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Detecting Signals of Associations between Dietary Supplement Use and Mental Disorders from Twitter

Yefeng Wang,

Institute for Health Informatics, University of Minnesota, Minneapolis, MN, wang4688@umn.edu

Yunpeng Zhao,

Department of Health Outcomes and Biomedical Informatics, University of Florida, Gainesville, Florida, yup111@ufl.edu

Jiang Bian,

Department of Health Outcomes and Biomedical Informatics, University of Florida, Gainesville, Florida, bianjiang@ufl.edu

Rui Zhang

Institute for Health Informatics, and College of Pharmacy, University of Minnesota, Minneapolis, MN, zhan1386@umn.edu

Abstract

In this study, we attempted to detect signals of association between dietary supplement use and mental disorders from Twitter. We collected tweets ranging from 2016 to 2017 which mention five dietary supplements. A case cohort of 257 users were identified by adapting a natural language processing method with further manually verified to have taken one supplement. We then randomly selected 257 users who had not taken any dietary supplement as the control cohort and compared the sentiment and mental health signals of their tweets to the case cohort. We have observed significant differences in the sad, anxious, and negative sentiment between the two cohorts. These results have shown that Twitter is a potential source for detecting signals of association between dietary supplement use and anxiety disorders, depression, and mood disorders.

Keywords

mental health signals; social media; Twitter; natural language processing

I. INTRODUCTION

The incidence of mental disorders is higher in the US where 25% of adult Americans have been diagnosed with at least one mental disorder [1]. Most of the mental disorders are typically treated with prescription drugs; for example, bipolar disorder is typically treated by lithium; however, these drugs are not always effective and may cause serious adverse reactions [1, 2], which forces patients to resort to dietary supplements including melatonin, St. John's wort, kava, ginkgo biloba, and Ginseng [3].

Approximately 65% of American adults use social media like Facebook and Twitter to get and share health-related information [4]. Social networking sites allowing users to record and share their daily life with friends have been used to investigate the mental disorders. Previously, De Choudhury et al. explored the depression prediction potential of Twitter. The study also took antidepressant usage into account, but the effect of dietary supplement use was not considered [5]. Coppersmith et al. looked into the difference of Twitter usage behavior between the users that have self-diagnosed mental disorders and control group users [6, 7]. While these studies put more emphasis on analyzing the language using patterns in the tweets, the influence of dietary supplement use among mental disorders group has been overlooked. Motivated by these facts, in this study, we investigated the association between mental disorders and dietary supplement in Twitter. We collected the Twitter timeline of the users who posted about using dietary supplements that have mental disorders indications. We then compared the frequency of mental disorder keyword mentions and the sentiment in the tweets posted before and after supplement use.

II. METHODS & RESULTS

A. Tweet Collection and Supplement Use Cohort Identification

We searched tweets posted from 2016 to 2017 over a tweet database that contains over 1.57 billion English tweets [8] on 5 supplement ingredients and their lexical variants retrieved from the Unified Medical Language System (UMLS) Metathesaurus (version 2017AB), i.e. melatonin, St. John's wort, kava, ginkgo biloba, and ginseng.

A rule-based NLP system based on our previous study [9] were adapted to detect supplement use status on the collected tweets. This results in 1,802 tweets from 1,712 users that are likely to contain supplement use information. The subset of the tweets was further annotated by two annotators to confirm the dietary supplement use status of the Twitter users. The Cohen's Kappa is 0.94 for the annotation of 100 randomly selected tweets on whether the user has taken supplements. For further longitudinal analysis, we further eliminated our study to users who posted their supplement use within 3,200 most recent tweets. This finally results in 257 users as our case cohort, including 251 taken melatonin. We randomly selected 257 users from the annotated dataset who have not used any supplement as the control group.

B. Sentiment and Mental Health Signal Comparison

We selected a set of keywords representing mental health issues from the ADR lexicon [10]. We tallied the most frequently mentioned mental disorder keywords within the timeline of the case cohort and found that anxiety disorders, depression, and mood disorders were the most common mental health disorders.

We used Linguistic Inquiry and Word Count (LIWC) [11] to quantify the difference in mental health signals between the case and the control cohort. We chose to compare the positive, negative, anger, anxiety, and sad emotions reflected by the tweets. The positive and negative emotions indicate the general emotional states of the user, while the anger, anxiety, and sad emotions can be regarded as specific mental health signals of anxiety disorder,

depression, and mood disorders of the user. As shown in Figure 1, the users in both cohorts expressed similar amount of positive emotions, but the case cohort that had taken supplements expressed more negative sentiment. Especially, these users used words that expresses anger, anxiety, and sadness more frequently than the users in the control group. The result suggested that the users that had taken melatonin are more likely to have anxiety disorders, depression, and mood disorders than the users that have not taken any dietary supplement.

III. DISCUSSION

This study attempted to detect signals of sentiment (i.e. positive and negative) and mental health signals (i.e. anger, anxiety, and sad emotions) from the tweets of dietary supplement users. We found that melatonin users expressed anger, anxiety, and sadness more frequently. This is consistent with the fact that melatonin secretory pattern variations are closely related to mental disorders [12]. This suggests that Twitter can be used to find potential associations between dietary supplement use and mental disorders, but further investigation via clinical trials is still required.

This study has a few limitations. We only looked into 5 dietary supplements, and the majority (251 out of 257) Twitter users in the cohort reported melatonin usage. Also, few tweets mentioned the usage of the herbal supplements, St. John's wort, kava, ginkgo biloba, and ginseng. Therefore, we will also investigate the effect of other commonly used dietary supplements such as serotonin (5-hydroxytryptamine), omega-3 fatty acid, and multivitamins in the future [1, 3]. Another limitation is the size of our current cohorts. A feasible solution is to retrace each user's timeline with our tweet database instead of using the Twitter search API.

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Fig. 1. Boxplot of word count percentage of LIWC emotional categories on the case and the control group. The p -value of the independent t -tests was appended for each column. The word count percentage difference in negative, anxiety, sad emotion category was statistically significant.