Communicating diabetes and diets on Twitter – a semantic content analysis

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Abstract: This paper analyses: 1) the semantic content of tweets discussing diabetes and diets: 2) the conversational connections of those tweeting and those being mentioned in the tweets. The content analysis of the tweets aims at mapping what kinds of diets are mentioned in conversations about diabetes and in what context. Our data consists of 9,042 tweets containing the words 'diabetes' and 'diet'. The findings indicate that analysing Twitter conversations can be a fruitful and an efficient way to map public opinions about diabetes and diets, as well as other medical issues that concern many people. The results also showed that many private persons act as diabetes advocates spreading information and news about diabetes and diets. Surveying these topics can be useful for healthcare practitioners; as these are in contact with patients with diabetes, it is important that they are aware of both the most discussed topics and the most common information sources, who are often laymen.

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1   Introduction

The rapid increase of the worldwide prevalence of diabetes has been called epidemic (Bonow and Gheorghiade 2004), even a 'silent pandemic' (Shaw and Tanamas, 2012). Estimates suggest that diabetes was the fifth leading cause of death globally in the year 2000 (Roglic et al., 2005). According to Shaw and Johnson (2011) diabetes is the sixth leading cause of death in the USA. It has also been projected that from 2010 to 2030, there will be a 69% increase in numbers of adults with diabetes in developing countries and a 20% increase in developed countries, respectively (Shaw et al., 2010). In Finland, a good 8% of the adult population has diabetes, and an additional 9% of the population suffers from impaired glucose tolerance, i.e., prediabetes (International Diabetes Federation, 2009). In the USA, over 24 million people have diabetes (Shaw and Johnson, 2011) and as many as 79 million people have prediabetes, representing more than one-third of the adult population and half of people aged over 64 years (Bergman, 2013). Their risk of developing type 2 diabetes is estimated to be 4–12 times higher than it is for people with normal glucose tolerance (Albright and Gregg, 2013). Attempts to tackle this development are, hence, needed, and as communication plays a crucial role in influencing people's attitudes and behaviour, the role of information and communication related to

diabetes is an important topic, nonetheless information and communication in social media.

Social media as a term came along around 2005 [Lietsala and Sirkkunen, (2008), p.17]. In social media people share content such as videos, text, and multimedia, that is, content they have made themselves, or content brought from somewhere else [Lietsala and Sirkkunen, (2008), p.19]. Social media can be divided into the following genres: content creation and publishing tools (e.g., blogs), content sharing (e.g., Flickr, YouTube), social networks (e.g., Facebook, LinkedIn), collaborative productions (e.g., Wikipedia), virtual worlds (including for instance social virtual worlds like Second Life and game-like virtual worlds like World of Warcraft), and add-ons (e.g., Google Maps) [Lietsala and Sirkkunen, (2008), p.26]. Social media are speeding up the communication and they enable communication from one to many or from many to many, instead of the earlier one-to-one communication particularly in healthcare (Hawn, 2009). In social media online health communication is dynamic, in contrast to static as traditional health-related websites are, and offers users with certain conditions the benefit to learn about the condition, and to receive support from others with similar experiences (Greene et al., 2010). Bender et al. (2011) found that Facebook has become a popular tool for awareness raising, fundraising, and support seeking concerning breast cancer. Social networking communities enable people to share their knowledge and experience, and thus create a rich array of user-generated content. In fact, peers are now important sources of information (Scanfeld et al., 2010). Antheunis et al. (2013) studied patients and professionals in gynecology and obstetrics and found that patients mainly used Twitter (59.9%) for increasing knowledge and exchanging advice and Facebook (52.3%) for social support and exchanging advice. Professionals used LinkedIn (70.7%) and Twitter (51.2%) for communication with colleagues and marketing. There were, however, also barriers to use social media for health related purposes. Patients' barriers to use social media were privacy concerns and unreliable information whereas professionals' barriers were that social media are thought to be insufficient in the way that they put an extra burden of time and resources on the professional, and a perceived lack of skills.

It has been argued that social networks could become central to future healthcare delivery. Currently, health information from networks complements traditional sources, but social networks have the potential to change patterns of health inequalities and access to healthcare (Griffiths et al., 2012). It has been claimed that e-health and social media are a way to a more patient-centred healthcare system (Hawn, 2009). Social networking tools offer the potential of supported learning, networking with peers, families and friends, or sharing problems, processes and outcomes with a global community (Pulman, 2009). There are, furthermore, suggestions that social media, not the least Twitter, could be an effective disease surveillance tool (Stoové and Pedrana, 2014; Chew and Eysenbach, 2010; Signorini et al., 2011).

One of the most important factors associated with our well-being is our diet. This is even more important concerning people with diabetes, who usually need to apply restrictions to their diet. A healthy low-calorie, low-fat diet, together with physical activity and behaviour modifications, is usually enough to help prevent the onset of type 2 diabetes and can decrease the severity of diabetes complications among those who are already ill (Shaw and Johnson, 2011). Diets can be sensitive to vagaries of fashion (Fakih et al., 2014; Lee et al., 2013); and as especially social networks spread information (and misinformation) rapidly and widely, it is important to be aware of the nature of

discussions about this matter. Scanfeld et al. (2010) claim that especially healthcare professionals should have basic understanding of the nature of the health information that is shared on Twitter.

The aim of this paper is to analyse:

1   the semantic content of tweets discussing diabetes and diets

2   the conversational connections of those tweeting and those being mentioned in the tweets.

With this we will better understand how and in what context diabetes and diets are discussed online and what parties are involved in that discussion.

2   Twitter and health information

Evermore researchers have started to show interest in health-related content on social media, especially as information sources for groups of patients (e.g., Pulman, 2009). Twitter, as a particular type of social media, enables rapid, global communications between people with shared interests and information dissemination to a wider audience. On Twitter users can create and exchange user-generated content with a potentially larger audience than, for example, Facebook or Myspace which are more designed for social networking rather than information sharing (Prier et al., 2011). Because the messages sent on Twitter, the tweets, are limited to a maximum of 140 characters the users do not need to put much effort in creating content and updates can be more frequent than for traditional blog posts (Pulman, 2009). As such, Twitter has become a popular platform for conversations about health conditions, diseases, and medicines (e.g., Prieto et al., 2014) and it could, furthermore, provide an effective information channel for practitioners to provide relevant information (Pulman, 2009). It has been argued that as Twitter gives the opportunity to reach a vast population in real time independent of geographical location, it should be utilised more for health promotion by authorities. Through Twitter healthier lifestyles and adherence to treatment might be promoted, as well as knowledge about diseases could be increased (Carrillo-Larco, 2012). Although tweets are limited to 140 characters, they can include links to websites with more detailed information (Redfern et al., 2013). A study on swine flu tweets showed that as many as 90% of all tweets contained references to the information they provided (Chew and Eysenbach, 2010). Antheunis et al. (2013) found that patients mainly used Twitter to stay updated on new developments in healthcare (52%), increase knowledge on one's disease (39%), express emotions (30%), and compare with other patients (30%). Twitter was, furthermore, the most used social media (by 18% of patients) for doctor-patient communication, followed by Facebook (by 10% of patients).

Mining of Twitter data provides a snapshot of the public's opinions and behavioural responses. If monitoring of Twitter communications is done longitudinally, it would allow identification of changes in opinions or responses. The analyses allow health authorities to become aware of and rapidly respond to concerns that the public raises (Chew and Eysenbach, 2010). Monitoring tweets might provide cost effective and quick health status surveillance, as the health related tweets are created and shared in realtime, possibly including people who will not seek medical help and hence would not appear in any statistics. Health-related content on Twitter does provide both public and relevant

health-related data that may allow tailoring of health interventions more effectively. Health-related behaviours like tobacco use can be identified and measured over certain periods of time (Prier et al., 2011). Heaivilin et al. (2011) investigated the contents of 1,000 tweets about dental pain from seven non-consecutive days. They found that Twitter users shared information about dental pain and actions taken against it extensively. The most common categories were general statements of dental pain (83%), actions taken in response to toothache (22%), and impact on daily life (15%). They conclude that dental professionals need to act in order to be among those giving persons suffering from toothache advice. Scanfeld et al. (2010) reported a content analysis of tweets in order to determine the main categories of content mentioning antibiotics and to explore cases of misunderstanding and misuse. Eleven categories were determined: advertisements, advice/information, animals, cost, diagnosis, general use, other, positive feedback, resistance, side effects/negative reactions, and wanting/needing. Later a category labelled misunderstanding and/or misuse was added to replace advertisements. The researchers found that Twitter is a space for informal sharing of health information and advice. Antibiotics were most commonly mentioned in the category 'general use', that included tweets about taking antiobiotics, followed by the category 'advice and information', that included references and links to news articles, with the category 'side effects/negative reactions' in third place. Tweets that were categorised as misunderstandings were often connected to the belief that antibiotics would help in the case of colds (Scanfeld et al., 2010).

Twitter has in recent years also been more commonly used in medicine. Medical journals, professional and biotech organisations, universities, politicians, and others have started to use this service. Medical journals can use Twitter to engage their audiences, those attending conferences can use Twitter to interact with each other, and doctors can use Twitter to interact with, for example, organisations or the media (Micieli and Micieli, 2012). The American Society of Nephrology has, furthermore, started to use social media, including Twitter, during its annual conference to inform and educate the public about kidney disease (Desai et al., 2012). Redfern et al. (2013) studied tweets of 15 Twitter accounts by professional organisations and scientific journals associated with cardiovascular medicine. Most of the contents were about health professional education (59%), followed by consumer education (19%), marketing (11%), social communication (6%), and fundraising (5%). They concluded that cardiovascular health information can be disseminated quickly, efficiently, and worldwide. Benefits are particularly relevant concerning promotional activities, awareness of health issues, and during scientific meetings. Dumbrell and Steele (2013) in their study on information tweeted by Australian health-related organisations, found that most of the health information was in the form of links to relevant sources. Concerning type of information, most (42.3%) of the tweets were public health awareness and public health advice dissemination. These were followed by organisational news and fundraising tweets.

Twitter has, furthermore, interested researchers as a source for disease surveillance especially during epidemics, such as in the case of Influenza A H1N1 (swine flu) in 2009 (Chew and Eysenbach, 2010; Signorini et al., 2011). Signorini et al. (2011) examined the use of information on Twitter to track rapidly-evolving public sentiment concerning the swine flu, and tracked and measured actual disease activity by collecting a sample of tweets from the end of April 2009. They concluded that Twitter-based surveillance can provide a complement to traditional disease-surveillance systems. Another type of

surveillance is connected to suggestions that Twitter could be used as a tool for monitoring of blood glucose through diabetes management systems (Pulman, 2009), or medication intake, where patients may register to a service reminding them to take their medications regularly (Scanfeld et al., 2010).

Twitter has a large potential of disseminating information through the networks of followers and the culture of retweeting, but this information can be both valid and invalid (Scanfeld et al., 2010). It has, in fact, been found that it is more common that health-related tweets link to news websites, than to sites of government and public health authorities (Chew and Eysenbach, 2010). Health-related content can, furthermore, have negative associations. The results of a study on Tobacco-related tweets show that Twitter is used to promote both positive and negative health behaviours (Prier et al., 2011). McNeil et al. (2012) explored how seizures are portrayed on Twitter by conducting a qualitative content analysis on seizure-related status updates and found that as many as 41% of tweets containing the words seizure or seizures were derogatory in nature, as they were either metaphorical or belonged to the category Ridicule/Joke. It seems that the issue is still largely associated with stigmatisation and Twitter can potentially propagate negative attitudes. There have also been other types of criticism against Twitter, including that there are a lot of tweets that say nothing of importance, that it is an asynchronous service that does not guarantee that individual tweets are read or responded to, and that it distracts frequent users and is time consuming. Privacy concerns have been put forward, as well (Pulman, 2009).

3   Diabetes and social media

Shaw and Johnson (2011) studied the online health information seeking behaviour of a group of diabetics in the USA, in order to see if they use social media and if they would be willing to use these sites to discuss health information. The 57 diabetics surveyed were quite active online users; 86% sought online health information, and 82% sought information about diabetes. Nearly 60% of the respondents did, furthermore, use social networking sites such as Facebook, 73% read online blogs, and about 50% watched YouTube, but less than 20% used Twitter. As many as 65% of the respondents, furthermore, said that they would be willing to discuss health information in an online environment such as chat rooms, discussion groups, or online support groups. There were over 500 diabetes related groups on Facebook. The results suggest that social media, in particular social networking sites like Facebook, may be an appropriate way to reach people to deliver diabetes education and to implement social support networking. Diabetes-specific online social networking sites do exist, but they do not have the same number of subscribers as for instance the diabetes related groups on Facebook (Shaw and Johnson, 2011).

Greene et al. (2010) conducted a content analysis of discussions about diabetes on Facebook in 2009 and found that the users were a diverse population of patients, family members, advertisers, and researchers, affecting the form of the posts. Most posts (66%) were information-providing and described the users' personal experiences with diabetes management, whereas 29% of the posts tried to provide emotional support. Promotional posts, often advertisements for 'natural' products, were the third most common category (27%). Nearly, a quarter of the posts shared aspects that the users probably did not want to share with their physicians. The researchers conclude that users gain interpersonal and

community support, access forms of specialised knowledge on diabetes management from peers, and can articulate positive but realistic self-images as diabetic individuals. According to Winston (2010), Twitter can encourage members of, for example, communities of diabetics to share experiential knowledge, such as their health stories. Through the process of sharing information members of these so-called end-user communities learn from one another as well as have an opportunity to develop themselves. Clinical knowledge, on the other hand, is shared by for instance hospitals and can include real time broadcasts of surgeries. Winston (2010) conducted a case study of a juvenile diabetic and found that experiential knowledge was the type that was mainly tweeted. This included reports on daily events, practical guides on how to take a blood sugar count, and problems to maintain sports activities.

One of the drawbacks of the amount of health information on the internet in general and social media in particular is that it can be inaccurate or misleading, and the information on social networking sites do not necessarily form any exception. Despite of high ratings, a website can be scientifically inaccurate (Lo and Purham, 2010). The study by Weitzman et al. (2011) on the quality and safety of diabetes-related social networks did, in fact, show varying quality. They studied the ten most frequently referenced social network sites on diabetes and found that only around half of the studied sites contained contents that were aligned with diabetes science or clinical practice recommendations. Safety, on the other hand, was mixed with gaps in external and internal review approaches. Despite internal safety review misinformation and advertisements for cures for diabetes were present. Technological safety was found poor, as well.

4   Aim and methods

The aim of this paper is to analyse

1   the semantic content of tweets discussing diabetes and diets

2   the conversational connections of those tweeting and those being mentioned in the tweets.

Methods that can be used to study social media information include mining, aggregating, and analysis of online textual data. Tweets can be used for content and sentiment analysis and knowledge translation research (Chew and Eysenbach, 2010). This study uses a content analysis of the tweets that aims at mapping what kind of diets are mentioned in conversations about diabetes and in what context (e.g., diets that help and diets that do not help and whether these follow the official guidelines). For mapping the most frequent conversational connections of those involved in the diabetes conversations (i.e., those sending the tweets and those being mentioned in the tweets) we will use methods from social network analysis to explore

a   the opinion leaders in the conversations

b   the sources mentioned in the messages.

Opinion leaders are those who are in a position to influence other tweeters' attitude and behaviour, as well as control the information flow in the network (Xu et al., 2015).

A total of 607,905 tweets containing the word 'diabetes' were collected via Twitter's Application Programming Interface (API) using Webometric Analyst (http://lexiurl.wlv.ac.uk/) between October 4 and November 6, 2013. These tweets were sent by 349,551 different tweeters. A total of 211,993 tweets contained a URL, linking to some other online location. A total of 9,042 contained the word 'diet'. Many of these mentioned 'diet' as some particular diet with weight loss as the target, while others referred to 'diet' as dietary that is habitually eaten. These tweets were sent by 6,116 different tweeters.

In order to analyse the semantic content of the tweets the frequently used noun phrases (i.e., word sequences of nouns and adjectives that end with a noun) were extracted from the tweets using VOSviewer (Van Eck and Waltman, 2010) and the semantic word map created from the co-occurrences of the noun phrases was visualised with Gephi (Bastian et al., 2009). To focus on the most frequently discussed topics related to diabetes and diets we filtered the word map by including only the noun phrases that were mentioned five or more times and that were connected to other noun phrases at least twice. This left us with a semantic network of 266 nodes (the noun phrases) that were connected to each other through 497 edges (co-occurrences). Using the built-in community detection algorithm in Gephi we visualised the local clusters in the map to see which noun phrases were tightly connected, and therefore, frequently mentioned together. In a similar fashion the conversational connections were extracted from the tweets (i.e., the usernames of the tweeters and those being mentioned in the tweets) and visualised with Gephi. To protect the identity of the parties involved in the diabetes communication on Twitter the resulting communication network is presented here without including any usernames.

5   Results

A total of 25 communities of tightly connected noun phrases were detected in the graph (Figure 1). These 25 clusters represent the very core of the Twitter communications about diabetes and diets. The resulting semantic map depicted in Figure 1 presents a decentralised image of the communications, indicating how the communication surrounding diabetes and diets is not focused around a single diet. Several different types or names of diets were mentioned in the tweets, including Cuban diet, low carb diet, low calorie diet, glycemic diet, alkaline diet, and bean diet.

Figure 1   Semantic map from the co-occurrences of the noun phrases in the tweets about diabetes and diets (resolution = 1, modularity = 0.917) (see online version for colours)

A closer look at the clusters and connections between the noun phrases reveal for instance a connection between 'gestational diabetes' and 'carb diet' in the Twitter conversations (Figure 2), however, the connection was mainly created due to a frequently tweeted article sent at @medpagetoday stating that:

> "Low Carb Diet Won't Help in Gestational Diabetes http://t.co/1loKmtqMLH @medpagetoday."

Figure 2   Noun phrases connected to 'carb diet' (see online version for colours)

From Figure 2, we can also see how 'carb diet' is also connected to many other words and noun phrases, some of which bring some added value to the analysis of online conversations about diets and diabetes, while others are too generic to have any meaning for the outcome of the analysis. The methodology automatically removes the so called stopwords from the analysed texts, but removing words that are meaningful per se but not meaningful for the analysis would require a more qualitative research design. The chosen methodology does nevertheless present its strength in summarising large amounts of data and illustrating the most frequent topics or themes in the online conversations.

Another example of frequently discussed topics is gastric bypass surgeries or bariatric surgeries:

> "Diabetes Improvements After Gastric Bypass Due to Diet: The finding is based on a prospective study of 10 pati... http://t.co/EMhQjUwClR."

Many of the thematic clusters in figure 1 were created due to frequent tweeting about news and new studies about a specific type of diet and its connection to diabetes. The most frequently retweeted tweet was however a recommendation by an American doctor and TV show host Dr. Mehmet Oz to prevent diabetes with vinegar:

> "rt @[DrOz] never too late to prevent diabetes, add teaspoon of vinegar to your diet daily to lower your blood sugar #OzTip."

This, and slight variations of it, were retweeted about 700 times among the over 9,000 tweets mentioning diabetes and diets. The impact of this particular advice is also apparent when looking at the most frequently used hashtags, as the hashtag #OzTip appeared in the tweets the second most times, following #diabetes as the top hashtag (Table 1). Hashtags can be considered as labels or titles that connect the tweet to a particular topic or give it context. Thus, analysing hashtags can give some information about the semantic context of the tweets. Apart from the two most frequently used hashtags most of the remaining hashtags in the top ten are connected to health aspects (e.g., #weightloss, #health, #obesity), while two, #soda and #dietsoda, are connected to frequent retweets about diet soda and its possible connection to diabetes:

> rt @organicconnect big soda secret how diet soda make you fat #dietsoda #soda #fat #unhealthy #diabetes

Table 1   The top ten most frequently used hashtags and the number of times they appeared in the tweets

Hashtag	*n*
#diabetes	1,370
#OzTip	712
#weightloss	175
#Health	138
#Soda	131
#Fat	130
#DietSoda	128
#Unhealthy	125
#diet	102
#obesity	78

The conversational connections were also mapped (Figure 3) and the in-degrees and out-degrees of the usernames were compared. This allowed us to map who the most frequently mentioned usernames were (in-degree) and who were mentioning other usernames most frequently (out-degree). Our assumption is that the tweeters that frequently mention other usernames, i.e., those with a high out-degree, are those that actively initiate conversations and that possibly function as diabetes advocates. While those that are frequently being mentioned by others, that is, have high in-degree, are frequently mentioned as sources of news or information and that are therefore in a position where they can influence what kind of information is shared and used. These connections and the different roles are illustrated in Figure 3.

Figure 3   Conversational connections in the diabetes communications on twitter (node size equals degree centrality, edge thickness equals number of connections (mentions) between the tweeters)
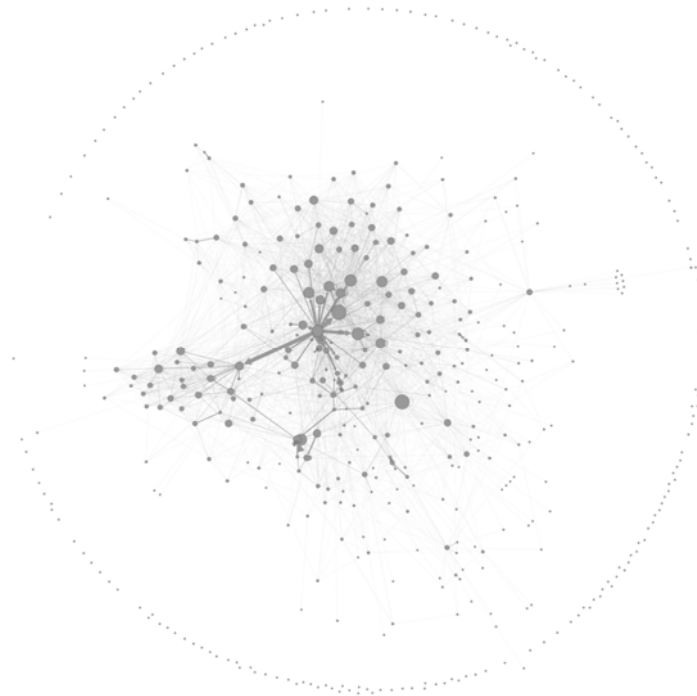
The strongest connections in Figure 3 are between @1Medical2News, an account tweeting and retweeting breaking medical news, and accounts that belong to a company specialised in medical technology (@EveryDayHealth, 366 mentions), a news sharing account from a company specialised in medical technology (@diabetesfacts, 288 mentions), and a UK-based charity organisation (@DiabetesUK, 200 mentions).

The Twitter accounts that were most frequently mentioned in the tweets, i.e., had the highest in-degree, were American Diabetes Association (in-degree = 82), Sanofi[1] USA Diabetes (80), Diabetes Mine[2] (60), JDRF Juvenile Diabetes Research Foundation (57), and Diabetes Hands Foundation[3] (56). The in-degrees for the remaining usernames were

less than 50. The two Twitter accounts with clearly highest out-degree (i.e., usernames that mentioned other usernames most frequently) were Divabetic (out-degree = 93), which is "a national non-profit organization that empowers women affected with diabetes to stay healthy and positive about their diabetes self-care management", and 1Medical2News (89), an account tweeting breaking medical news and information. The out-degrees for the remaining usernames were less than 50.

We chose the usernames with an in-degree of 20 or higher (44 users) and the usernames with an out-degree of 20 or higher (47 users) for closer analysis and coded the usernames based on the type or role of the user (Table 2). Private persons were both frequently mentioned (38.6%) and frequently mentioning other usernames (53.2%). Among those with high in-degrees were more organisations, compared to those with high out-degrees, indicating how organisations of various types are frequently mentioned in tweets, perhaps as sources of information, but they are not that active at connecting with other users.

Table 2   Usernames with highest in-degrees and highest out-degrees coded by role

	Role of usernames with high in-degree	*Role of usernames with high out-degree*
Company	13.6% (6)	12.8% (6)
Magazine	4.5% (2)	2.1% (1)
News sharing	6.8% (3)	4.3% (2)
Online community	4.5% (2)	6.4% (3)
Organisation	20.5% (9)	8.5% (4)
Private person	38.6% (17)	53.2% (25)
Research	9.1% (4)	6.4% (3)
Other	2.3% (1)	6.4% (3)
	100.0% (44)	100.0% (47)

Overall, there were some overlap between the usernames with high in-degree and usernames with high out-degree (r = 0.534).

6   Discussion

Social media, not the least Twitter, are consolidating their role as channels for information related to health. Twitter is a fast way to reach a vast amount of people worldwide with health-promoting information (e.g., Carillo-Larco, 2012), and many patients use it to stay updated with healthcare, to become more knowledgeable about diseases, to express emotions, or to compare with other patients (Antheunis et al., 2013). Within medical science Twitter is more important than ever, as well, providing a way for medical journals to engage their readers, for conference delegates to stay attached (Micieli and Micieli, 2012), or for medical organisations to educate the public (Desai et al., 2012; Redfern et al., 2013). Twitter and Facebook do, furthermore, act as channels for patient-provider communication (Antheunis et al., 2013). One of the most alarming health threats today is diabetes (e.g., Roglic et al., 2005), and hence diabetes and social media have started to attract the interest among some researchers (e.g., Shaw and

Johnson, 2011; Greene et al., 2010; Winston, 2010). This paper adds to the growing knowledge around this topic and presents results of a study on the semantic content of a total of 9,042 tweets discussing diabetes and diets between October 4 and November 6, 2013, as well as the conversational connections of those tweeting and those being mentioned in the tweets.

Content analysis has been used previously to analyse health-related content in Twitter conversations (e.g., Chew and Eysenbach, 2010; Heaivilin et al., 2011; Greene et al., 2010; Scanfeld et al., 2010; Redfern et al., 2013; Dumbrell and Steele, 2013; McNeil et al., 2012; Xu et al., 2015), but to the best of our knowledge, no one has previously studied related concepts concerning diet and diabetes in Twitter posts and presented them in semantic maps. Tweeters often tweet about their own experiences of, for example, diabetes management (Greene et al., 2010; Winston, 2010), dental pain (Heaivilin et al., 2011), use of antibiotics (Scanfeld et al., 2010) or smoking cessation (Prochaska et al., 2012). In the case of the swine flu outbreak in 2009, however, personal experiences came second to the tweets sharing news or updates, possibly containing a link to an article. Over 90% of the tweets contained a link to the information it shared (Chew and Eysenbach, 2010). These links can add more detailed information to the otherwise short tweets (Redfern et al., 2013). In our study of diabetes and diets, the tweets were frequently of this resource type as roughly a third of all the tweets contained a URL. For the tweets about diabetes and diets roughly two thirds contained a URL. A closer examination of the linked sources showed that many of these URLs appeared to be blogs and other news sites for which the author or the owner could not be verified, which we find somewhat alarming. These URLs were frequently shared on Twitter without any discussion of the accuracy or reliability of the information on them.

The results showed that many private persons act as diabetes advocates spreading information and news about diabetes and diets. Such opinion leaders might influence others' attitudes and behaviour, as well as control the information flow (Xu et al., 2015). Also previous research has shown that the resources the tweets link to are not necessarily scientific. In the case of tweets about the swine flu, around 23% of all tweets linked to a news website, whereas only 1.5% linked to sites of government and public health authorities (Chew and Eysenbach, 2010). Weitzman et al. (2011), furthermore, reported that also many diabetes-related social networking sites lack a link to, for example, a specific disease or professional association, which affects the quality of the contents. In the current study, however, the highest in-degree, that is, the Twitter account that was most frequently mentioned in the tweets, was that of the American Diabetes Association.

Surveying Twitter for people's opinions has advantages: tweeting about experiences of health-related issues often happens in real-time, and the risk of recall bias is diminished. Users also represent a global community, and posting can be quite frequent. People are also keen on sharing their experiences, perhaps because they find comfort in the fact that they are not alone on the matter or possibly because they want to seek or exchange advice or get social support (Heaivilin et al., 2011; Antheunis et al., 2013). Although it must be remembered that Twitter users are not representative for the entire population (Chew and Eysenbach, 2010, Heaivilin et al., 2010; Signorini et al., 2011), and that some posts might be embellished or exaggerated (Scanfeld et al., 2010), tweets can be a rich and relevant source of data (cf., Chew and Eysenbach, 2010; Signorini et al., 2011). Chew and Eysenbach (2010) claim that for health professionals, it is important to monitor online public response and perceptions especially in emergency

situations so that the effectiveness of knowledge translation strategies can be examined. This is supported by our findings and experiences dealing with the data.

It has been shown that also diabetics frequently seek online health information and are willing to discuss health-related topics in social settings (Shaw and Johnson, 2011). For healthcare practitioners knowledge about the topics that were found in the current study can be very useful. This is especially important as tweets might even contain pure misunderstandings of, for example, the use of certain medications (Scanfeld et al., 2010), and sometimes sensitive aspects of diabetes management that are not likely to be revealed to a doctor are discussed in social media, such as how you can extend your intake of alcohol (Greene et al., 2010). A fair amount of the diabetes-related contents are, furthermore, promotional, often advertising products that are not approved in diabetes care (Greene et al., 2010; Weitzman et al., 2010). In a study on dental pain on Twitter it was found that both professional and non-professional entities are targeting users expressing toothache, often in order to sell products (Heaivilin et al., 2011). Tweets can, furthermore, promote unhealthy behaviours such as tobacco use (Prier et al., 2011) or propagate negative attitudes towards certain illnesses (McNeil et al., 2012). Lo and Parham (2010) recommend that physicians promote the benefits of online information, by guiding patients to use reliable websites, for example, and not feel threatened about the fact that patients might have sought information elsewhere. This recommendation can also be supported by the findings of this study.

7   Conclusions

Social media in general and Twitter in particular show great promise to mine for health related communications and to discover public concerns and opinions. The findings of the current study indicate that analysing Twitter conversations with methods from social network analysis can be a fruitful and an efficient way to map public opinions about diabetes and diets, as well as other medical issues that concern many people. A limitation is, however, that the analysis is not going deeper into the linked sources, but as these sources were often blogs or news sites we emphasise that the information on these sites should be treated with caution. More research is, however, needed to find out what exactly the proportion of the somewhat questionable websites is in the diabetes discussion on Twitter. It is important for health practitioners to be aware of topics discussed on Twitter and common information sources. For example, when they are in contact with patients with diabetes they need to be aware of the patients' opinions and beliefs, and also about the sources the patients use to get their information (and misinformation) from, as these are often laymen. Because the discussions in social networks such as Twitter might have the potential to affect both the opinion and the behaviour of their patients, this will help the practitioners to, for instance, be prepared to correct possible misunderstandings and cope with the possibility that their advice are questioned, but also to guide the patients to reliable information sources.

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Notes

1 "Sanofi US is part of a leading global healthcare company that discovers, develops, produces and markets innovative therapies to help protect health and enhance people's lives" http://www.sanofi.us/.

2 "Diabetes newspaper with a personal twist" http://www.diabetesmine.com/about.

3 "Our mission is to bring together people touched by diabetes for positive change so that nobody living with this condition ever feels alone" http://diabeteshandsfoundation.org/.