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Contents of Japanese pro- and anti-HPV vaccination websites: A text mining analysis

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ABSTRACT

Objective: In Japan, the human papillomavirus (HPV) vaccination rate has sharply fallen to nearly 0% due to sensational media reports of adverse events. Online anti-HPV-vaccination activists often warn readers of the vaccine's dangers. Here, we aimed to examine frequently appearing contents on pro- and anti-HPV vaccination websites.

Methods: We conducted online searches via two major search engines (Google Japan and Yahoo! Japan). Targeted websites were classified as "pro," "anti," or "neutral" according to their claims, with the author (s) classified as "health professionals," "mass media," or "laypersons." We then conducted a text mining analysis.

Results: Of the 270 sites analyzed, 16 contents were identified. The most frequently appearing contents on pro websites were vaccine side effects, preventable effect of vaccination, and cause of cervical cancer. The most frequently appearing contents on anti websites were vaccine side effects, vaccine toxicity, and girls who suffer from vaccine side effects. Main disseminators of each content according to the author's expertise were also revealed.

Conclusion: Pro-HPV vaccination websites should supplement deficient contents and respond to frequent contents on anti-HPV websites.

Practice implications: Effective tactics are needed to better communicate susceptibility to cervical cancer, frequency of side effects, and responses to vaccine toxicity and conspiracy theories.

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1. Introduction

Cervical cancer, which is commonly caused by chronic infection with an oncogenic strain of human papillomavirus (HPV), is the third most commonly diagnosed cancer and the fourth leading cause of cancer death in women worldwide [1,2]. HPV vaccination is recommended by the World Health Organization [3] and has been made available in most industrialized countries. However, in some countries, HPV vaccination coverage is not as high as expected [4–6].

In Japan, the HPV vaccination rate for age-eligible young girls was as high as 70–80% in 2011 and 2012 [7]. In April 2013, the HPV vaccine became a routine prophylactic vaccine under the Preventive Vaccination Law in Japan, which recommended vaccination for all girls aged 11–16 years. However, at almost the same time, the *Asahi Shimbun*, one of the most authoritative and influential newspapers in Japan, publicized the case of a junior high school student who suffered from difficulties walking and performing mathematical calculations after receiving HPV vaccination. Similar cases were increasingly reported as adverse events gained media attention, though without sufficient proof of a causal relationship between vaccination and reported events. In consideration of public concerns about these events, the Japanese government suspended its proactive recommendation of HPV vaccination in June 2013. As a direct result, the HPV vaccination rate of age-eligible girls fell sharply to only a few percent by 2014 [8]. The safety of HPV vaccination is now a worldwide concern [9,10]. In countries such as the United States, Greece, and Hong Kong, fear concerning adverse reactions to HPV vaccination is a significant reason for avoiding vaccination [11–13].

In many populations, anti-vaccination sentiment has existed in the form doubt, fear, and opposition to vaccination [14,15]. This has had a demonstrable impact on vaccination policies, individuals, and community health [16]. Anti-vaccination messages are

Abbreviations: HPV, human papillomavirus; ELM, elaboration likelihood model.

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especially more common on the Internet than in other media forms [17]. The Internet is cited as one of the main sources of information on immunization for individuals struggling with vaccination decisions in different countries [18–20]. Individuals often use a general search engine and easily produced search terms (e.g., "vaccination"), and these terms return anti-vaccination websites in the top 10 hits [18,21]. Importantly, these websites warn their readership against receiving HPV vaccination [21,22]. HPV vaccination in Japan is no exception. Anti-HPV vaccination activists, who are mostly self-proclaimed specialists lacking specialized knowledge and some health professionals, propagate on the Internet that HPV vaccine has little or no efficacy yet carries a high risk of adverse side effects. Viewing an anti-vaccine website for merely 5–10 min increases perceptions of vaccination risks and decreases perceptions of vaccine omission risks [23]. Moreover, these decreased intentions to vaccinate persisted 5 months later [24]. Thus, HPV vaccination opposition online may incite fear concerning adverse events, stoke anti-vaccination sentiment, and ultimately prolong the HPV vaccination crisis in Japan. This urgent scenario prompted the present study.

We previously assessed the readability of pro- and anti-HPV vaccination websites and found that anti-HPV vaccination messages were easier to read than their pro-vaccination counterparts [25]. Readability of messages may contribute to their ease of acceptance by some audiences [25]. However, in addition to readability, contents of pro- and anti-cancer screening websites may also contribute to readers' acceptance of one or the other position. Although studies have revealed contents of anti-vaccination websites [21,22,26], contents of Japanese anti- and pro-HPV vaccination websites are unknown. Therefore, we aimed to use a text mining method to examine frequently appearing contents on Japanese pro- and anti- HPV vaccination websites. We herein address three research questions: 1) what are the most frequently appearing contents on pro- and anti-HPV vaccination websites; 2) what are the distributions of these contents; and 3) who disseminates these contents.

2. Methods

2.1. Material collection

We conducted online searches on October 5, 2016 using a formula for Japanese-language input entered into the two most popular search engines in Japan, Google Japan (www.google.co.jp) and Yahoo! Japan (www.yahoo.co.jp), which respectively accounted for approximately 66% and 30% of all internet searches in September 2016 [27]. Although the English language has terms such as "vaccine," "vaccination," and "immunization," the Japanese language only contains the terms "wakuchin" and "yobouseshu." "Wakuchin" corresponds to "vaccine" and "yobouseshu" corresponds to "vaccination" and "immunization." Additionally, Japanese refer to HPV vaccine as "sikyu keigan (i.e., cervical cancer) wakuchin." Therefore, the search was performed using the keywords "sikyu keigan AND (wakuchin OR yobouseshu)," which was translated in this manuscript as: cervical cancer AND (vaccine OR vaccination); cervical cancer AND (vaccine OR vaccination) AND (danger OR safe); (side effect OR safety); (benefit OR risk); (approval OR disapproval); (necessary OR unnecessary); (efficacious OR inefficacious); (meaningful OR meaningless); (receive OR not receive). The top 100 results were reviewed for each search formula by the first author. Duplicate listings; bulletin board systems; Twitter; Wikipedia; videos; and websites exclusively about the government's suspension of proactive recommendation for HPV vaccination (e.g.; municipal press releases) were excluded.

2.2. Material classification

The sentiments/claims of the materials were independently classified as "pro," "anti," or "neutral" by two raters: the first author and a trained rater (for coding guidelines, see Table A1). Additionally, "pro" and "anti" materials were classified into categories by the first author according to the authors' professional expertise. Materials were classified as authored by "health professionals" if physicians, nurses, pharmacists, or researchers wrote them or they appeared on websites of pharmaceutical companies, research centers, hospitals, or municipalities because these materials were usually edited by health professionals such as physicians. "Mass media" indicated materials that appeared on websites of newspapers, magazines, or news sites. "Laypersons" was used to refer to materials that appeared on websites of non-medical organizations (e.g., consumer organizations) or written by individuals other than the aforementioned professionals.

2.3. Coding procedure

We analyzed the materials by using a text mining method using KH Coder [28,29], a software program for quantitative content analysis which supports Japanese text. It utilizes ChaSen Morphological Analyzer and the R statistical software environment. KH Coder has been successfully applied for public health studies both in and outside of Japan [30–32]. KH Coder conducts a morphological analysis, lists frequently appearing terms, analyzes hierarchical and co-occurrence relations among terms, and extracts paragraphs or sentences into which coding rules fit.

Coding rules are combinations of terms and logical operators, such as "and," "or," "and not," and "or not." For example, a coding rule to extract paragraphs including a message of "benefit and risk" of medical practice could be: "(benefit or advantage or merit) and (risk or disadvantage or demerit)." In this study, to investigate frequently appearing contents on pro- and anti-HPV vaccination websites, we created coding rules by combining frequently appearing terms and logical operators. Accordingly, our coding procedure began by investigating the most frequently appearing terms in the materials.

The total number of terms analyzed was 176,975, and the total number of unique terms analyzed was 14,810. For clarity of analysis, we excluded common general terms (e.g., "this," "it," and "think") before the investigation. To investigate the most frequently appearing terms, we extracted the top 100 terms in order of higher probability of appearance in all, pro, and anti materials.

We then analyzed those terms by hierarchical cluster analysis (Ward method) [33,34]. The calculation unit was one paragraph, which also applied to the following. Analytical results were presented using a dendrogram, within which lines were drawn to show clusters of terms close in the appearance pattern. This analysis helped to explore how the terms were used in the materials. We also reviewed sentences that included the terms to examine the full context in which the terms were used.

Additionally, we conducted a network analysis of co-occurrence of terms [33,34]. Analytical results were presented in the figure of a network, within which the terms with a great degree of co-occurrence were linked to each other. The degree of co-occurrence was determined using the Jaccard similarity coefficient. This analysis helped to explore the contents that the linked terms represented.

We created coding rules that represented specific contents by combining frequently appearing co-occurring terms. We sought to create as many codes as possible to exhaustively examine frequently appearing contents. We conducted trial analyses,

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