Title
Public Health Surveillance of Pediatric Dentistry via Twitter

Permalink
https://escholarship.org/uc/item/6d699935

Author
Mullen, Shirin A.

Publication Date
2013

Peer reviewed|Thesis/dissertation
Public Health Surveillance of Pediatric Dentistry via Twitter

by

Shirin Mullen, DDS

THESIS

Submitted in partial satisfaction of the requirements for the degree of

MASTER OF SCIENCE

in

Oral and Craniofacial Sciences

in the

GRADUATE DIVISION

of the

UNIVERSITY OF CALIFORNIA, SAN FRANCISCO
Acknowledgements

This project would not have been possible without a community of support. It has been a true honor to work with such an amazing team. I would like to thank all who offered guidance, critique, encouragement and patience throughout this journey. Thank you to my committee for your support and help. To Natalie Heaivilin, Kristina Ahlwardt, and April Cole who were instrumental in developing the coding scheme. Thank you to Sarah Forbes who spent many long hours coding the tweets with me. It was an absolute joy to work with you. Thank you to Dr. Barbara Gerbert for helping me get started on this wonderful journey and for being a constant and radiant light throughout the project. To Jens Page for your tremendous help in getting the tweets. This project would not have been possible without you.

My most profound thanks to my wonderful mentor Dr. Janice Tsoh. Thank you for your constant and unwavering guidance and support. Your depth of knowledge and skill for teaching are inspiring. Thank you for putting in the long hours, for being patient with me, and for always having a positive attitude. It is truly an honor to work with you as a scholar and now as a friend.

And finally, thank you to my wonderful parents and sister who have always stood by me and have guided me throughout all my endeavors. Thank you to my beloved Justin. Your encouragement, patience, and love mean the world to me.
ABSTRACT

Background: Twitter is a social networking site that has become a leading global real-time communications platform. Twitter users post brief 140-character long messages (‘tweets’) on a variety of topics. To date, it is not known what parents are saying about their children’s oral health on Twitter.

Purpose: The purpose of this study was to understand parents’ actions and perceptions towards their child’s oral health on the Twitter.

Methods: Publically available tweets on Twitter were extracted from 14 randomly selected non-consecutive days in December 2012 and January 2013. A total of 1451 tweets meeting the search criteria were extracted and, after excluding ambiguous or irrelevant tweets, a total of 1073 tweets were included and analyzed. Tweets were coded using pre-established non-mutually exclusive categories.

Results: The 1073 included tweets were coded into 5 main categories: attitude (n=606, 56.6%), event (n=535, 49.9%), action (n=499, 46.5%), concern/question (n=203, 19%), and behavior (n=77, 7%). The proportions of tweets with negative (n=321, 53.0%) and positive (n=285, 47.0%) attitudes expressed by parents were similar. The most frequent reported events included eruption (n=237, 44.3%), exfoliation (n=194, 36.3%) and grinding (n=62, 11.6%). The most frequently reported actions were general dental appointment (n=204, 40.9%), prevention (n=165, 33.1%), and extraction (n=44, 8.8%). A majority of the tweets describing children’s behaviors were negative (n=55, 71%) rather than positive (n=22, 29%) ones. The most frequent concerns and questions were about esthetics (n=57, 28%), eruption (n=34, 17%) and dental home/access to care (n=27, 13%).
Conclusions: Twitter can serve as a rich source of data on parental perceptions and actions towards their child’s oral health. Parents report their child's dental events, actions and behaviors, as well as express concerns, questions and attitudes on Twitter. Parents frequently report their child’s dental visits. Among those who report an attitude about these dental visits, only 1 in 3 are positive. Future research is warranted to understand factors contributing to positive and negative attitudes toward pediatric dental care. As Twitter evolves the way society interacts and communicates, it is critical for oral health professionals to actively monitor and engage in the dialogue to improve societal health and well-being.
TABLE OF CONTENTS

ABSTRACT ................................................................................................................................. iv

TABLE OF CONTENTS .............................................................................................................. vi

INTRODUCTION .......................................................................................................................... 1

METHODS .................................................................................................................................... 3

Study Design and Setting ............................................................................................................ 3
Data collection .............................................................................................................................. 3
Search Terms Selection ............................................................................................................... 4
Development of coding scheme ................................................................................................. 5
Qualitative Coding and Data analysis .......................................................................................... 6

RESULTS ...................................................................................................................................... 6

Event .......................................................................................................................................... 9
Action ......................................................................................................................................... 10
Attitude ....................................................................................................................................... 8
Concern/Question ......................................................................................................................... 11
Behavior ...................................................................................................................................... 11

DISCUSSION ............................................................................................................................... 11

TABLES ....................................................................................................................................... 18

Table 1 Distribution of non-mutually exclusive major categories and subcategories . 18
Table 2 Coding Description and Sample tweets ...................................................................... 19

FIGURES ...................................................................................................................................... 20

Figure 1 Coding Scheme ............................................................................................................ 20
Figure 2 Word Cloud ................................................................................................................... 20
INTRODUCTION

There have been significant advancements in the worldwide web (Internet) that have changed the way people obtain and disseminate information. People have gone from passively obtaining information from the Internet to actively creating content in an open and interactive manner.\(^1\) These advancements have created a wealth of user-generated content on the web of shared experiences, concerns, and questions posed to an online community.\(^2\) The online interactions are made possible by social media, the means by which people communicate in virtual communities and networks.\(^3\) These online communities have increased rapidly in recent years with an estimated 62% of adults worldwide now using social media.\(^4\) These rapid developments have not only changed communication on global events,\(^5\) but also the way people obtain and disseminate information about their health.\(^6\) One social networking site that has become a global real-time communications platform is Twitter (San Francisco, CA).\(^7\) Twitter has undergone rapid growth since its inception in 2006. Currently, Twitter has 200 million users broadcasting 400 million tweets per day.\(^8\) Twitter has been used as a way to stay updated on medical advances in real time\(^9\) and to further health professional communication and continued education.\(^10\) It has been found that 12% of Americans looking online for health information have used Twitter to share updates about themselves or others.\(^11\)

Among US adult Internet users (which comprise 74% of all US adults), 80% have searched online for health information and 34% have read health information generated by other users.\(^12\) More than half (51%) of parents who use the Internet have reported searching online for general pediatric health information at least once in the past three months.\(^13\) A majority of the US population searches for health information on the web. However little is known about
the kinds and credibility of the information available. Peer-reviewed journal articles and professional presentations are the two primary methods that researchers use to disseminate their work. It has been argued that scientists are failing to communicate science to the public at large and in a timely manner. Social media websites, such as Twitter, have promising potential to facilitate communication between health professionals and research communities to the lay public. Increasingly more health organizations and scientific societies are becoming involved in social media for education and promotion of oral health and view their involvement as a critical move in this Internet society. The American Academy of Pediatrics and The American Academy of Pediatric Dentistry have active Twitter accounts with 19,713 and 3,220 followers, respectively. Also, almost every major scientific society of dentistry has a Twitter account.

In order to improve the dissemination of information and health promotion, it is important to understand public perceptions and attitudes of health topics. Infodemiology, an emerging field that involves the analysis of near real time information collected from the Internet, has shown to be important in informing public health and public policy. Twitter has been used increasingly to provide a platform for researchers to analyze public perceptions and attitudes about health topics such as the H1N1 flu epidemic, concussions, antibiotic use, dental pain, epilepsy, and cancer screening.

Pediatric oral health is a significant health issue that demands attention. Dental decay is the most common chronic childhood disease in the United States today, five times more common than asthma. Dental care is the most prevalent unmet health need among children in the United States and throughout the world. Striking oral health disparities exist, with poor and
minority children accounting for the majority of dental decay and disease. Poor oral health can have significant and long-standing effects on a child’s overall health, growth, and development. Parents are primarily responsible for the health of their young children. Investigating parents’ perceptions about their children’s oral health will further the understanding of the oral health disparity and will improve the formulation and dissemination of appropriate oral health information. To date, there has not been research conducted on children’s oral health behavior on social media sites. We sought to explore the nature and content of pediatric dental communications on Twitter.

METHODS

Study Design and Setting

This cross-sectional study conducted qualitative content analysis of publically available content on the Twitter social networking site (www.Twitter.com). Twitter is a forum in which people can share information in real-time through 140 character messages called “tweets.” The content on twitter is largely public, with a downward trending 6% of accounts being private in 2009. Users may select to be a ‘follower’ to other individual users and organizations by receiving their tweets. When a user with a public account broadcasts a tweet it is sent to their followers and can also be retrieved publically through public online searches.

Data collection

Twitter data was retrieved through a data collection script created and submitted to the Twitter Search API (https://dev.twitter.com/docs/api/1/get/search). The data collection script included a specified query that consisted of a series of search terms and logical operators.
The Twitter Search API's time based parameters were used to confine the selected date range of tweet extraction. The data collection script was programmed to run to repeatedly poll the Twitter Search API and retrieve all the specified tweets from the selected dates. The resulted collection of tweets generated by the Search API contained contents of the selected tweets, timestamp, the author of a tweet, and other related user information as available. The assembled data were then flattened and exported in a tab-delimited format for import into spreadsheets or statistical software. We analyzed the content of a random non-consecutive 14-day sample of publically available tweets during the months of December 2012 to January 2013, which defined the ‘study period.’ In order to obtain equal representation from each weekday, a random number generator was used to randomly select each weekday twice during the study period. To reduce biases introduced by advertisements, or active Twitter users repeating or resending tweets conveying similar contents, we included only the first tweet from each unique user with the earliest date and time stamp in the study sample, and excluded subsequent tweets from the same user. Re-tweets (re-shared tweets from another user) and spam (commercial links or advertisements) were also excluded. We did not confine our analysis to any specific user location, age, or gender. Individuals were not contacted and information set as private was not accessed.

**Search Terms Selection**

The objective of the study was to capture what parents are saying about their children’s pediatric dental situations on Twitter. An initial set of inclusionary search terms that were likely to capture descriptions of dental situations such as “teeth” and “dentist” and parent-child relationship such as “my child” and “my son” were identified. To exclude re-tweets and advertisements, the exclusionary terms “RT” and “http” were used. Search terms that
yielded a majority of irrelevant tweets, such as “nail” which yielded irrelevant statements such as “fight tooth and nail,” were excluded from further analysis. Some words, such as “baby” and “our child,” were not included because they did not result in more relevant tweets or resulted in a higher number of irrelevant tweets. The search term identification (API, Twitter, San Francisco) went through 13 iterations. With each iteration a new inclusion or exclusion term was added or removed and 50-100 tweets was pulled and analyzed. Each set of pulled tweets generated additional inclusion and exclusion terms that were further analyzed. The goal was to obtain the highest degree of relevant tweets without narrowing our search such that we would be excluding valuable information. Using this interactive process of adding one new exclusionary term at a time and assessing the search results, the following final set of inclusion and exclusion terms were selected: Inclusion – (“Dental” OR “Teeth” OR “Tooth” OR “Dentist”) AND (“my child” OR “my son” OR “my daughter” OR “my kid”); Exclusion – “http” OR “RT” OR “dog” OR “puppy” OR “fairy” OR “whitney” OR “bieber” OR “comb” OR “nail” OR “skin” OR “dagger.” These search terms consistently yielded 60% relevant tweets with 3 separate random samples of 100 tweets.

Coding Scheme Development

After exploratory searches were done, a sample of 800 tweets was obtained and analyzed. The sample of tweets was categorized until thematic saturation was obtained and a coding scheme was formed. The coding scheme consisted of broad themes that branched into more specific categories. The research team of 5 members reached consensus on the final non-mutually-exclusive five major categories and 33 subcategories (Figure 1). After the final coding scheme was developed, an independent set of 50 tweets was used to determine inter-rater reliability between the primary coder [SM] and each of the 4 other team members. The
average Cohen’s Kappa and PABAK were .98 and .97, respectively, which indicated high degree of agreement in categorization of tweets between coders.

**Qualitative Coding and Quantitative Data analysis**

A total of 1451 Tweets were collected using the final set of inclusion and exclusion search terms set from the randomly selected 14 days during the study period. Two coders reviewed all 1451 tweets independently to determine if the tweets should be included and to designate codes to each included tweets. Discrepancies occurred with 110 (8%) of tweets and were resolved by regular meetings and discussion. When conflicting codes (e.g. child negative attitude and parent positive attitude) were designated to a tweet the dominant code was selected. A total of 1073 (74%) tweets were included for analysis. To be included in the analysis, a tweet was required to be written by a parent in regards to their child’s dental situation. Tweets written about someone else’s child, not about a dental situation, or incomprehensible were excluded (n=378). The quantitative data was analyzed by IBM SPSS Statistics, Version 21. Descriptive statistics, which include frequencies for each coding major and subcategories, mean number of codes per tweet and its standard deviation (SD) were computed.

**RESULTS**

Figure 2 shows a word cloud, a graphical representation of word frequency, created on http://www.wordlenet/ using the text contents from 1073 tweets. The larger the font size of the word in the word cloud, the more frequently the word was used in the tweet. The most frequent words were teeth, son, daughter, tooth, going and dentist. All of these words except for “going” were used as search terms and thus were expected to be found most frequently in
the word cloud. Other words that were not search terms that appear to have high frequency are brush, first, lost, take, like, just, now, appointment, grind, and front.

Each tweet was classified in at least one major category, which may be further classified into one or more subcategories. The categories were not mutually exclusive. The mean number of major categories coded per tweet was 1.79 (SD = 0.68; median =2.0), ranged from 1 to 4. The mean number of subcategories coded per tweet was 1.83 (SD= 0.74; median = 2.0), ranges from 1 to 5. For example, the tweet “At the dentist with my son, poor baby has to be put in a blanket. He hates it. :( #specialneedskidproblems” contains 4 major categories plus one subcategory within each major category coded: i) Event (subcategory: special needs); ii) Action (subcategory: dental visit); iii) Attitude (subcategory: negative); iv) Behavior (subcategory: negative). Table 1 provides detailed information on the number and percentage of tweets classified within each of the major categories and subcategories. Of the 1073 included tweets, 57% described an Attitude (e.g., “positive” or “negative” towards dentistry), 50% reported a dental Event (e.g., eruption, exfoliation, etc.), 47% reported a dental Action (e.g., a general dental appointment, dental procedure, etc.). Fewer tweets (19%) contained a dental Concern or Question, and 7% reported a positive or negative Behavior of the child towards a dental situation.

Overall, half (51%) of the tweets received classifications for 2 major categories, 35% were classified into a single major category, and 14% were classified into > 2 (range 3 to 5) major categories. A majority (70%) of the tweets received 2 or more coded subcategories (range 2
to 5), 30% were coded into a single subcategory. Representative examples of tweets for each of the major categories are shown in Table 2.

**Attitude**

Each attitude-coded tweet was classified into either positive or negative attitudes. In case of the presence of both positive and negative attitudes (n = 17), a dominant attitude (either positive or negative) was selected. Slightly over half of the attitude-coded tweets reporting negative attitudes (n=321, 53%). To further describe the attributes of negative and positive attitudes, the Attitudes code was subdivided into dental setting and non-dental setting and further into parent or child subcategories.

Of the 606 total tweets reporting an attitude, a majority (73%) described an attitude associated with a non-dental setting, and 27% described an attitude related to a dental setting. None reported attitudes related to both settings on the same tweet. For example, “So happy today...my son grew his first tooth!!! Wooooopieeee!!!,” was coded as reporting an attitude in the non-dental setting. In contrast, “The highlight of my day was taking my daughter to the dentist!” was coded with a dental setting attitude.

Among tweets reporting attitudes related to a dental event or situation that does not involve a dental setting (n=445), the distribution of positive (49.7%) and negative attitudes (50.3%) were half-and-half. In contrast, about 1 in 3 attitudes related to dental settings (such as dentist, hygienist, or dental appointment) was positive (37.9%), while 2 in 3 were negative (62.1%). A Pearson chi-square test was conducted to examine the association between the
types of attitudes (positive versus negative) and the settings involved (dental versus non-
dental). Results indicated there were a significantly high portions of negative attitudes
expressed involving dental settings when compared to non-dental settings, $\chi^2(1) = 7.35, p = 0.007$.

Regarding the source of the attitudes, of 606 attitude-coded tweets, 82.7% were from parents
only (e.g., “My Son Bit His Cheek Real Bad B/c His Mouth Was Numb. I Hate The
Dentist!”), 8.6% referred to that of a child (e.g., “My Kid Loves Brushing His Teeth,
Especially Since I Got Him An Electric/Spinning Big Boy Tooth Brush”), and 8.7% referred
to attitudes expressed by both parent and child (e.g., “ever since we bought the yummy-
flavored toothpaste for the kids, my son wants to brush his teeth a million times a day. it's
hilarious.”). The proportions of positive attitudes expressed by parents only, child only, and
both parent and child were: 46.1%, 59.6%, and 43.4%, respectively. The distributions of
positive and negative attitudes by the source were statistically similar ($\chi^2 (2) = 3.76, p = 0.15$).

Event

Among the 535 tweets reporting some sort of dental events, the most common reported event
was eruption (44%), followed by exfoliation (36%) and grinding (12%). Other less common
events reported were trauma (n=21, 4%), pain (n=22, 4%), caries (n=16, 3%), and special
needs (n=4, 0.7%). All tweets reported up to 2 events, with a majority (n=514; 96%) reported
a single event. More than half (n=12; 55%) of the tweets reporting two events reported
eruption and pain. For example, “my son teeth coming in!!! :( and he wont stop crying!!”
**Action**

Of the 499 tweets reporting a dental action, a description related to a general dental appointment was the most common action (n = 304, 41%). Other less common actions reported in dental settings were orthodontics (n=14, 3%), sedation (n=8, 3%), medication prescribed (n=3, 1%), or emergency treatment (n=2, 0.4%). Most tweets (67%, 204 out of 304) reported going to a dental visit, but did not state what occurred at the dental visit (e.g., “The irony or torture that I sit at the dental office for my son, and eat chocolate in front of him, while he sits in the chair...”) versus a small proportion (33%, 100 out of 304) that described a more specific action at the dentist (e.g., “…to get his cavities fixed”).

The second most common action was related to prevention (33%). Prevention actions were defined as the implementation of hygiene practices at home, such as nutrition, brushing, or flossing. For example, “My son has a Captain Rex spin toothbrush. I so enjoy brushing his teeth! :D.” Within the tweets reporting a prevention action, 34% reported a difficulty with prevention (e.g., “My son is horrible at brushing his teeth right. I always have to watch him because otherwise he just plays around”). Nearly all (95%) of the tweets reporting a difficulty with prevention specified the cause of difficulty was due to the child’s uncooperative behavior (n=28, 50%), nutrition barriers (n=21, 38%), or time management (n=4, 7%). A roughly equal number of tweets reported a tooth extraction by the dentist (n=44, 9%) versus tooth extraction by the parent or child at home (n=32, 6%).
Concern/Question

Of the 203 total tweets reporting a concern or question, the largest subcategories were aesthetics (28%), eruption (17%), dental home/access to care (13%), prevention (10%), grinding (10%), exfoliation (5%), and dental visit/treatment (5%). Examples of common concerns were: “My child can't have crooked teeth, I won't let then suffer like I do,” and “my daughter is 14 months and only has 6 teeth...when should I take her to the dentist??” Other less common parental concerns and questions subcategories were behavior (n=3, 1%), pain (n=2, 1%), and trauma (n=2, 1%).

Behavior

Among the 77 tweets reporting a child’s behavior towards a dental situation, a majority reported negative (71%) verses positive (29%) child behavior. In the dental setting category, there were 17 (63%) negative verses 10 (73%) positive child behavior tweets (e.g., “My daughter refuses to let the dentist take X-rays of her teeth. Hate going to the dentist. #Traumatizing”). In the non-dental settings, there were 38 (76%) negative verses 12 (24%) positive child behavior tweets (e.g. “The fact that I still have to hold my child down to brush his teeth blows me away. You'd think at 3 years old he would cooperate a little.”).

DISCUSSION

This is one of the first studies to examine the topic of pediatric dentistry on Twitter. This study demonstrates that parents are conversing about the oral health of their children on Twitter and that these conversations can be easily found using simple search terms. With the 140-character constraint of Twitter, parents are able to provide rich information in describing
their child’s dental experiences. These findings reveal new avenues for investigations of parents’ perceptions and actions in regards to their child’s dental situations in order to better understand factors that influence the oral health of children.

One of the major findings of this study was that tweets about children’s dental eruption, exfoliation, and grinding were the most frequently reported events and were also among the most frequently reported questions and concerns, with one in three (32%) concerns on one of these topics. These findings are consistent with frequently asked questions by parents to dental professionals in the clinical setting. Also, the largest category of questions and concerns were those about dental esthetics (28%). Previous studies have also shown esthetics to be a major concern of parents. For example, a study evaluating factors motivating patients and their parents to seek orthodontic treatment found that 87% of parents were concerned about the appearance of their child’s teeth. This study also found that a frequent concern and question of parents is about finding a dental home or access to care. Access to dental care concerns among parents are expected to rise as the fastest growing populations of children are those with the highest oral disease rates and least access to dental care. The similarities between this study and previous findings suggest that the experiences shared by parents on Twitter are similar to those in the general public, thus supporting the Twitter as a data source.

The most frequent action related to children’s oral health that parents tweet about was dental visits. Further investigation is needed to understand further the contents of what parents are saying about their child’s dental appointments and the attitudes and concerns are associated with them. The second most frequently reported dental action was caries prevention.
Extensive decay in preschool children, or early childhood caries (ECC), is a major health problem that requires aggressive rehabilitation and prevention. Up to 50% of children with ECC who receive comprehensive dental treatment under general anesthesia will require retreatment after 6 months. Prevention at home is critical and cannot be taken lightly. Health professionals must investigate what barriers parents are facing in preventing dental decay in their children and implement effective methods to educate, empower, and support parents in their efforts. In this study, it was found that among all tweets that reported a preventative measure, 34% reported difficulty, and half were due to the child’s uncooperative behavior. A questionnaire survey found that 59% of mothers stated that they lacked the skill to clean their children’s teeth. Another study found that parents, whose children had recently had comprehensive treatment under general anesthesia, highly valued oral health professionals sharing practical tips or giving actual demonstrations of oral care techniques such as lying a 2-year-old boy down in the parents lap and holding him tight while brushing. This need for instruction and assistance with behavior management is consistent with the difficulty expressed by parents in this study with uncooperative children during preventative measures. In addition to demonstrating techniques with parents in the clinical setting, health professionals can meet this need by posting tips and web links of demonstration or discussion of techniques for dental decay prevention on Twitter.

More than half of the tweets in the study contained an associated attitude (57%). In the non-dental setting, the positive and negative attitudes were about 50%. In contrast, only 1 in 3 attitudes relating to the dental setting were positive. The larger number of negative attitudes towards the dental visits could be correlated with the high number of negative behaviors
(71%) of the children at the dentist. It is important to explore further the attitudes of parents as research shows that parents’ beliefs and attitudes toward dental health influence the way in which they practice oral hygiene with their child. It has been found that mother’s positive oral health-related attitudes are associated with brushing twice daily and sound dentition in children. Similarly, parents with positive attitudes to hygiene and diet had almost five times lower caries experience then those parents with less positive attitudes. Therefore, it is important to explore ways to positively influence parental attitudes towards their children’s dental experiences. Early evidence indicates that social media has potential to shift consumer behavior through influencing perceptions and attitudes. For example, in a randomized trial in which vaccination information, social feedback, and online booking were provided to consumers, influenza vaccination rates were significantly higher than control group (12% vs. 5%). Further, research suggests that social networks can directly mediate health conditions such as obesity and depression by influencing the social norms and behaviors that lead to them. Social networks have also been shown to influence patterns of health screening, sleep, and drug use. Thus, social media is a promising tool for improving parental attitudes towards dental care providers and their children’s oral health. Further studies need to examine factors associated with parental negative and positive attitudes and how these attitudes can be influenced through social media.

The question of what responsibility and moral obligation health professionals have to ensure that health information on the Internet is accurate and accessible must be carefully considered and explored. The Internet and social media is no passing fad; healthcare providers must not ignore this cultural phenomenon. Engagement in social media can help
raise awareness of disease prevention and evidence based health practices, publish health-related news, and close the gap of accessible evidence based health care information. The MayoClinic has been at the forefront of social media, launching a Facebook page in 2007 and joining Twitter in 2008. The MayoClinic has also made information from its expert researchers, scientists, and physicians available to the public. The MayoClinic claims that its involvement in social media has opened up communication and enabled them to have more in-depth information sharing with patients.\textsuperscript{10} The dental profession is in a unique position to influence the health of children at large through its involvement in social media. Twitter not only can serve as an effective avenue for health information sharing, but also as a data source for investigating perceptions of parents, particularly those of minority and low-income populations, whose children are most at risk for dental disease. Twitter use for 25-35 year olds more than doubled between November 2010 to May 2011, increasing from 9% to 19% of total Internet users in this age bracket.\textsuperscript{45} On average, women have their first child at 25.4 years old.\textsuperscript{46} Thus, one of the fastest growing age groups on Twitter are those with young children. Furthermore, a majority of Twitter users are African-American and Hispanic with one in ten African-American Internet users visiting Twitter on a typical day.\textsuperscript{45} Minority and low-income children disproportionately experience dental decay, with higher levels of caries found in African-American and Hispanic groups.\textsuperscript{47} Twitter may provide an effective way to reach these minority groups, which are often hard to reach, with health information.\textsuperscript{48} Additional studies should be conducted to further explore the perceptions, attitudes, questions, and concerns of parents regarding their children’s oral health on social media. With increased knowledge of these populations, new health behavior interventions can be designed that deliver important information to these social networks directly.
There are several limitations to this study. First, we extracted tweets out of a randomly selected 14-day period in a specific timeframe. It is possible that the tweets during this timeframe are not representative of tweets at other periods of time. However, the 14 days were chosen from two months that include both holiday and non-holiday time periods in order to capture a variety of circumstances that may affect the content of the Tweets. The coding process required some degree of individual’s subjective judgment and could be subject to bias. The research team worked to minimize bias by calibrating the team members on coding and having two researchers code all tweets. In addition, the exact demographics from the Twitter users are unknown and the population posting about pediatric dentistry may differ from the general population using Twitter. Finally, to minimize over inflation of the topics from repeat users conveying similar contents, we only included the first tweet from each unique user during the sampling period. This methodology could have resulted in the loss of depth of the information on each conversation and the sequence of events for each particular user. Future studies can explore the progression of events and influencing factors for each user’s reported experiences.

Despite these limitations, this study contributes several important findings. This study demonstrates that Twitter is a unique data source in which parents are extensively sharing information regarding their child’s dental situations in real time. Through Twitter, parents discussed their child’s dental events (e.g. trauma, eruption), actions (e.g. dental visit, home prevention), behavior, and questions/concerns (e.g., grinding, eruption). More than half the tweets involved expressions of an attitude, with roughly equal negative and positive attitudes.
in the non-dental setting, and predominating negative attitudes associated with a dental setting. These findings revealed what parents are discussing their children’s oral health on Twitter. Social media is a force that has and will continue to transform communications worldwide. It is vital that the dental profession does not get left out of the conversation, but works to engage parents by reaching them in these arenas that they are already actively participating. Through social media, health professionals have the potential to make important and lasting contributions.
### Table 1 Distribution of non-mutually exclusive major categories and subcategories

<table>
<thead>
<tr>
<th>Major categories</th>
<th>N (%)*</th>
<th>Subcategories</th>
<th>N (%)+</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Attitude</strong></td>
<td>606 (56.5%)</td>
<td>Negative</td>
<td>321 (53.0%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Positive</td>
<td>285 (47.0%)</td>
</tr>
<tr>
<td><strong>Event</strong></td>
<td>535 (49.9%)</td>
<td>Eruption</td>
<td>237 (44.3%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Exfoliation</td>
<td>194 (36.3%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Grinding</td>
<td>62 (11.6%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pain</td>
<td>22 (4.1%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Trauma</td>
<td>21 (3.9%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Other (Caries, Special Needs)</td>
<td>20 (3.7%)</td>
</tr>
<tr>
<td><strong>Action</strong></td>
<td>499 (46.5%)</td>
<td>General Dental appointment</td>
<td>204 (40.9%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Prevention</td>
<td>165 (33.1%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Extraction</td>
<td>44 (8.8%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Home Extraction</td>
<td>32 (6.4%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Examination</td>
<td>27 (5.4%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Orthodontic</td>
<td>14 (2.8%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Dental visit– Other (Medication, Sedation, Emergency)</td>
<td>13 (1.2%)</td>
</tr>
<tr>
<td><strong>Concern/Question</strong></td>
<td>203 (19%)</td>
<td>Esthetics</td>
<td>57 (28%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Eruption</td>
<td>34 (17%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Dental Home/Access to Care</td>
<td>27 (13%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Grinding</td>
<td>20 (10%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Prevention</td>
<td>20 (10%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Habits</td>
<td>16 (8%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Exfoliation</td>
<td>11 (5%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Dental visit/Treatment</td>
<td>11 (5%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Caries</td>
<td>8 (4%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Other (Behavior, Pain, Trauma)</td>
<td>7 (3.4%)</td>
</tr>
<tr>
<td><strong>Behavior</strong></td>
<td>77 (7%)</td>
<td>Negative</td>
<td>55 (71%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Positive</td>
<td>22 (29%)</td>
</tr>
</tbody>
</table>

* Percentage of tweets out of total included tweets (n=1073)

+ Percentage of tweets out of total Tweets in respective major category
<table>
<thead>
<tr>
<th>Major Category</th>
<th>Definition</th>
<th>Sample tweet</th>
</tr>
</thead>
</table>
| **Attitude**    | Parent or child’s attitude towards a dental experience                      | • “It’s picture day at my son’s school today! YAY! I hope he smiles big…I love his little perfect teeth”  
• “My son has perfect teeth already 😊” |
| **Event**       | Child’s dental experience/incident                                          | • “Ugh my son has an abscess tooth”  
• “My son is growing in 2 top teeth!” |
| **Action**      | Child’s dental action                                                      | • “At the dentist with my daughter. Time for her to get the choppers cleaned”  
• “My son is brushing his teeth for the 3rd time today” |
| **Concern/Question** | Parent concern or question regarding their child’s dental experience       | • “I'm going to need to work 2 part time jobs just to pay for my kid's dental work.”  
• “How soon can babies start cutting teeth? My son is 7 weeks old and has a white spot in his gums, could this be a tooth?” |
| **Behavior**    | Child’s behavior towards a dental experience                               | • “My daughter is a rock star at the dentist. Climbs up in that chair like she owns the place. Love that girl.”  
• “My son lost his first two baby teeth. They had to be pulled out. He refused the shot…” |
FIGURES

Figure 1 Coding Scheme

Attitude
- Negative
- Positive

Event
- Trauma
- Eruption
- Exfoliation
- Pain
- Grinding
- Caries
- Special Needs

Action
- General Dental Appointment
- Restoration
- Extraction
- Examination
- Medication
- Sedation
- Emergency
- Orthodontics
- Home Extraction
- Prevention

Concern/Question
- Dental Visits/Treatment
- Dental Home/Access to Care
- Grinding
- Eruption
- Exfoliation
- Caries
- Prevention
- Esthetics
- Habits
- Behavior
- Pain
- Trauma

Behavior
- Negative
- Positive

Figure 2 Word Cloud

- son
- daughter
- teeth
- get
dentist
brush
goin
day

20
REFERENCES


2. The experts vs the amateurs: A tug of war over the future of media. managing technology.


24. Taubman M, Nash D. The scientific and public-health imperative for a vaccine against


26. Children's dental care access in medicaid: The role of medical care use and dentist


28. Cunningham M. More than just the kappa coefficient: A program to fully characterize
inter-rater reliability between two raters. SAS global forum. SAS Global Forum
(Washington, DC, USA). Web site.

Dentist4Kids.com, Parents Section Web site.


## APPENDICES

### A. CODE DEFINITIONS AND SAMPLE TWEETS

<table>
<thead>
<tr>
<th>Code</th>
<th>Definition</th>
<th>Sample Tweet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Event</td>
<td>Experience/incident</td>
<td>My son already bust his head and chipped his tooth all within a month</td>
</tr>
<tr>
<td>Trauma</td>
<td>Broke/chiped/displaced/avulsed Tooth</td>
<td>My daughter has a tooth coming in</td>
</tr>
<tr>
<td>Eruption</td>
<td>Erupting teeth</td>
<td>My son just lost a tooth</td>
</tr>
<tr>
<td>Exfoliate</td>
<td>Exfoliating teeth</td>
<td>My kid is crying for two reasons. 1. his tooth hurts. 2. he wants his teeth to fall out. now what?</td>
</tr>
<tr>
<td>Pain</td>
<td>Dental Pain</td>
<td>My son grinds his teeth when he sleeps</td>
</tr>
<tr>
<td>Grinding</td>
<td>Bruxism/tooth grinding</td>
<td>At the dentist with my daughter.</td>
</tr>
<tr>
<td>Caries</td>
<td>Dental Caries</td>
<td>Fixing to go to my son first dentist check up. Awe. He is so grown.</td>
</tr>
<tr>
<td>Special needs</td>
<td>Special needs child</td>
<td>#Autism ads a lot of extra to events cuz my son lost his first tooth and almost certainly swallowed it.</td>
</tr>
<tr>
<td>Action</td>
<td>Child's dental action</td>
<td></td>
</tr>
<tr>
<td>General Dentist Appointment</td>
<td>Dental visit - reason for visit not specified</td>
<td>At the dentist with my daughter.</td>
</tr>
<tr>
<td>Restoration</td>
<td>A filling or crown by the dentist</td>
<td>At the dentist with my son. He is a trooper - getting 3 fillings.</td>
</tr>
<tr>
<td>Extraction</td>
<td>A extraction by the dentist</td>
<td>Sitting at the dentist's waiting for my son to get a tooth extracted.</td>
</tr>
<tr>
<td>Examination</td>
<td>Periodic dental recall/checkup appointment</td>
<td>Fixing to go to my son first dentist check up. Awe. He is so grown.</td>
</tr>
<tr>
<td>Medication</td>
<td>Medication perscribed or recommended by dentist</td>
<td>As my son Walker gets some P.M. From his dentist, I’m reminded of how we should maintain our walk with Christ on a continuing basis! our dentist gave my daughter laughing gas</td>
</tr>
<tr>
<td>Sedation</td>
<td>Sedation used in the dental appointment(ex. nitrous/oral sedation/general anesthesia)</td>
<td></td>
</tr>
<tr>
<td>Emergency</td>
<td>Emergency dental treatment (ex. Trauma or infection)</td>
<td>Happy Holidays @iamladycc My daughter broke her tooth &amp; had to get it repaired as well. Never realized how important a little tooth could be</td>
</tr>
<tr>
<td>Home Extraction</td>
<td>Self extraction or extraction by a parent</td>
<td>My son has just managed to pull his wobbly tooth out.</td>
</tr>
<tr>
<td>Prevention</td>
<td>Implementation of hygiene practices at home (diet/brushing/flossing)</td>
<td>Teaching my son how to brush his teeth.</td>
</tr>
<tr>
<td>Prevention - difficulties</td>
<td>Difficulty in implementing or compliance with oral hygiene practices at home (ex. due to behavior or lack of time)</td>
<td>My son is horrible at brushing his teeth right. I always have to watch him because otherwise he just plays around.</td>
</tr>
<tr>
<td>---------------------------</td>
<td>------------------------------------------------------------------------------------------------------</td>
<td>-------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Prevention - uncooperative</td>
<td>Difficulty in implementing prevention interventions due to uncooperative behavior of child.</td>
<td>The fact that I still have to hold my child down to brush his teeth blows me away. You’d think at 3 years old he would cooperate a little.</td>
</tr>
<tr>
<td>Prevention - Time management</td>
<td>Difficulty in implementing prevention interventions due to time management issues (ex. lack of time/busy schedules)</td>
<td>The hardest thing in my life right now is remembering to brush my child's 2 teeth.</td>
</tr>
<tr>
<td>Prevention - Nutrition barriers</td>
<td>Difficulty in implementing prevention interventions due to nutritional barriers</td>
<td>Just had to clarify this for my son. You have to brush your teeth <em>AFTER</em> you eat the cookie. Order of operations matters kiddos!</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Attitude</th>
<th>Parent or child’s attitude towards a dental experience</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attitude - Dental Setting</td>
<td>Attitude towards the dentist or dental visit/treatment. Defined by expression of an emotion or a reaction/response.</td>
</tr>
<tr>
<td>Attitude - Child</td>
<td>Child’s attitude towards the dentist, dental treatment, or dental visit</td>
</tr>
</tbody>
</table>

| Att-Child + | Positive | My son's dentist has iPads on the walls and a free arcade...tf? No wonder he loves the damn dentist! |
| Att-Child - | Negative | My son asked me to sing #SoftKitty to him tonight cause he's nervous about the dentist tomorrow. #momlife #proud #bigbangtheory #thatsmyboy |

| Attitude - Parent | Parent’s attitude towards the child’s experience with the dentist, dental visit, or treatment |
| Att-Par + | Positive | They’ve done that at my kid’s elementary school! Free dental checkups & they also get free flu shots too :) |
| Att-Par - | Negative | My daughter refuses to let the dentist take X-rays of her teeth. Hate going to the dentist. #Traumatizing |

| Attitude - Non-dental Setting | Attitude towards the dental experience in a non-dental setting (outside dental office or dental care). |
| Attitude - Child | Child’s attitude towards the non-dental setting experience |

<p>| Att-Child + | Positive | My child loves to brush her teeth and now loves to floss!!! |</p>
<table>
<thead>
<tr>
<th>Attitude</th>
<th>Parent's attitude towards the child's non-dental setting experience</th>
</tr>
</thead>
<tbody>
<tr>
<td>Att-Child</td>
<td>Negative</td>
</tr>
<tr>
<td>Att-Par +</td>
<td>Positive</td>
</tr>
<tr>
<td>Att-Par -</td>
<td>Negative</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Behavior - Dental</th>
<th>Child's behavior towards the dentist, dental treatment, or dental visit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beh-Child +</td>
<td>Positive</td>
</tr>
<tr>
<td>Beh-Child -</td>
<td>Negative</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Concern/Question</th>
<th>Concern or question regarding their child's dental experience</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dental visit/Treatment</td>
<td>Dental treatment/visit</td>
</tr>
<tr>
<td>Dental Home/Access to Care</td>
<td>Finding a dental home or making an appointment</td>
</tr>
<tr>
<td>Grinding</td>
<td>Bruxism/grinding</td>
</tr>
<tr>
<td>Eruption</td>
<td>Tooth eruption</td>
</tr>
<tr>
<td>Exfoliation</td>
<td>Tooth exfoliation</td>
</tr>
<tr>
<td>Caries</td>
<td>Dental decay</td>
</tr>
</tbody>
</table>


<table>
<thead>
<tr>
<th>Prevention</th>
<th>Oral health prevention (home care/oral hygiene/diet)</th>
<th>Why must I fight with my child everyday about brushing her teeth!!!</th>
</tr>
</thead>
<tbody>
<tr>
<td>Esthetics</td>
<td>Esthetics of teeth (ex. Size, shape, color, alignment)</td>
<td>My son has perfect teeth. Hope they grow back like that. #BabyTeeth</td>
</tr>
<tr>
<td>Habits</td>
<td>Oral habits. (ex.. Thumb sucking, finger biting)</td>
<td>My son has the worst habit of biting his nails...lmao but he can't no more...HE HAS NO TOOTH</td>
</tr>
<tr>
<td>Behavior</td>
<td>Behavior at the dentist</td>
<td>At the dentist with my son!! I hope he don't be actin up!! Lol</td>
</tr>
<tr>
<td>Pain</td>
<td>Dental pain</td>
<td>Took my daughter to the dentist again. She's a fighter! So hard to see her go through this pain, but it's gotta be done.</td>
</tr>
<tr>
<td>Trauma</td>
<td>Parental concern regarding their child’s dental trauma.</td>
<td>My child his seriously Houdini .. He got the whole front of his cage collapsed .. Teeth were chipped gums bleed. Idk what to do?</td>
</tr>
</tbody>
</table>
B. UCSF LIBRARY RELEASE

Publishing Agreement

It is the policy of the University to encourage the distribution of all theses, dissertations, and manuscripts. Copies of all UCSF theses, dissertations, and manuscripts will be routed to the library via the Graduate Division. The library will make all theses, dissertations, and manuscripts accessible to the public and will preserve these to the best of their abilities, in perpetuity.

I hereby grant permission to the Graduate Division of the University of California, San Francisco to release copies of my thesis, dissertation, or manuscript to the Campus Library to provide access and preservation, in whole or in part, in perpetuity.

Shirin Muller  9/4/13
Author Signature Date