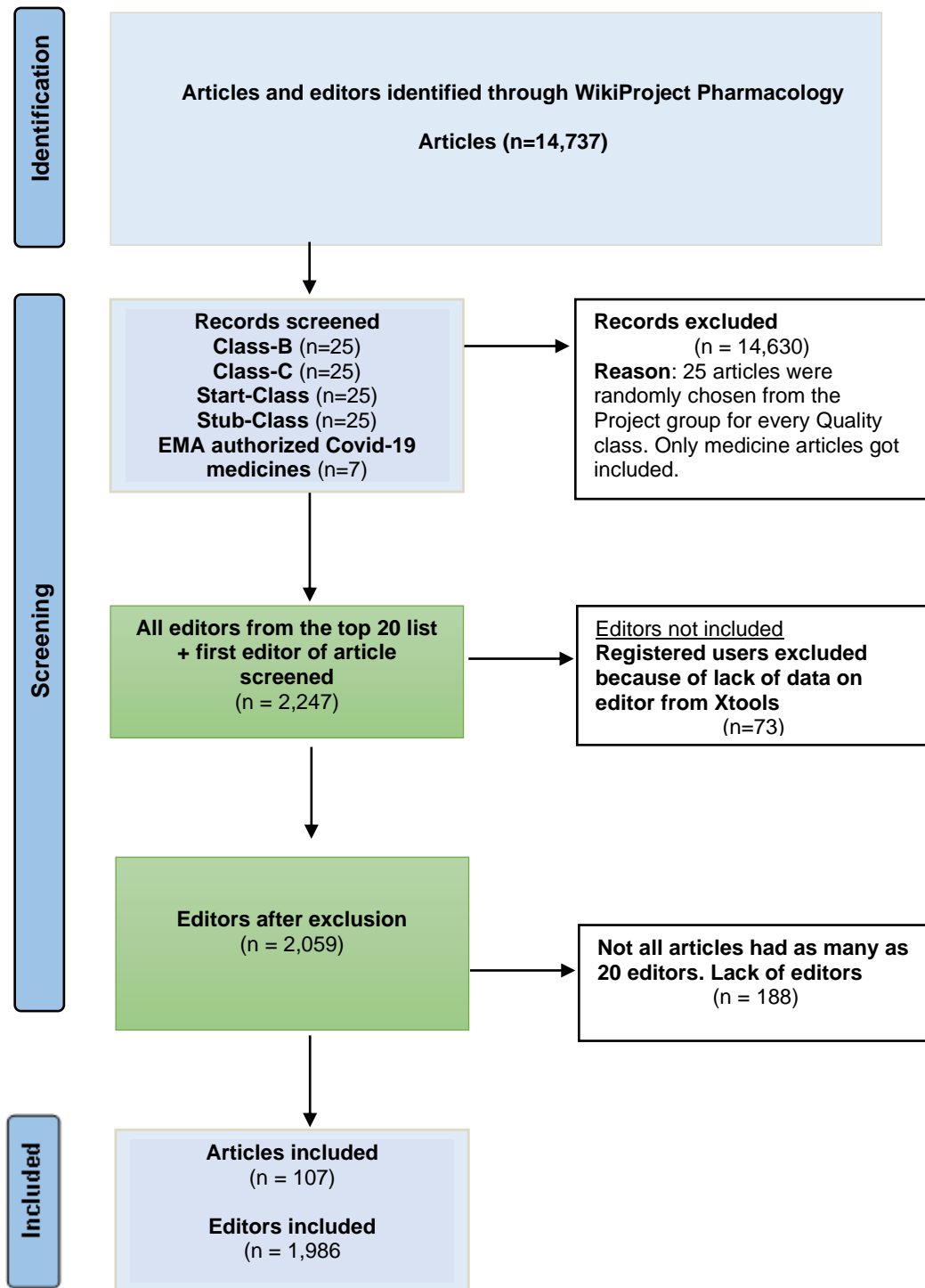
Figure 2 PRISMA flow diagram of the included articles and editors.

5.2 Article analysis

Of the 107 articles included, ten articles (~9%) contained the presence of editors with affiliation to the pharmaceutical industry. Of the ten articles with an affiliation, one article belonged to Class-B, five articles belonged to Class-C, three articles were from Start-Class, and one article from Stub-Class. None of the seven articles of Covid-19 medicines had any presence of the pharmaceutical industry. A full overview of which articles that got included, and which had affiliation can be seen in *figure 3*. The articles with an affiliation were observed to have bigger first edits done to the article, they contained more added references, they had more daily average views, more reverts done to the article, bigger length of the article, more total edits made, more anonymity, more bot edits, more editors present, compared to articles with no detected affiliation, as seen in *table 4*. However, none of these differences were statistically significant, as seen in *table 5*.

A full overview of which articles that got included, and which had affiliation can be seen in *figure 3*.

In general, Class-B articles had more edits, editors, anonymity, reverts, bot edits, major edits, daily average views, added references, and larger edits made to the article, compared to other categories. However, Class-C had bigger first edits made, and Class-B articles the smallest, compared to other categories.

Quality

(n=107)

B	C	Start	Stub	Covid-19

Article name

B
Doxycycline
Buprenorphine
Zaleplon
Amoxicillin
Tetracycline
Ketorolac
Buspirone
Metolazone
Rivastigmine
Spironolactone
Methyltestosterone
Captopril
Methotrexate
Methadone
Camptothecin
Acetazolamide
Oxandrolone
Memantine
Apomorphine
Ondansetron
Rivaroxaban
Fentanyl
Cefalexin
Quazepam
Imatinib

C
Prazepam
Macrolide
Amitraz
Clorazepate
Glybuzole
Abacavir
Terbinafine
Vicriviroc
Amcinonide
Amineptine
Fleroxacin
Bupivacaine
Apremilast
Forasartan
Nintedanib
Adalimumab
Phenylephrine
Sitagliptin
Mupirocin
Benadryl
Idraparinux
Ertapenem
Cyanocobalamin
Pirfenidone
Metamizole

Start
Minoxidil
Bosentan
Carvedilol
Pitolisant
Ethotoin
Venetoclax
Phenoxymethylpenicillin
Olaparib
Evolocumab
Neomycin
Amlexanox
Chloroprocaine
Brentuximab vedotin
Ramelteon
Methylepitiostanol
4-Chlorokynurenine
Telotristat ethyl
Sulfamethoxazole
Bupranolol
Halofantrine
Cefadroxil
Teriparatide
Perampanel
Flunisolide
Bamipine

Stub
Dostarlimab
Amiphenazole
Thebacon
Lenacapavir
Safrazine
Luspatercept
Econazole
Bunitrolol
Toceranib
Hexethal
Avacopan
Lomefloxacin
Lumefantrine
Atoltivimab
Nifuratel
Tofenacin
Isoetarine
Iprazochrome
Rociverine
Salinomycin
Clominorex
Macimorelin
Benralizumab
Cabotegravir
Quinupramine

Covid-19
Anakinra
Regdanvimab
Tocilizumab
Casirivimab/
imdevimab
Remdesivir
Sotrovimab
Nirmatrelvir

Affiliation

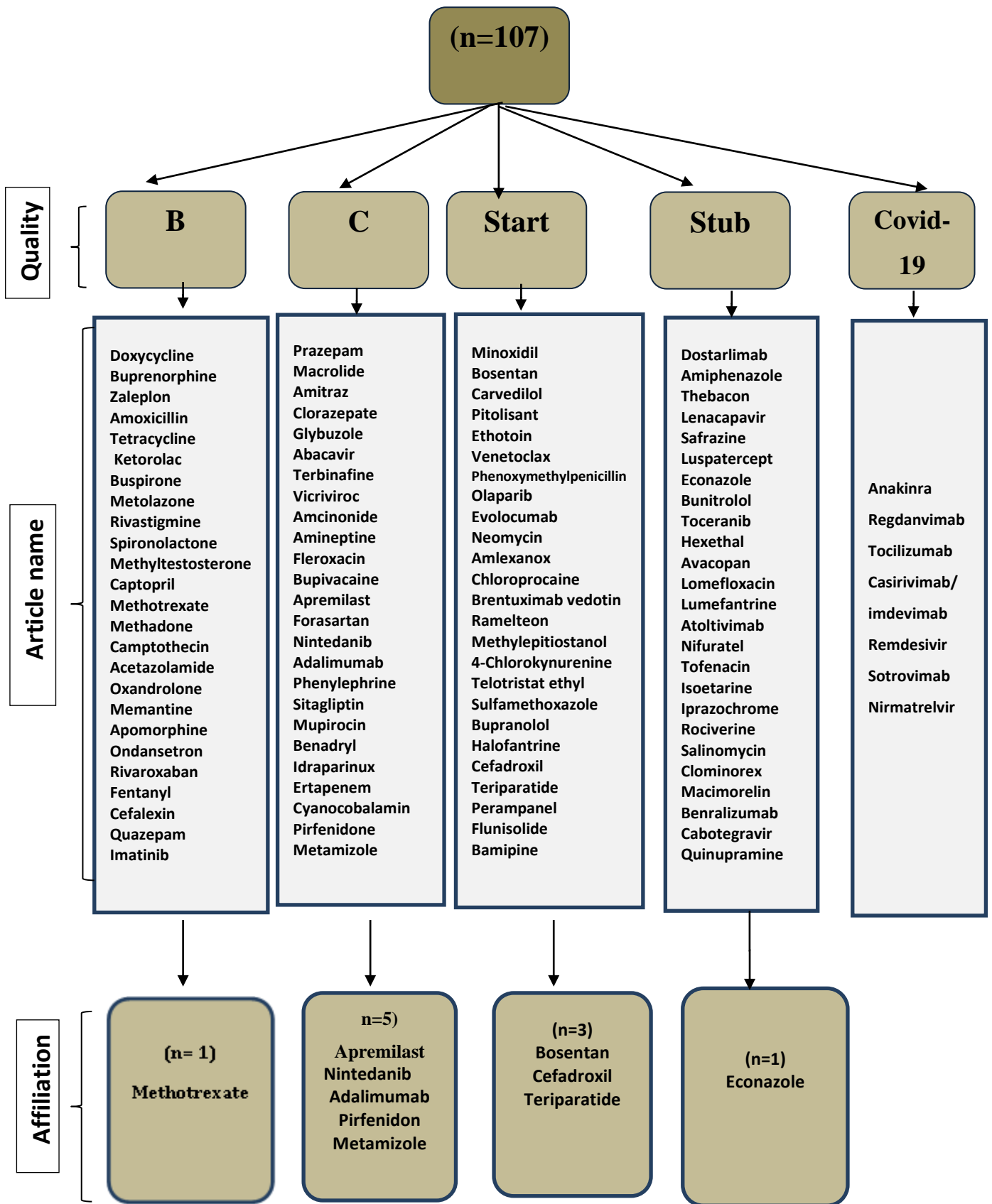| (n= 1) Methotrexate	n=5) Apremilast Nintedanib Adalimumab Pirfenidon Metamizole	(n=3) Bosentan Cefadroxil Teriparatide	(n=1) Econazole

Figure 3 Flow diagram of all included articles, their respective classes, and affiliation status.

31

Table 4 Descriptive statistics of continuous and categorical variables by editors with and without affiliation.

Continuous variables, median	Affiliation	Non-Affiliation
Length of article	22,922	17,730
Total edits	210	185
Total editors	94	86
Total Ip-addresses	48	27
Total bot edits	37	27
Total reverted edits	9	6
Age of article	17	16
First edit (byte)	426	952
Total references	55	34
Total major edits	150	139
Daily average	141	73
Categorical variables, count		
Quality:		
B	1 (4%)	24
C	5 (22%)	23
Start	3 (12%)	25
Stub	1 (4%)	25
Importance:		
High	2 (7%)	29
Mid	6 (12%)	49
Low	1 (8%)	13
???	1 (17%)	6
Total Watchers		
>30	5 (10%)	51
>100	3 (10%)	30
>200	1 (10%)	10
>500	0	4
<500	1 (50%)	2

Table 5 Statistical tests comparing the two groups affiliation and non-affiliation

Continuous variables	*P* value (Two-tailed test)
Length of article	0.83
Total edits	0.98
Total editors	0.84
Total Ip-addresses	0.94
Total bot edits	0.51
Total reverted edits	0.75
Age of article	0.38
First edit (byte)	0.91
Total references	0.68
Total major edits	0.93
Daily average	0.64
Categorical variables	**OR [95% CI]**
Quality:	
B	1.0 [0.06-17.6]
C	5.43 [0.6-50]
Start	3 [0.29-30]
Stub	Base
Importance:	
High	0.46 [0.03-5.3]
Mid	0.73 [0.075-7.2]
Low	0.73 [0.045-8.7]
???	Base
Total Watchers	
>30	0.99 [0.22-4.4]
>100	base
>200	1 [0.093-10.7]
>500	-
<500	5 [0.34-72.8]

5.3 Editor analysis

13 out of 1,986 editors (0,65%) were found to have an affiliation to the pharmaceutical industry. From these editors, two had declared their affiliation, and were found from the medicine article's talk page. They got included in the analysis, although they didn't edit the main page directly, because they had an affiliation.

Between the editors with and affiliation and no affiliation, there was no observed difference in the median on total reverts and edits made to the article. Of the editors with an affiliation, six were registered users, whilst seven edited behind an Ip-address. One notable difference was in Ip-addresses. In total, only 289 of 1,986 editors edited behind an Ip- address. However, almost half of those who had an affiliation edited behind an Ip-address, as seen in *table 6*. Further, the editors with no affiliation have contributed much more in terms of total edits, pages edited, and pages created. Whilst editors with an affiliation have contributed far less and have no users rights. Some editors with an affiliation edited the same article, as seen in *table 7*. Moreover, there seemed to be almost equal number of editors editing pre and post the FDA recommendations released in 2014, as seen in *figure 4*.
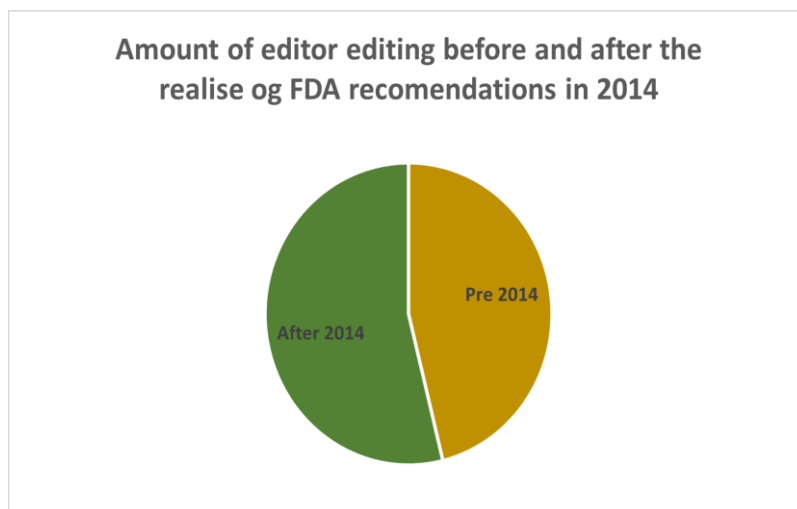

Figure 4 Sector diagram illustrating editors editing pre- and post-FDA recommendations from 2014

Table 6 Descriptive statistics of editor characteristics by editors with and without affiliation

Continuous variables, median	Affiliation	Non- affiliation
Age	8	15
Live edits	11	26,406
Deleted edits	0	612
Total edits	11	26,857
Pages edited	5	9,564
Pages created	1	1210
Blocked	0	0
Total edits done to the article	3	3
Total reverts done to the article	0	0
Dichotomous variables, percent		
Ip-address	54 %	14 %
User- rights:		
Autopatrolled	0	35 %
Extended-confirmed	0	73 %

Table 7 Description of each editor with an affiliation to the pharmaceutical industry

Editor	Year of edit	Article name	Pharmaceutical company	Description
Editor 1	2012	Econazole	Rephco Pharmaceuticals	Registered user. The editor has a pattern of promoting for the same pharmaceutical company in previous edits.
Editor 2	2018	Metamizole	Ozone laboratories	Ip-address. The editor was classified with an affiliation due to a suspicious edit.
Editor 3	2009	Cefadroxil	GlaxoSmithKline	Ip-address. ISP-server was directly linked to the company's server.
Editor 4	2009	Cefadroxil	Eskayef Bangladesh Limited	Ip-address. The editor has a pattern of promoting the same pharmaceutical company in previous edits.
Editor 5	2010	Bosentan	Acetelion	Registered user. The editor has a pattern of promoting the same pharmaceutical company in previous edits.
Editor 6	2013	Methotraxate	Delta Pharma Limited	Ip-address. The editor has a pattern of promoting the same pharmaceutical company in previous edits.
Editor 7	2017	Teriparatide	Radius Health	Ip-address. The editor declared its affiliation and made suggestions to the articles talk page.

Editor 8	2015	Teriparatide	CinnaGen	Registered user. The editor has a pattern of promoting products from the same pharmaceutical company in previous edits.
Editor 9	2014	Nintedanib	Boehringer Ingelheim	Registered user. Editor declared affiliation on its own talk page and made suggestions to the articles talk page.
Editor 10	2005	Adalimumab	Abbot laboratories	Ip-address. ISP directly linked to the pharmaceutical company. Also, the was the article creator of this article.
Editor 11	2016	Adalimumab	Cadila healthcare	Registered user. The editor has a pattern of promoting products from the same pharmaceutical company in previous edits.
Editor 12	2015	Pirfenidone	Aarambh Life Science	Registered user. The editor has a pattern of promoting the same pharmaceutical company in previous edits.
Editor 13	2018	Apremilast	Ajanta Pharma	Ip-address. The editor has a pattern of promoting the same pharmaceutical company in previous edits.

5.4 Adjusted Statistical analysis

A logistic regression was performed, where affiliation status was the binary outcome. The regression model did not contain the "total edits" variable, as it had a linear relationship with the "total editors" variable. This relationship seems plausible, as more editors naturally increases the total edits to the article. For this reason, "total edits" was not included in the adjusted analysis. The results of the adjusted analysis show that there is no significant association between the independent variables and the affiliation status of the articles (See *Appendix A* for the full regression model).

5.5 Network analysis

From the 107 articles included, a total of 17,850 editors were observed to have edited these articles. However, only editors who had edited more than once were included as edges to make the visualization easier. This resulted in 107 nodes and 5617 edges.

The nodes were differentiated by articles with and without affiliation too visualize their position in the network. The network graph of articles is shown in *figure 5*. The pink nodes represent the articles with affiliation, and the green nodes are the articles without an affiliation. The average degree for the whole network is 104.99 links between any node. This means that, on average, ca. 105 articles share at least one editor. When differentiating between the two groups, the average degree is 105.8 for articles with affiliation, and 104.9 for articles without affiliation. The graph density is 0.99. Density ranges from 0 to1, where 1 is a dense graph where the many nodes share multiple links. Overall, the nodes in the graph are closely related to each other.
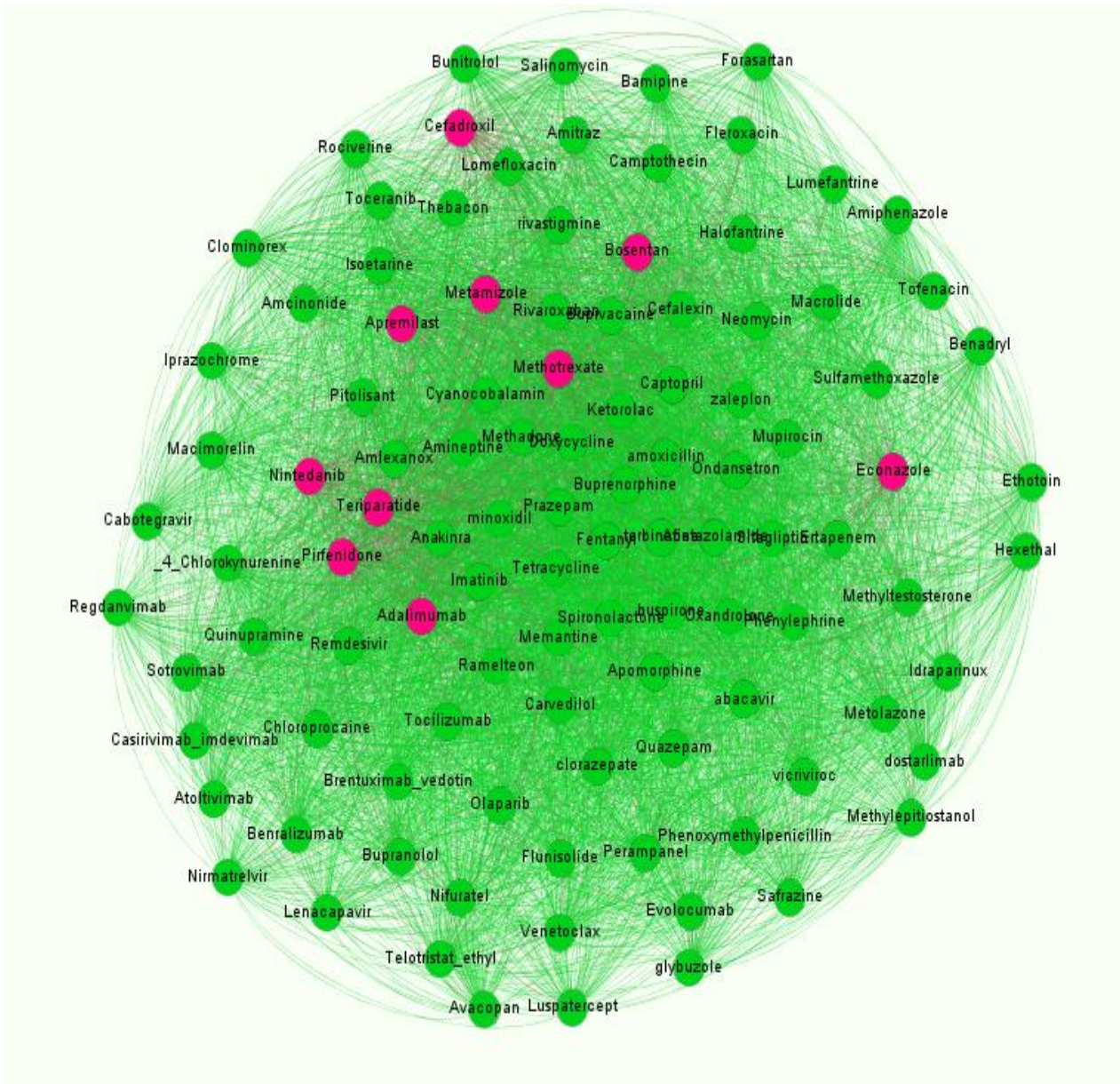
Figure 5 Network graph of articles with affiliation (pink) and without affiliation (green).

5.6 Content analysis:

The inclusion for the content analysis were all editors with an affiliation. This resulted in the inclusion of text written by a total of 13 editors (See *Appendix B* for the orginized raw data). The text was mostly from the articles. However, for some editor, such as editor 7 & editor 9, the text was taken from the article's talk page. Moreover, for editor 9, the user- page was also analyzed, as the editor had declared its affiliation there.

Codes were inductively derived (by NBM, AL, SAC, AS, MU, MOA, CS, AE). The codes, their meaning, and number of editors matching them are summarized in *table 8*.

The 13 editors with an affiliation were derived from the ten articles with an affiliation. Three articles (cefadroxil, teriparatide, and adalimumab) had two editors affiliated, while 7 articles only had one editor with an affiliation. Of all articles, adalimumab was the only article that had an editor with an affiliation that created the page.

The content analysis gave an insight into what editors with a pharmaceutical affiliation focus on when writing medicine articles on Wikipedia. Three main themes emerged from the inductive analysis: (a) Promotion, (b) Regulation, and (c) Pharmacology, as seen in *figure 6*.

Table 8 codes derived from the content analysis, their meaning, and number of editors with the specific code.

| Code	Meaning	Number of editors (n)
NBM	Name of brand or manufacturer (or both). Every time the brand name or the companies name (or both) were mentioned, this code was applied.	12
SAC	South Asian country. Every time a south Asian country is mentioned in the text.	6
AL	Added link. When the editor added the link to the manufacturer's website. Either as a reference or	6
AS	Approved status.	2
MU	Medical use. This code is used when an editor mentions the medical use of the medicine.	4
MOA	Mechanism of action.	2
CS	Clinical studies, either directly written about a study trial or used in references.	2
AE	Adverse effects	2
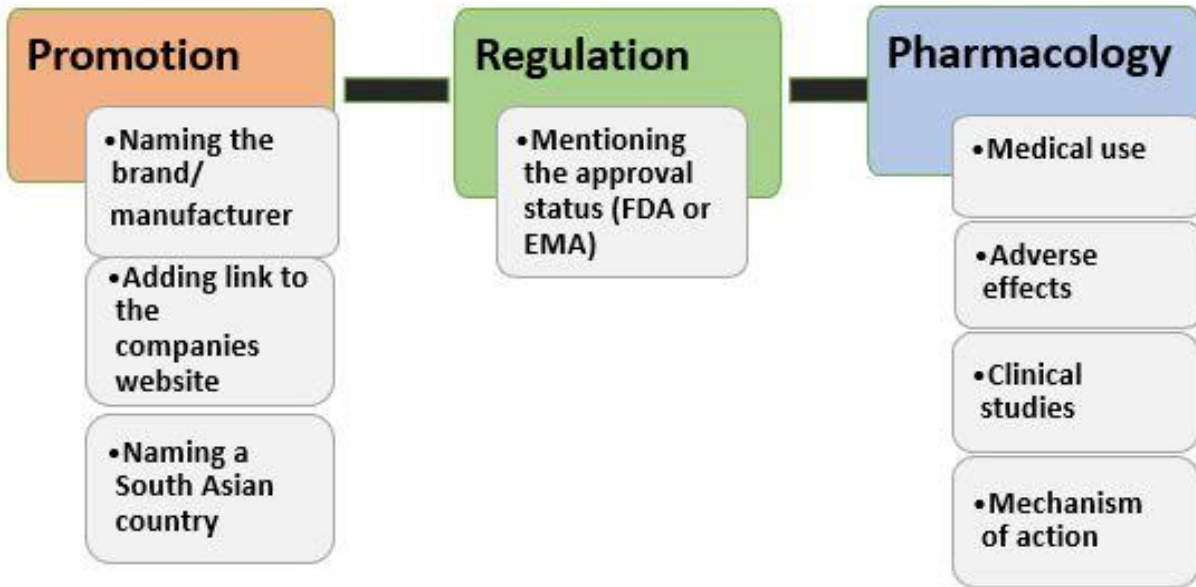
Figure 6 Themes and their corresponding codes that emerged from the content analysis

5.6.1 Promotion

The promotional theme emerged from codes that enhanced the manufacturer's name or product. This was a compilation of the codes describing: name of manufacturer/brand name, adding links to the company website, or highlighting a specific country.

Most editors specified the brand/manufacturer name. In total 12 editors specified the name of the brand or the manufacturer. Of those, nine editors named both the brand and manufacturer, three specified only the manufacturer, while only one editor only named the brand.

Editor 1 (registered user):

Article name: Econazole

"In Bangladesh it is sold under the brand name Ecoderm manufactured by Rephco Pharmaceuticals. The combination of Econazole Nitrate with Triamcinolone acetonide is also available under the brand name Ecoderm [the manufacturer's website was used as reference]." (2012)

Here, the editor is highlighting the manufacturer name, the brand name, and the country. This would be no beneficial knowledge for someone that does not live in that country. In addition, this is not the medical writing that Wikipedia aspires to have in its medicine article. Therefore, this text is more beneficial to manufacturers' interests, than the reader. This same pattern was seen in another editor, that edited the Methotrexate article. The editor wrote the exact dose availability in the market, alongside the brand, manufacturer, and country:

Editor 6 (Ip-address):

Article name: Methotrexate

"In Bangladesh there is only one manufacturer of methotrexate with the brand name Methotrax. They only manufactures it in oral solid dosage form (2.5 mg and 10 mg tablet. They promote the drug only in rheumatoid arthritis, ankylosing spondylitis and psoriasis.<ref>http://www.deltapharmabd.com</ref>" (2009)

"(Brand name Methotrax in Bangladesh by Delta Pharma Limited)… Now Methotrexate is marketing worldwide." (2013)"

One of the codes that emerged from the content analysis was the mention of a South Asian Country. The recurring South Asian countries were India, Pakistan, and Bangladesh. In total six out of thirteen editors mentioned a South Asian country in their edit. Editor 3 had its ISP directly linked to GlaxoSmithKline, and made the following contributions:

Editor 3 (Ip-address):

   Article name: Cefadroxil

   ""Duricef", Pakistan" (2009)

Another code that emerged was adding the link to the company's website. In total six editors added the link to the company's website, either as a reference or randomly. One editor only added the link of the pharmaceutical company without writing anything else. This editor added the same link to multiple medicine articles without any other text.

Editor 5 (registered user):

   Article name: Bosentan

   "http://www1.actelion.com/en/index.page "

5.6.2 Pharmacology

The pharmacology theme emerged from the codes describing: the mechanism of action, medical use, adverse effects, and clinical trials. These codes were only derived from four editors. Of all the editors with an affiliation, only two of them declared their affiliation: editor 7 and editor 9. These two editors were the only ones that wrote quite a lot about pharmacology-related topics. Although they never directly edited the article page, as per Wikipedia's guidelines, they made suggestions to the article's talk page. Here they made substantial suggestions, regarding the mechanism of action, clinical studies, and adverse effects.

Editor 7 wanted to flag some misinformation written Teriparatides main article under the category of medical use. The editor first introduced him/herself. Thereafter, the editor showed example of the paragraph that he/she disagreed with under "medical use" category, and followed it by writing the how the paragraph under "medical use" should be written:

Editor 7 (Ip-address):

    Article name: Teriparatide's talk page

> *" I am Senior[personal information] at Radius Health, Inc., a biopharmaceutical company based out of Waltham, MA. I'm here to flag misinformation that is currently included on the Teriparatide page.*
>
> *I am aware of Wikipedia's policies and guidelines, including those on WP:COI, WP:RS, WP:V and WP:NPOV, and I will abide by them. My edit suggestions will be restricted to Talk pages, and I will not engage in directly editing any teriparatide-related article…*
>
> *If you have any questions about my editing activities, please leave me a message on my User Talk page. "*

The editor continued by the writing down the paragraph under "medical use" section in Teriparatide's article that the editor disagreed with:

> *Medical use: Teriparatide is the only anabolic (i.e., bone growing) agent[1] indicated for use in postmenopausal women with osteoporosis at a high risk for fracture or with a history of osteoporotic fracture, patients with multiple risk factors for fracture, and for patients who have failed or are intolerant to other available osteoporosis therapy.[4] It has been FDA-approved since 2002.[5] It is effective in growing bone (e.g., 8% increase in bone density in the spine after one year)[6] and reducing the risk of fragility fractures.[5][7] Osteoporosis medications are generally safe, but some side effects of teriparatide include headache, nausea, dizziness, and limb pain.[5]"*

The editor continued by writing what the paraph should look like:

"revised: *Updating the first sentence of the first paragraph under the "Medical uses" section to correct the fact that there is now more than one anabolic agent approved for the treatment of postmenopausal women with osteoporosis"

"medical use: Teriparatide is one of two available [[anabolic]] (i.e., bone growing) agents[1]<ref> indicated for use in postmenopausal women with osteoporosis at a high risk for fracture or with a history of osteoporotic fracture, patients with multiple risk factors for fracture, and for patients who have failed or are intolerant to other available osteoporosis therapy.[4] It has been [[FDA]]-approved since 2002.[5] It is effective in growing bone (e.g., 8% increase in bone density in the spine after one year)[6] and reducing the risk of fragility fractures.[5][7] Osteoporosis medications are generally safe, but some side effects of teriparatide include headache, nausea, dizziness, and limb pain."

Further, editor 9 had some suggestions to Nintedanib's article, so the editor went to the articles talk page and wanted to make some pharmacology related suggestions to make the Wikipedia entry more up to date:

Editor 9 (registered user):

Article name: Nintedanib's talk page

"I would like to propose the following updates to the Nintedanib Wikipedia entry … to ensure the content is up-to-date and reflects the current regulatory status of nintedanib …

Nintedanib (trade name, Vargatef® in NSCLC, Ofev® in IPF) is a small molecule tyrosine kinase inhibitor (TKI) developed by Boehringer Ingelheim for the treatment of lung cancer patients with advanced adenocarcinoma and patients with idiopathic pulmonary fibrosis (IPF). Nintedanib inhibits the receptors for vascular endothelial growth factor (VEGF), fibroblast growth factor (FGF) and platelet derived growth

factor (PDGF) which are involved in the formation and maintenance of new blood vessels (angiogenesis) and signalling pathways of fibrotic processes"

" Mechanism of action: Nintedanib targets growth factor receptors, which have been shown to be involved in the mechanisms by which pulmonary fibrosis occurs. Most importantly, nintedanib inhibits receptors for platelet-derived growth factor (PDGF), fibroblast growth factor (FGF) and vascular endothelial growth factor (VEGF).[18] [19] [20] By blocking these signaling pathways involved in fibrotic processes, it is believed that nintedanib reduces disease progression in IPF by slowing the decline of lung function."

Another editor, editor 10, also wrote about the indication. Editor 10 was the only article creator of all the editors with an affiliation. This is a breach of COI guidelines, as someone with an affiliation should not create a Wikipedia page of their company's product. This editor's Ip-address was also found to be directly linked to the Abbot laboratories company server. The editor wrote very little about anything other than just a short description of the indication, the brand name, and the manufacturer name.

Editor 10 (Ip-address and article creator):

Article name: Adalimumab:

"Humira is a fully human TNF-alfa inhibitor, for the treatment of moderate to severe Reumatoid arthritis. Humira's manufacturer is Abbott Labs."

5.6.3 Regulation

The regulation theme emerged from only one code describing the approval status of the product. This was only mentioned by two editor, editor 7 and 9, which declared their affiliation. They both wrote when the medicine got approved by the FDA, and editor 9 also wrote about the approval in Europe.

Editor 7 (Ip-address):

    Article name: Teriparatide's talk page

    "It has been [[FDA]]-approved since 2002.[5] It is effective in growing bone (e.g., 8% increase in bone density in the spine after one year)"

Editor 9 (registered user):

    Article name: Nintedanib

    "As currently noted, nintedanib is approved by the FDA for the treatment of idiopathic pulmonary fibrosis under the trade name Ofev®... Ofev® received a positive opinion from the European Medicines Agency's Committee for Medicinal Products for Human Use (CHMP) on 20 November 2014.."

6 Discussion

This is the first study that has aimed to understand the prevalence, factors, content, and editors from the pharmaceutical industry on Wikipedia's medicine articles. The results of this study are a great addition to the current literature, which lacks knowledge as to how the pharmaceutical industry is present on Wikipedia's medicine articles.

One of the aims of this study was to identify editors from the pharmaceutical industry in Wikipedia's medicine articles. It was able to achieve that through a cross-sectional design. Of 107 articles included, 10 articles (~9%) were detected to have editors from the industry. Of all the editors analyzed from the respective articles, only 0.65% had an affiliation with the industry. This demonstrates that there is a presence of the pharmaceutical industry in Wikipedia's medicine articles, albeit rather minor.

This study also aimed to find an association to explain the presence of the industry in these Wikipedia articles. The adjusted statistical analysis shows no significant association between any variables and the articles edited by industry editors. Hence, it seems quite random what articles get edited by the pharmaceutical industry. For this reason, it is plausible to conclude that there is no synchronized effort from the industry to edit medicine articles on Wikipedia. Rather, the decision to edit an article is individual to each company.

Further, this study aimed to understand the connection within the editorial team. The network graph illustrates that almost all articles share at least one editor with another article. When differentiating between the articles with and without affiliation, the results are almost identical. Meaning, that there is no difference between these groups of articles in sharing editors. Hence, some editors appear in many articles, regardless of whether the articles are affected by affiliation or not. Similarly, the total number of watchers had no effect on the article; therefore, it does not matter how central the article is or how monitored it is. With this, one can conclude that the articles can be edited by the industry regardless of how the editorial team is connected.

In total, thirteen editors were found to have an affiliation. Of those, eleven editors breached Wikipedia's guidelines. This was done by the editors directly editing the article page. Only two out of thirteen editors declared their affiliation. These two editors also refrained from

directly editing the article page. They followed Wikipedia's guidelines by only making suggestions to the article's talk page.

However, out of these two editors who declared their affiliation—only one of them had a registered user. The other, editor 7, edited behind an Ip-address. Editor 7 mentioned contacting it through its user page when someone had any questions. Since editor 7 is not registered, it does not have a user page. This indicates, that even if the editor was familiar with Wikipedia's COI guidelines, it may not be familiar with all practices. This might explain why the eleven other editors breached Wikipedia policies; because, they might simply not know them.

Moreover, almost half of those with an affiliation edited behind an IP address. Whereas only 14% without an affiliation edited behind an Ip-address. This could also be explained by the fact that editors from the pharmaceutical industry do not read Wikipedia's policies and community practices before editing. On the contrary, it could also be that they know the rules, but choose not to adhere. However, it is not possible to determine the intention of these editors from just the results of this project. What is known, however, is that most editors with an affiliation—breach Wikipedia's guideline. This is quite new knowledge on the topic of the editors from the pharmaceutical industry. The pilot study in 2015 that detected presence of pharmaceutical industry, did not study the editors it found. In this study, the editors have been studied in detail, which has made it possible to compare the editors with each other, to study their content, and their connections with each other.

6.1 Comparing editors with and without an affiliation

Regarding the variables "total edits to the article" and "total revert to the article"; there was no difference between the editors with and without affiliation. What was different, however, was the proportion of registered users amongst editors with no affiliation. The majority of editors with "no affiliation" had a registered user account. Only a small minority edited behind an Ip address. This would mean, that the people with no affiliation see the benefit of having a registered user.

Consequently, they had a disproportional advantage regarding the extended-confirmed and autopatrolled user rights. As many as 73% of the editors with "no affiliation" had extended-confirmed user rights. Whereas editors with an affiliation did not have any user rights. This means that editors with an affiliation, despite being registered, did not get promoted to any user rights. This can be explained by the fact that editors with an affiliation are less active in the community. This trend was seen descriptively, where registered users amongst the non-affiliation group had a superior number of total edits, pages edited, and pages created, compared to the affiliation group. Hence, the editors without an affiliation are bigger contributors to the community, resulting in them being more trusted, and promoted to various user rights.

6.2 Promotion

From the thematic analysis, the promotion theme was the most prevalent. Almost all editors mentioned the manufacturer or brand name. Further, nearly half of the editors, either added a link to their company webpage or mentioned a South Asian country in their edit. This demonstrates that edits from the industry are mainly based on promotion. It could be because some pharmaceutical companies have caught up to Wikipedia being a prominent web page for health queries. Therefore, using the webpage could be a way to highlight their brand name or manufacturer name.

The promotion could be seen as something so minor as adding the company's webpage link. This is possibly an easy way for the companies to redirect people to the company's sites. This way the reader knows who the manufacturer is, and they can quickly go to their webpage for more information.

Interestingly, a South Asian country was mentioned almost half of the time. These countries were usually mentioned as to where the medicine is being produced. This recurring theme can be explained by the growing pharmaceutical industry in South Asia. In 2020 the government of India came out with a report stating that their pharmaceutical industry is the 3rd largest in the world [63]. Further, the production, operation, and workforce are cheaper there, making it beneficial for pharmaceutical companies to make it a part of their supply chain [64]. This gives a high probability of the editors with affiliation—coming from a South Asian country.

With that, it would make sense that mentioning a south Asian country could be a natural part of their editing.

However, even with promotion, there was no misinformation. Meaning, there were no exaggerated statements about the benefits, nor any lies about the product. Therefore, there seems to be no malintent behind the edits. However, the promotional edits and the direct editing of the actual article page, are against Wikipedia's conflict-of-interest guidelines. The Webpage does not wish to be a marketing ground for other companies, and such edits are a breach to its guidelines. In addition, the promotional edits are irrelevant information for the vast majority of the readers. Even if the companies are not breaking guidelines set by the FDA; it could still be seen as unethical to break the rules of the medium that is being used for promotion.

6.3 Other themes of content analysis

The content analysis did also have other themes present, such as regulation and pharmacology. However, most of the pharmacology and regulation codes were derived from only two editors. These are the same ones that declared their affiliation. Both editor 7 and editor 9, made suggestions to the articles talk page about the medicine's mechanism of action, adverse effects, medical use, and clinical studies. They also wrote about the medicine's approval status from either the FDA or EMA, and what year the medicine got authorized.

It seems that the editors who declare their affiliation, are the ones that write the most in their edits and have more useful suggestions. On the contrary, editors that did not declare their affiliation, had much shorter edits. Most of the time they only wrote one sentence containing the name of the brand or manufacturer. This could be that those declaring affiliation are much more serious about the content of the article. Rather than wanting to highlight their company and brand name, they bring more sustenance to the article through suggestions. Thus, it seems that the editors that care about making the article more up to date, are also more likely to adhere to Wikipedia's rules and policies.

6.4 EMA Covid-19 articles

None of the seven articles of the recent Covid-19 authorized medication (by EMA) had any traces of the pharmaceutical industry present. This can be explained by the recent discussion regarding misinformation spread on the internet regarding Covid-19, and how to hinder that. During the Covid-19 pandemic, Wikipedia made a conscious effort to combat misinformation being spread. The World Health Organization (**WHO**) even partnered with Wikipedia to hinder misinformation regarding Covid-19 on Wikipedia [65].

Today Wikipedia has a whole project group dedicated to Covid-19 articles: WikiProject Covid-19. Some of the articles are even locked, meaning there cannot be any changes until certain editors of WikiProject Covid-19 review them. Because of this recent effort to combat misinformation, all articles related to Covid-19 on Wikipedia have been strictly monitored [65, 66]. The strict surveillance can explain why there are no editors with affiliation present in these articles.

On the other hand, it could also be because the industry views these articles as complete. The changes might be so quick and up to date, that there might be no need for the industry to get involved in these articles. However, such a conclusion would presuppose that the motivation of industry is to only edit articles that are not up to date. In this study, the major contribution to the articles from the industry seems to be mostly promotion. Making it more likely, that the non-existing presence of the pharmaceutical industry, is due to the fact the Covid-19 articles are under strict surveillance, and not because they are up to date.

6.5 Volunteering and labor intensity

During the data collection for the editor analysis, it was apparent that some editors were recurring in multiple articles. This is also seen in the network analysis, where most articles share more than one editor. This trend was seen in all articles included, regardless of affiliation. The most reoccurring editors were usually administrators, or active editors. These recurring editors were active in the community, addressing problematic users and content. Proving that the community is far less anarchic than most think.

Nevertheless, all the corrections made by the Wikipedians are still labor-intensive. For Wikipedians to catch someone with an affiliation they would have to: be aware of the changes being made to every article, review them, and make a subjective judgment of whether affiliation is present. So even if Wikipedia is far less anarchic than public perception, it still cannot catch all editors with an affiliation, as this study demonstrates. Although, this study has shown that most articles are not edited by the industry, they are still present to some degree.

6.6 Suggestions to Wikipedia

Wikipedia's goal for its content is to be as neutral as possible. This entails no conflict-of-interest present in any article. Therefore, some results derived from this study might be beneficial for Wikipedia to combat the interference of the pharmaceutical industry on its webpage.

Firstly, it seemed that none of the editors with an affiliation had user rights such as autopatrolled or extended-confirmed. Whereas as many as 73% of the editors without an affiliation were promoted to be extended-confirmed of the 1,973 editors studied. Therefore, to reduce people with an affiliation, it could be a good strategy to only let users with an extended-confirmed user right to edit these articles. However, such an action contradicts with Wikipedia's wish to give an open access to editing. This would also reduce number of newcomers to join editing. This is specially not ideal as Wikipedia already is facing low newcomer retention [26]. On the other hand, the Covid-19 articles demonstrated that sometimes locked pages, are effective in keeping the industry out. Therefore, it does prove that WikiProject Pharmacology would have to sacrifice open access to keep the industry completely out. At the same time, the alternative would be to increase awareness of the industry being present, so that the community can respond quicker every time they have a suspicion. But as discussed earlier, this route is far more labor intensive, and would require a lot of effort from the editors in the community. Nevertheless, this study shows that the pharmaceutical industry is present, and the project group does have to think about ways to eliminate such presence if it wishes to provide content with neutral point-of-view.

Secondly, the project group should do an extra affiliation check when a South Asian country is mentioned, or when a link to the company's webpage is attached. It was observed in this study that a South Asian country is frequently mentioned by the editors with an affiliation.

Lastly, WikiProject Pharmacology does not differentiate between the different pharmacology topics. Therefore, it could create an individual banner to label medicine articles. This can make future work and research on this topic easier.

6.7 Usability of Wikipedia

Earlier, there has been a discussion about the usability of Wikipedia's pharmacology content. There has been a divergence of opinion; some have seen the potential, whilst others have opposed it. In 2011, *Lavsa et al* studied the reliability of Wikipedia medication content for pharmacy students. Wikipedia's content was compared with the medicines manufacturer's package inserts. It was then concluded that the pharmacy students should be encouraged to use other credible sources; because, Wikipedia lacked references, accuracy, and complete information[16]. However, this was an unfair comparison, because Wikipedia itself does not aim to imitate the manufacturer insert of a medication. Nor does Wikipedia aim to imitate a textbook, as per the comparison made by *Kreanbring et al 2014 [14].* Wikipedia has a clear distinct way of writing medical content. It aims to give a bird-eye view of the topic, and only uses secondary and tertiary sources. Therefore, the previous comparisons made, do not attempt to distinguish Wikipedia's own goals for its content. A fairer comparison would have been to other encyclopedias.

A study conducted by *Clauson et al. 2008* compared the completeness and accuracy of Wikipedia with the Medline Drug Reference (**MDR**). It was found that MDR could answer 80% of the questions, and Wikipedia could only answer 40% of the defined questions [17]. However, *Clauson et al. 2008* did not differentiate between the different quality classes that Wikipedia has. The four different classes of category such as B, C, Start, and stub, are quite different in terms of their completeness, accuracy, and quality. The higher the quality of an article, the better the article is supposed to be. Therefore, an article with a low grade, for instance, a stub article, would not be as complete compared to other quality classes. The results from this project found that articles with a Quality grade of B, had on average more

edits, editors, and major edits done to the article. This explains that the higher the grade of the article, the more work is done on the article, suggesting that it would be more complete. This was not taken into consideration in *Clausen et al.* 2008 research when concluding that Wikipedia articles lacked completeness compared to the MDR [17].

Although this project does not aim to investigate the accuracy, completeness or reliability of Wikipedia's pharmacology content, the findings of this project can be an input into to the discussion. The findings from this project demonstrate that the pharmaceutical industry is present on Wikipedia's medicine articles. Where 9% of the articles are detected to have the industry present. Of these articles only 0,65% of the editors are from the industry. This means that even though the webpage is not, as of today, immune to edits made by the pharmaceutical industry, most of the content is not affected by the industry. From a credibility perspective, the results can be used to demonstrate the lack of anarchy on Wikipedia. Arguing against the stigma around Wikipedia, which it often gets in academia [10].

6.8 Earlier detection of pharmaceutical industry

Already in 2015 Dr. James Heilman, a prolific medical Wikipedian, reported suspicion regarding interference of the pharmaceutical industry in Wikipedia's medical content [53]. The same year, a pilot project found traces of the pharmaceutical industry in medicine articles on Wikipedia [8]. These findings align with the result of this project. Here the study sample was larger and randomized. With that, there is a certainty that the pharmaceutical industry is present in Wikipedia's medicine articles.

The pilot project hypothesized that more editors, and therefore more watchers, might be a protective measure against editors with an affiliation[8]. However, the results of this study showed the number of watchers does not play a significant role in that regard.

Interestingly, Doctor James Heilman, mentioned that big pharmaceutical companies had contacted him, such as GlaxoSmithKline, Alexion, and IMS Health. These companies wanted advice on how to edit Wikipedia and the process of editing its medical content [53]. One of these companies—GlaxoSmithKline— was found to be editing Cefadroxil's Wikipedia

article. This shows that some pharmaceutical companies are actively reaching out. They are showing an interest in wanting to be a part of the Wikipedia page of their product.

There can be various motivations as to why pharmaceutical companies engage on Wikipedia: They could see the potential in promotion, or be motivated by the 2014 FDA recommendations of correcting misinformation about their product on the internet. The intention behind the FDA recommendations was to encourage pharmaceutical companies to hinder misinformation from being spread on the internet by a third party [7]. However, for this to have happened, there should have been a sudden increase in the number of editors in the pharmaceutical industry after 2014. The results from this project show that approximately half of the editors edited pre-2014, and half edited after 2014. Thus, the FDA requirement does not seem to be an apparent motivation for the pharmaceutical industry to get involved on Wikipedia.

On the other hand, the editors that declared their affiliation, and made important suggestions regarding pharmacology, medical use, and mechanism of action, seemed to be edited after the release of the FDA recommendations. It could be that the recommendations resulted in some companies being interested in editing Wikipedia in a meaningful way. However, as of today, it would not be possible to know what the real motivation was.

6.9 Methodology discussion

6.9.1 Markers for pharmaceutical affiliation and grey area

One of the anticipated problems in this study was the possibility of misclassifying the editor's affiliation status. Therefore, criteria were set in place to minimize such scenarios.

Some editors were easily categorized as an "editor with an affiliation". Those editors either had their Ip-address directly linked to a pharmaceutical company or voluntarily declared their affiliation. However, others were difficult because they had no direct evidence, and only their edit history was available. In those cases, the pattern of the edit history was studied to differentiate editors with and without affiliation. The edit history had to show a clear pattern of favoring one pharmaceutical company for the editor to be classified as an "editor with affiliation".

For instance, if the edit history showed that the editor wrote the promotional text for multiple companies simultaneously, it would not be classified as affiliation. This is because it would not be clear which company the editor was affiliated with. Although, I am aware that this criterion does not consider companies that edit on behalf of other companies, such as Contract Research Organization (**CRO**); this criterion is important to hinder misclassifying categorizing hobby writers, that have an interest in multiple companies (but do not have an affiliation).

In addition, if one editor had promoted the manufacturer's brand, but had only done it one time, without any history of doing it again, and no other evidence was available, then the editor was given the benefit of the doubt, and not classified with an "affiliation".

These two criteria for the edit history were meant to prevent appointing affiliation without a reasonable basis. Therefore, it was not enough to just suspect affiliation, but the suspicion had to have evidence supporting it.

This led to the marker for pharmaceutical affiliation being defined as either declared affiliation, Ip-address directly linked to a pharmaceutical company, or the editor having a pattern of repetitive promotion of one specific pharmaceutical company. With these criterions in place, it was possible to have a systematic approach to determine the affiliation status of an editor.

The latter criterion was only challenged once, as one editor had a quite suspicious edit to the - metamizole article. The edit was regarding a detailed address of the manufacturer. This was discussed with my supervisor, and a consensus was reached that the editor most probably had an affiliation. That edit was quite suspicious, as someone without an affiliation would rarely write the address in such detail. Therefore, this is the only edit that got categorized as a pharmaceutical edit, without previous history. This editor mentioned both the brand and manufacturer, in addition, the editor wrote the whole address in full detail

Editor 2: (Ip-address)

   Article name: Metamizole

   "United Kingdom: "Algozone" (Ozone laboratories, 180 Tottenham Court Road, Queens House, W1T7PD, London, UK" (2018)

Another grey area was an editor who stated that it has previously worked in the pharmaceutical industry. However, it was not clear what companies the editor had worked for. The recent position of the editor was a statistician; however, it was not declared any company, or if this is a matter of conflict of interest. The editor became a matter of uncertainty, where the edit history did not show a pattern of promotion of one company, no one in the community had any issue with this editor, and the editor did not state a direct affiliation to a company. For these reasons, the editor was not classified with an affiliation, as per consensus with my supervisor.

One editor was found to have a clear conflict of interest. However, it was not an interest to the pharmaceutical industry, but rather the university the editor worked for. An administrator from that university had written down the name of the research group from that university which had invented and synthesized the medicine. However, even if this affiliation was interesting, it was not relevant to my project, as this was not an affiliation to a pharmaceutical company. Thus, the editor was not classified belonging to the pharmaceutical industry.

6.9.2 Strengths

Firstly, the study had a mixed methods approach, which allows the study to encompass many aspects of the pharmaceutical industry's presence in Wikipedia's medicine articles. Although this study does not show changes over time, it has provided a clear picture of how the pharmaceutical industry is present today, through statistical analysis, content analysis, and network analysis. In addition, the study has included the newest authorized Covid-19 medicines by the EMA, which are relevant to this time.

Secondly, all hundred articles were selected randomly. Moreover, the study has included an equal amount of the four quality classes of WikiProject pharmacology: B, C, Start, and Stub. Resulting in increased external validity.

Thirdly, a systematic approach was taken to assign someone: "editor with an affiliation". Some editors had either declared their affiliation or had their Ip address directly linked to a pharmaceutical company. For other editors, where the edit history had to be reviewed, strict criteria were in place to hinder the misclassification of editors with no affiliation into "editors with an affiliation". Furthermore, no editor got excluded without being screened for affiliation. Assuring those potential "editors with affiliation" from the excluded batch—were not missed.

Lastly, a content analysis was done on the edits by editors with an affiliation. The codes were derived inductively. There were no preconceived notions of what the codes should be. The themes were allowed to emerge from the content, making it possible to form new theories and concepts.

6.9.3 Weaknesses

There is a possibility of misclassification of editor "with an affiliation" to "no affiliation". Meaning, that there is a possibility that some of the editors that were not assigned an affiliation—do have an affiliation to a pharmaceutical company. This could be caused by following reasons:

- The article was not reviewed in its entirety. Meaning, that only the content of maximum 21 editors was reviewed. So, all the edits made by other editors were not reviewed. Therefore, there could possibly be more editors with an affiliation. However,

reviewing the top 20 editors and the article creator, made it possible to only review the editors that contributed the most to the article. If one had reviewed all editors, then a total of 17,850 editors had to be analyzed. This would have been quite unproductive, as some of these editors did quite minor edits, such as fixing grammar. Therefore, if some editors were missed, they would not have been amongst those who did much to the article either way.

- The IP check does not provide any information of the server if it is intentionally made anonymous. Therefore, those who wanted to, could easily have hidden their IP addresses server. In addition, if the IP address is dynamic, it is not possible to know if it is only one person behind it.

Thus, it is possible, that editors "with an affiliation" got classified as "no affiliation". The implications of such a scenario would only be that there is a bigger presence of the pharmaceutical industry in the included articles. Meaning that the found prevalence of the industry presence are the least that it could be.

Furthermore, this study is not able to tell if these companies are paying the editors to edit on behalf of them, or if they are just hobby writers who happened to also work for pharmaceutical companies. Therefore, the only thing that can be assured is that there is a conflict of interest regarding the editors. However, the study cannot determine the stance of the company itself.

Moreover, this study imitates the cross-sectional design. As a result, it cannot say anything about the changes in time. Therefore, this study is only able to measure the prevalence of the pharmaceutical industry's presence. Moreover, sufficient sample size was not calculated beforehand. As of today, WikiProject Pharmacology does not differentiate medicine articles from other pharmacology topics. Therefore, it is uncertain how big the sample of only medicine articles could be.

6.10 Future work

1. In the future, one can study how the pharmaceutical industry is present in other places of the internet. For instance, other places with medical information, or even some social media platforms.

2. Since this study did not include all medicine articles on Wikipedia, a larger sample size can be considered in future work. Also, an observational design could be used to observe changes with time.

3. More filters to the network analysis could be added to observe changes between articles with and without affiliation. More filters to the edges can be added to see if the differences increase or not. Moreover, one can study grouped clusters in the network analysis of the editor analysis.

7 Conclusion

This study has detected a small presence of the pharmaceutical industry in Wikipedia's medicine articles. No factors were associated with such presence: Implying that the decision to edit an article is individual to each company, and not affected by external factors. Most of the content written by editors with an affiliation were promotional. However, there was no misinformation or any exaggeration about the product. Further, most editors with an affiliation breached Wikipedia's conflict-of-interest guidelines. None of the editors with an affiliation had any user rights and were generally far less active in contributing to the webpage. Whereas the editors with no affiliation had more users' rights, especially the extended-confirmed user right. If Wikipedia wishes to eliminate all interference from the pharmaceutical industry, it must consider strategies as to who is allowed to edit these articles. The results of this study also add nuance to the debate regarding the usability of these article; the community was observed to lack anarchy, which in turn increases the webpage's credibility.

8 References

1.   Hughes, B., et al., *Junior physician's use of Web 2.0 for information seeking and medical education: a qualitative study.* Int J Med Inform, 2009. **78**(10): p. 645-55.
2.   Sandars, J. and C. Morrison, *What is the Net Generation? The challenge for future medical education.* Medical Teacher, 2007. **29**(2-3): p. 85-88.
3.   Heilman, J.M. and A.G. West, *Wikipedia and medicine: quantifying readership, editors, and the significance of natural language.* J Med Internet Res, 2015. **17**(3): p. e62.
4.   Shafee, T., et al., *Evolution of Wikipedia's medical content: past, present and future.* J Epidemiol Community Health, 2017. **71**(11): p. 1122-1129.
5.   Metcalfe, D. and J. Powell, *Should doctors spurn Wikipedia?* J R Soc Med, 2011. **104**(12): p. 488-489.
6.   Farič, N. and H.W. Potts, *Motivations for contributing to health-related articles on Wikipedia: an interview study.* J Med Internet Res, 2014. **16**(12): p. e260.
7.   Food and Drug Administration. *Guidance for Industry: Internet/Social Media Platforms: Correcting Independent Third-Party Misinformation About Prescription Drugs and Medical Devices*. 2014 [cited 2021 30.09.2021]; Available from: https://www.fda.gov/regulatory-information/search-fda-guidance-documents/internetsocial-media-platforms-correcting-independent-third-party-misinformation-about-prescription
8.   Svendsen, K. and K.H. Skancke, *Wikipedia and Medicines: Who edits medicine articles on the English Wikipedia?* Septentrio Conference Series, 2019(2).
9.   Wikipedia. *Wikipedia:About*. [cited 2022, April 27; Available from: https://en.wikipedia.org/wiki/Wikipedia:About.
10.   Hodson, R., *Wikipedians reach out to academics.* Nature, 2015.
11.   Giles, J., *Internet encyclopaedias go head to head.* Nature, 2005. **438**(7070): p. 900-901.
12.   Shafee, T., et al. *Wikipedia's medical content: A new era of collaboration*. 2016, October 29 [cited 2022, April 27; Available from: https://diff.wikimedia.org/2016/10/29/wikipedia-medical-content/.
13.   Cochrane Community. *Wikipedia: an important dissemination tool for Cochrane.* 2017, March 1 [cited 2022, April 27; Available from: https://community.cochrane.org/news/wikipedia-important-dissemination-tool-cochrane.
14.   Jona, K., et al., *Accuracy and Completeness of Drug Information in Wikipedia: A Comparison with Standard Textbooks of Pharmacology.* PLoS One, 2014. **9**(9).
15.   Kupferberg, N. and B.M. Protus, *Accuracy and completeness of drug information in Wikipedia: an assessment.* Journal of the Medical Library Association, 2011. **99**: p. 310+.
16.   Lavsa, S.M., et al., *Reliability of Wikipedia as a medication information source for pharmacy students.* Currents in Pharmacy Teaching and Learning, 2011. **3**(2): p. 154-158.
17.   Clauson, K.A., et al., *Scope, Completeness, and Accuracy of Drug Information in Wikipedia.* Annals of Pharmacotherapy, 2008. **42**(12): p. 1814-1821.
18.   Kuznetsov, S., *Motivations of contributors to Wikipedia.* Computers & society, 2006. **36**(2): p. 1.

19. Wikipedia. *Wikipedia:Core content policies*. 03.11.2021 [cited 2022 16.01.2022]; Available from: https://en.wikipedia.org/wiki/Wikipedia:Core_content_policies.
20. Wikipedia. *Wikipedia:Neutral point of view*. 01.01.22 [cited 2022 16.01.22]; Available from: https://en.wikipedia.org/wiki/Wikipedia:Neutral_point_of_view.
21. Wikipedia. *Wikipedia:No original research*. 14.01.2022 [cited 2022 16.01.2022]; Available from: https://en.wikipedia.org/wiki/Wikipedia:No_original_research
22. Wikipedia. *Wikipedia:Verifiability*. 07.01.2022 [cited 2022 16.01.2022]; Available from: https://en.wikipedia.org/wiki/Wikipedia:Verifiability.
23. Wikipedia. *Wikipedia:Manual of Style/Medicine-related articles*. [cited 2022, April 27; Available from: https://en.wikipedia.org/wiki/Wikipedia:Manual_of_Style/Medicine-related_articles.
24. Wikipedia. *Wikipedia:Conflict of interest*. 11.01.2022 [cited 2022 16.01.2022]; Available from: https://en.wikipedia.org/wiki/Wikipedia:Conflict_of_interest.
25. Wikipedia. *Wikipedia:Why not create an account?* 07.01.2022 [cited 2022 16.01.2022]; Available from: https://en.wikipedia.org/wiki/Wikipedia:Why_not_create_an_account%3F
26. Halfaker, A., A. Kittur, and J. Riedl, *Don't bite the newbies: how reverts affect the quantity and quality of Wikipedia work*, in *International Symposium on Wikis*. 2011, ACM. p. 163-172.
27. Wikipedia. *Help:Watchlist*. 07.11.2021 19.01.2022]; Available from: https://en.wikipedia.org/w/index.php?title=Help:Watchlist&action=history.
28. de Laat, P.B., *The use of software tools and autonomous bots against vandalism: eroding Wikipedia's moral order?* Ethics and information technology, 2015. **17**(3): p. 175-188.
29. Wikipedia. *Wikipedia:User access levels*. 10.01.22 16.01.22]; Available from: https://en.wikipedia.org/wiki/Wikipedia:User_access_levels
30. Wikipedia. *Wikipedia:Administrators*. 14.01.2022 [cited 2022 16.01.2022]; Available from: https://en.wikipedia.org/wiki/Wikipedia:Administrators.
31. Wikipedia. *Wikipedia:Bureaucrats*. 12.01.2022 [cited 2022 16.01.2022]; Available from: https://en.wikipedia.org/wiki/Wikipedia:Bureaucrats.
32. Wikipedia. *Wikipedia:Requests for adminship*. 05.01.2022 [cited 2022 16.01.2022]; Available from: https://en.wikipedia.org/wiki/Wikipedia:Requests_for_adminship#About_RfB.
33. Wikipedia. *Users*. 16.01.2022 [cited 2022 16.01.2022]; Available from: https://en.wikipedia.org/wiki/Special:ListUsers/bureaucrat
34. Wikipedia. *Wikipedia:Autopatrolled*. 30.12.2021 [cited 2022 16.01.2022]; Available from: https://en.wikipedia.org/wiki/Wikipedia:Autopatrolled.
35. Wikipedia. *Wikipedia:Protection policy*. 07.01.2022 [cited 2022 16.01.2022]; Available from: https://en.wikipedia.org/wiki/Wikipedia:Protection_policy#Extended_confirmed_protection.
36. Niederer, S. and J. van Dijck, *Wisdom of the crowd or technicity of content? Wikipedia as a sociotechnical system.* New Media & Society, 2010. **12**(8): p. 1368-1387.
37. Steiner, T. *Bots vs. Wikipedians, Anons vs. Logged-Ins (Redux): A Global Study of Edit Activity on Wikipedia and Wikidata*. in *The International Symposium on Open Collaboration*. ACM.

38. Czarniawska, B., *Common Knowledge? An Ethnography of Wikipedia, Dariusz Jemielniak. Stanford University Press, Stanford, CA (2014), 293 pp.* Scandinavian Journal of Management, 2014.

39. Ioannides, Y.M., *A Review of Scott E. Page's The Difference: How the Power of Diversity Creates Better Groups, Firms, Schools, and Societies.* Journal of economic literature, 2010. **48**(1): p. 108-122.

40. Kaur, R., et al., *Human opinion dynamics: An inspiration to solve complex optimization problems.* Sci Rep, 2013. **3**(1): p. 3008-3008.

41. Wikipedia. *Wikipedia:Lamest edit wars*. [cited 2022, April 27; Available from: https://en.wikipedia.org/wiki/Wikipedia:Lamest_edit_wars.

42. Borra, E., et al. *Contropedia - the analysis and visualization of controversies in Wikipedia articles*. in *The International Symposium on Open Collaboration*. ACM.

43. Kriplean, T., et al. *Community, consensus, coercion, control: csw or how policy mediates mass participation*. in *Conference on Supporting Group Work*. ACM.

44. Wikipedia. *Wikipedia:Dispute resolution*. 11.12.2021 [cited 2022 16.01.2022]; Available from: https://en.wikipedia.org/wiki/Wikipedia:Dispute_resolution

45. Kittur, A., et al. *He says, she says: conflict and coordination in Wikipedia*. in *Conference on Human Factors in Computing Systems*. ACM.

46. Wikipedia. *Wikipedia:Blocks and bans*. 15.12.2021 [cited 2022 16.01.2022]; Available from: https://simple.wikipedia.org/wiki/Wikipedia:Blocks_and_bans

47. Wikipedia. *Wikipedia:Administrators' guide/Protecting*. 2022 11.11.2021 [cited 2022 16.01.2022]; Available from: https://en.wikipedia.org/wiki/Wikipedia:Administrators%27_guide/Protecting.

48. Wikipedia. *Wikipedia:WikiProject Pharmacology*. 20.09.2021 [cited 2022 16.01.2022]; Available from: https://en.wikipedia.org/wiki/Wikipedia:WikiProject_Pharmacology.

49. Wikipedia. *Pharmacology articles - FA quality*. [cited 2022 16.01.2022]; Available from: https://wp1.openzim.org/#/project/Pharmacology/articles?quality=FA-Class.

50. Wikipedia. *Wikipedia:WikiProject Council/Guide*. 22.04.2021 [cited 2022 16.01.2022]; Available from: https://en.wikipedia.org/wiki/Wikipedia:WikiProject_Council/Guide#Tagging_pages_with_WikiProject_banners

51. Wikipedia. *Wikipedia:WikiProject Pharmacology/Assessment*. 19.11.2021 [cited 2022 16.01.2022]; Available from: https://en.wikipedia.org/wiki/Wikipedia:WikiProject_Pharmacology/Assessment.

52. Wikipedia. *Wikipedia:Content assessment*. 16.12.2021 [cited 2022 16.01.2022]; Available from: https://en.wikipedia.org/wiki/Wikipedia:Content_assessment.

53. Pinsker, J. *THE COVERT WORLD OF PEOPLE TRYING TO EDIT WIKIPEDIA—FOR PAY*. [Newspaper article] 2015 11.08.2015 [cited 2022 17.01.2022]; Available from: https://www.theatlantic.com/business/archive/2015/08/wikipedia-editors-for-pay/393926/.

54. McCall, T., C. Cole, and A. Dailey, *Vertebroplasty and kyphoplasty: a comparative review of efficacy and adverse events.* Curr Rev Musculoskelet Med, 2008. **1**(1): p. 17-23.

55. Firanescu, C.E., et al., *Vertebroplasty versus sham procedure for painful acute osteoporotic vertebral compression fractures (VERTOS IV): Randomised sham controlled clinical trial.* BMJ, 2018. **361**(361): p. k1551-k1551.

56. Robinson, Y. and C. Olerud, *Vertebroplasty and kyphoplasty—A systematic review of cement augmentation techniques for osteoporotic vertebral compression fractures compared to standard medical therapy.* Maturitas, 2012. **72**(1): p. 42-49.

57. Wikipedia. *Wikipedia:Policies and guidelines*. [cited 2022, April 28; Available from: https://en.wikipedia.org/wiki/Wikipedia:Policies_and_guidelines.

58. Wikipedia. *XTools*. 03.01.2022 20.01.2022]; Available from: https://www.mediawiki.org/wiki/XTools.

59. Wikipedia. *XTools/Edit Counter*. 01.10.2021 20.01.2022]; Available from: https://www.mediawiki.org/wiki/XTools/Edit_Counter.

60. Wikipedia. *XTools/Simple Counter*. 08.05.2021 20.01.2022]; Available from: https://www.mediawiki.org/wiki/XTools/Simple_Counter.

61. Brereton, B., N. Hurley, and Dkit, *Review of Prell C. (2012) Social Network Analysis: history, theory and methodology Los Angeles, London, New Delhi, Singapore, Washington DC, Sage Publications Ltd*. 2014.

62. Faust, K. *Comparing Social Networks: Size, Density, and Local Structure*. 2006.

63. India, G.o., *Annual report 2020-21*, D.o. pharmaceuitcals, Editor. 2021.

64. The Washington Post. *India's low pharma costs are good for drug companies, good for consumers*. [cited 2022, April 28; Available from: https://www.washingtonpost.com/sf/brand-connect/makeinindia/indias-low-pharma-costs-are-good-for-drug-companies-good-for-consumers/.

65. The New York Times. *Wikipedia and W.H.O. Join to Combat Covid-19 Misinformation*. [cited 2022, April 28; Available from: https://www.nytimes.com/2020/10/22/health/wikipedia-who-coronavirus-health.html

66. Wikipedia. *Wikipedia:WikiProject COVID-19*. [cited 2022, April 28; Available from: https://en.wikipedia.org/wiki/Wikipedia:WikiProject_COVID-19.

Appendix

Appendix A: Multivariate analysis; logistic regression performed to predict the chance of an article having affiliation.

```
Logistic regression                              Number of obs =     103
                                                 LR chi2(20)   =   32.88
                                                 Prob > chi2   =  0.0347
Log likelihood = -16.377589                      Pseudo R2     =  0.5010
```

Affiliation	Odds ratio	Std. err.	z	P>|z|	[95% conf. interval]	
Lengthofarticlebyte	1.000073	.0001538	0.48	0.634	.999772	1.000375
Totaleditors	1.010966	.0350502	0.31	0.753	.9445509	1.082051
Totalwatchers	1.000221	.0011124	0.20	0.842	.9980435	1.002404
NumberofIpadresses	1.101491	.06558	1.62	0.104	.9801722	1.237825
Totalbotedits	1.203386	.1194203	1.87	0.062	.9906819	1.461758
Totalrevertededits	.921744	.0826305	-0.91	0.363	.7732211	1.098796
AgeYear	.8174892	.2055859	-0.80	0.423	.4993649	1.338277
Firsteditbyte	.9999421	.0002401	-0.24	0.809	.9994717	1.000413
Totalrefrences	1.053087	.055986	0.97	0.331	.9488799	1.168738
Totalmajoredits	.9526169	.0318732	-1.45	0.147	.8921509	1.017181
Dailyavarage	.9928239	.0082544	-0.87	0.386	.9767766	1.009135
Cat_watchers						
under30	76.91618	175.82	1.90	0.057	.8715369	6788.123
under100	1	(base)				
under200	.3399934	1.497062	-0.25	0.806	.0000607	1903.224
under500	1	(empty)				
over500	2.15e+07	4.51e+10	0.01	0.994	0	.
quality_num						
B	1.95e-11	4.10e-08	-0.01	0.991	0	.
C	1.148871	2.452357	0.07	0.948	.0175111	75.37536
start	3.381037	6.806052	0.61	0.545	.0653996	174.7933
stub	1	(base)				
Importance_num						
???	1	(base)				
high	2.568522	6.901451	0.35	0.726	.0132605	497.5154
low	2.707331	7.417474	0.36	0.716	.0126021	581.6222
mid	2.380003	4.641855	0.44	0.657	.0520512	108.8238
_cons	.0001072	.0005032	-1.95	0.052	1.08e-08	1.065292

Note: **_cons** estimates baseline odds.
Note: 19 failures and 0 successes completely determined.

Appendix B: Organized raw data collected from 13 editors with an affiliation for the content analysis.

Editor 1 (registered user):

Article name: Econazole

"In Bangladesh it is sold under the brand name Ecoderm manufactured by Rephco Pharmaceuticals. The combination of Econazole Nitrate with Triamcinolone acetonide is also available under the brand name Ecoderm"

Editor 2 (Ip-address):

Article name: Metamizole

"United Kingdom: "Algozone" (Ozone laboratories, 180 Tottenham Court Road, Queens House, W1T7PD, London, UK"

Editor 3 (Ip-address):

Article name: Cefadroxil

""Duricef", Pakistan"

Editor 4 (Ip-address):

Article name: Cefadroxil

" ""Arocef" (Eskayef Bangladesh Limited), Bangladesh"

Editor 5 (registered user):

Article name: Bosentan

"[http://www1.actelion.com/en/index.page] ... http://www.tracleer.com/]"

Editor 6 (Ip-address):

Article name: methotrexate

"In Bangladesh there is only one manufacturer of methotrexate with the brand name Methotrax. They only manufactures it in oral solid dosage form (2.5 mg and 10 mg tablet. They promote the drug only in rheumatoid arthritis, ankylosing spondylitis and psoriasis.<ref>http://www.deltapharmabd.com</ref>" (2009)

"(Brand name Methotrax in Bangladesh by Delta Pharma Limited)… Now Methotrexate is marketing worldwide."

Editor 7 (Ip-address):

Page name: Teriparatide's talk page

"… I am Senior (personal information) at Radius Health, Inc., a biopharmaceutical company based out of Waltham, MA. I'm here to flag misinformation that is currently included on the Teriparatide page.

I am aware of Wikipedia's policies and guidelines, including those on WP:COI, WP:RS, WP:V and WP:NPOV, and I will abide by them. My edit suggestions will be restricted to Talk pages, and I will not engage in directly editing any teriparatide-related article…

If you have any questions about my editing activities, please leave me a message on my User Talk page… "

"Medical use: Teriparatide is the only anabolic (i.e., bone growing) agent[1] indicated for use in postmenopausal women with osteoporosis at a high risk for fracture or with a history of osteoporotic fracture, patients with multiple risk factors for fracture, and for patients who have failed or are intolerant to other available osteoporosis therapy.[4] It has been FDA-approved since 2002.[5] It is effective in growing bone (e.g., 8% increase in bone density in the spine after one year)[6] and reducing the risk of fragility fractures.[5][7] Osteoporosis medications are generally safe, but some side effects of teriparatide include headache, nausea, dizziness, and limb pain.[5]"

" revised: *Updating the first sentence of the first paragraph under the "Medical uses" section to correct the fact that there is now more than one anabolic agent approved for the treatment of postmenopausal women with osteoporosis"

"medical use: Teriparatide is one of two available [[anabolic]] (i.e., bone growing) agents[1]<ref>{{cite web|url=https://www.accessdata.fda.gov/drugsatfda_docs/label/2017/208743lbl.pdf | title=TYMLOS Prescribing Information | publisher=fda.gov | accessdate=2017-09-06}}</ref> indicated for use in postmenopausal women with osteoporosis at a high risk for fracture or with a history of osteoporotic fracture, patients with multiple risk factors for fracture, and for patients who have failed or are intolerant to other available osteoporosis therapy.[4] It has been [[FDA]]-approved since 2002.[5] It is effective in growing bone (e.g., 8% increase in bone density in the spine after one year)[6] and reducing the risk of fragility fractures.[5][7] Osteoporosis medications are generally safe, but some side effects of teriparatide include headache, nausea, dizziness, and limb pain.[5]"

Editor 8 (registered user):

Article name: Teriparatide

"... and biosimilar form of it "CinnoPar" [reference] [CinnaGen] company]"

" CinnoPar<ref>http://www.cinnagen.com/index.php/our-products/human-medicines/cinnopar</ref>"

Editor 9 (registered user):

User pager of editor 9:

" ..I am working as a Medical Advisor at Boehringer Ingelheim GmbH in Germany. My intent is to provide information to the editors of Wikipedia for their use in Boehringer Ingelheim related pharmaceutical articles to help ensure that Wikipedia users received accurate and balanced information… I understand the main Wikipedia Policies and Guidelines… I will try to never directly edit any Boehringer Ingelheim related article and as an alternative I hope to enlist the help of other users to assess my suggestions for improved content"

Article name: Nintedanib:

" I would like to propose the following updates to the Nintedanib Wikipedia entry … to ensure the content is up-to-date and reflects the current regulatory status of nintedanib"

"As currently noted, nintedanib is approved by the FDA for the treatment of idiopathic pulmonary fibrosis under the trade name Ofev®. Also, the CHMP provided a positive opinion for the approval of nintedanib in IPF in the European Union.
(www.fda.gov/NewsEvents/Newsroom/PressAnnouncements/ucm418994.htm;
http://www.ema.europa.eu/ema/index.jsp?curl=pages/medicines/human/medicines/0

03821/smops/Positive/human_smop_000760.jsp&mid=WC0b01ac058001d127   ).
Regulations dictate that the Ofev® brand name – which also relates to the particular dosage of nintedanib for use in IPF – only be linked with this disease. In November Vargatef® received approval from the European Commission for the treatment of non-small cell lung cancer (NSCLC) (www.ema.europa.eu/ema/index.jsp?curl=pages/medicines/human/medicines/002569/smops/Positive/human_smop_000727.jsp&mid=WC0b01ac058001d127).   The brand name Vargatef® is only associated with NSCLC. I have provided some suggested wording amendments to the entry for nintedanib to make this important distinction clear to readers."

"As noted, the recent FDA approval of nintedanib (Ofev®), and positive opinion from the CHMP, for the treatment IPF would suggest the need for further details on the disease and relevant clinical trials. I have provided suggested wording to provide a brief overview of these points following a similar format to the existing content.

I would be grateful for any further guidance you may be able to offer to bring the nintedanib entry up-to-date and to clarify any perceived inaccuracies"

" Nintedanib (trade name, Vargatef® in NSCLC, Ofev® in IPF) is a small molecule tyrosine kinase inhibitor (TKI) developed by Boehringer Ingelheim for the treatment of lung cancer patients with advanced adenocarcinoma and patients with idiopathic pulmonary fibrosis (IPF). Nintedanib inhibits the receptors for vascular endothelial growth factor (VEGF), fibroblast growth factor (FGF) and platelet derived growth factor (PDGF) which are involved in the formation and maintenance of new blood vessels (angiogenesis) and signalling pathways of fibrotic processes.[18][19][20] "

Nintedanib is approved in the EU under the brand name Vargatef® for use in combination with docetaxel in adult patients with locally advanced, metastatic or locally recurrent NSCLC of adenocarcinoma tumour histology after first-line chemotherapy. It is also approved for the treatment of idiopathic pulmonary fibrosis (IPF) in the USA under the trade name Ofev®. Ofev® received a positive opinion from the European Medicines Agency's Committee for Medicinal Products for Human Use

(CHMP) on 20 November 2014. Nintedanib is also under investigation in a number of other solid cancers including hepatic cell carcinoma, mesothelioma and colorectal cancer."

"Mechanism of action

Nintedanib targets growth factor receptors, which have been shown to be involved in the mechanisms by which pulmonary fibrosis occurs. Most importantly, nintedanib inhibits receptors for platelet-derived growth factor (PDGF), fibroblast growth factor (FGF) and vascular endothelial growth factor (VEGF).[18] [19] [20] By blocking these signaling pathways involved in fibrotic processes, it is believed that nintedanib reduces disease progression in IPF by slowing the decline of lung function. [18] [19] [20]

1.3 Clinical studies

The clinical efficacy and safety of nintedanib in IPF has been established in 1,231 patients with IPF in one Phase II clinical trial (TOMORROW) and two replicate Phase III clinical trials, INPULSIS®-1 and -2.[18][21] These were double blind, randomised and placebo-controlled trialscomparing treatment with nintedanib 150 mg twice daily to placebo for 52 weeks. The INPULSIS® trials were identical in design and patients were randomised with a 3:2 ratio to nintedanib and placebo, the TOMORROW trial was similar in design but also included other treatment arms (dose finding study) in addition to treatment with 150 mg twice daily.[18][21][22]

Results from INPULSIS®-1 –and -2 show nintedanib slows disease progression by reducing the annual rate of decline in lung function by approximately 50%. The treatment effect on FVC was consistent across all 3 studies.[23] The TOMORROW and INPULSIS®-2 trials also met both secondary endpoints – results demonstrate there was significantly less deterioration in quality of life (measured by the St. George's Respiratory Questionnaire - SGRQ), and a reduced risk of a first acute

exacerbation in patients taking nintedanib versus placebo. In the INPULSIS®-1 trial there was no difference between the treatment groups for these key secondary endpoints. [18][22].

2.2 Adverse events

In INPULSIS®, the most common adverse events with nintedanib* were gastrointestinal, generally manageable and of mild to moderate intensity, rarely leading to treatment discontinuation.[22]

•   Diarrhoea was the most common adverse event experienced in 62% of patients treated with nintedanib versus 18% in patients in the placebo groups[22]

•   Less than 5% of patients discontinued treatment due to diarrhoea events[22]

•   In those patients who experienced diarrhoea, 95% of events were mild to moderate in intensity[22]

The proportion of patients with serious adverse events was similar in both treatment groups. [22]

More than 90% of eligible patients who participated in the INPULSIS® trials opted to continue with nintedanib treatment as part of an open-label extension trial.[24]"

Editor 10 (Ip-address and article creator):

Article name: Adalimumab:

"Humira is a fully human TNF-alfa inhibitor, for the treatment of moderate to severe Reumatoid arthritis. Humira's manufacturer is Abbott Labs."

Editor 11 (registered user):

    Article name: Adalimumab:

*"Exemptia is world's first biosimilar of Adalimumab launched by Cadila
Healthcare also known as Zydus Cadila<ref>{{Cite
web|url=http://www.exemptia.com|title=Adalimumab {{!}} Exemptia {{!}}
Exemptia Adalimumab {{!}} Adalimumab India {{!}} Adalimumab
Biosimilar|website=www.exemptia.com|access-date=2016-03-10}}</ref>."
(2016)*

Editor 12 (registered user):

    Article name: Pirfenidone

*"The Active Pharmaceutical Ingredient is now made by an Indian company Aarambh
Life Science too. http://www.aarambhlifescience.com/Factory.html"*

Editor 13 (Ip-address):

    Article name: Apremilast

      "& Aplex in India. (Ajanta Pharma)"