Health information quality of websites on periodontology

Article (Accepted Version)

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Running head: Information quality in periodontology

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Conflicts of interest

The authors have stated explicitly that there are no conflicts of interest in connection with this article.

Acknowledgements

I.B. is supported by the CNPq, National Counsel of Technological and Scientific Development of Brazil.

ABSTRACT

Aim. This study aimed to assess the quality of the information available on the Web on gum disease.

Methods. The term ‘gum disease’ was searched in Google and in MedlinePlus. The first 200 websites were analysed by the Journal of the American Medical Association (JAMA) criteria and the Health On the Net Foundation (HONCode) certification, instruments for assessing quality of health information. Data was analysed through the Mann-Whitney test or Kruskal-Wallis test, followed by the Dunn’s test, using the GraphPad Prism Software version 6.

Results. MedlinePlus presented a significantly higher JAMA score than Google. Google’s first ten results had a higher JAMA score than the remaining websites. Journalism and health portals are the most reliable affiliations, while commercial and dental practices had low JAMA scores. JAMA score was significantly higher in websites with the HONCode certification compared to the ones without it.

Conclusion. There are current concerns regarding patients’ use of the Internet for accessing health information. However, the conclusion we can make is that Google seems to favour websites with high quality information, at least in terms of JAMA score or HONCode accreditation. The JAMA score of dental practices’ websites could be improved by providing basic information such as authorship and date.

CLINICAL RELEVANCE

Scientific rationale. It is important to evaluate the quality of health information available on the Internet on periodontal disease in order to identify potential areas of misinformation and how websites are ranked by Google. **Principal findings.** Commercial websites and those of dental practices did not rank well in Google. Websites from dental practices had a low trustworthiness score. **Practical implications**. Dental practices websites could improve their trustworthiness measures by adding authors names and date. There is little risk of misinformation as Google ranks well health portals and professional websites.

INTRODUCTION

The use of the Internet has become widespread among general public allowing increasing access to health information online. Patients use the Internet for two main reasons, for emotional support and for informational support. Emotional support is fulfilled, on the Internet, by social networks, that provide peer support and sharing experiences (Moorhead et a., 2013). According to a study of seven European countries involving 7934 participants, 44% of the participants and 71 % of the Internet users had used the Internet for seeking health information (Andreassen et al., 2007). Similar results were reported from the Pew Internet & American Life Project (Fox, 2013), 59% of US adults and 72% of Internet users had looked online for health information in the past year. Previous studies indicate that the use of Internet to

search health-related information is not restricted to patients. A cross-sectional survey among GPs in France showed that 84.6% of the participants had used the Internet to seek information in clinical practice (Bernard et al., 2012). Another study, from (Hider et al., 2009), showed that all professional groups (medical, dental, nursing and allied health staff) accessed health information on google. The study reported that 63% of all professionals used Google at least once a month, compared to 42% that used Ovid/PubMed.

The use of the Internet in seeking health information may result in better-informed patients who are more engaged in caring for their health (Sassenberg and Greving, 2016), thus directly affecting the doctor-patient relationship (Christmann, 2013). However, concerns have been raised regarding the dissemination of inaccurate, incomplete or out of date information which may lead to non-evidence based practices or treatments (de Boer et al., 2007). Some professionals also fear that those who consult websites for medical information may not seek a doctor when with serious health problems. However, the study from the seven European countries suggest that this may not be always the case. The study found that the most common reason for using the Internet was to read health information, secondly to decide whether to see a doctor and thirdly, to prepare for and follow up on doctors' appointments (Andreassen et al., 2007).

There are several online sources to search for medical information on the Internet, including health portals, blogs, health-related and commercial websites. According to the Pew Internet & American Life Project (Fox, 2013), 77% of online health seekers use search engines such as Google, Bing, or Yahoo, while only 13% use a website

specialized in health information such as WebMD. Another study conducted in the United States with young participants (19 to 22 years) showed that the major source that they referred to for health information was Google, followed by family and friends, doctors, WebMD, Wikipedia, and the university's online health sources (Zhang, 2013).

To address the concerns regarding the safety of the Internet use in seeking health information, many studies have tried to measure the quality of information available on the web using various instruments (Silberg et al., 1997). The most commonly used are the Journal of the American Medical Association (JAMA) criteria and the Health On the Net (HON) code. The JAMA criteria, originally developed in 1997, assign a score for the quality of the website based on four requirements: disclosure of authorship, attribution of sources (references), disclosure of commercial interest and ownership of the website, and currency (indication of the date of update) (Silberg et al., 1997). The HONCode, developed by The Health on the Net Foundation, is a quality certification granted to websites which stick to eight ethical principles: authorship, complementarity, privacy, attribution, justifiability, transparency, financial disclosure, advertising policy (Boyer et al., 2011).

Our study aimed to assess the quality of health information available on the Internet on ‘gum disease’. ‘Gum Disease’ or periodontal disease is an inflammation and a bacterial infection which affect the tissues supporting the teeth. With time, the disease can cause loss of the teeth and the supporting tissues. (Fotek, 2014). The two most common forms of periodontal diseases are gingivitis and periodontitis. Gingivitis is the result of interaction between the microorganisms found in the dental biofilm and the tissues and inflammatory cells of the host (Kawar et al., 2011). When gingivitis is not

treated it can progress to periodontitis, which is a more advanced and irreversible disease (Research, 2013). Periodontitis is an inflammation of the tissues supporting the teeth, triggered by the host response to oral microorganisms, resulting in progressive destruction of the periodontal ligament and alveolar bone with pocket formation and/or recession. According to the report "Adult Dental Health Survey 2009" (Steele, 2011), showed that 45% of England's population presented a pocket of 4mm or more. In the context of large proportion of population suffering from the periodontal disease, the internet could play a vital role in promoting oral health by providing reliable and accurate oral health information.

The aim of this study was to analyze websites returned by a search engine on a query on periodontal disease by the JAMA criteria as well as by their typology, to identify patterns and potential weaknesses in the transparency/trustworthiness indicators.

METHODS

Identification and selection of websites

We searched the term "gum disease" in the search engine Google.co.uk and in MedlinePlus in June 2016. The search was conducted after having cleared cookies and the browser's history, so that it would not be influenced by previous browsing history. We analysed the first 200 hits of each search engine results page (SERP). Websites were excluded if they had non-accessible links, were not in English and/or

had no information on ‘gum disease’. The flow chart describing how the data were collected and processed is shown in Figure 1.

Classification of website affiliation

We classified the type of websites according to their affiliation (i.e. if they were commercial, dental practices, professional, health portal, journalism or other) (Table 1).

Assessment of trustworthiness (JAMA score and HONCode seal)

Reliability or trustworthiness of the websites were assessed using HONCode and JAMA criteria. Each website received a score according to JAMA criteria (Table 2). For each of these four criteria, we assigned a score of 1 if the information was present, or 0 if absent or unclear. Therefore, websites could obtain a score from 0 to 4 and mean JAMA score of 3 or above has been suggested to be of high quality (Silberg et al., 1997).

The HONCode is a quality certification from the Health On the Net Foundation, a Swiss-based non-profit organization. Accreditation is granted to websites that adhere to 8 ethical principles (Table 2). The HONCode accreditation is considered a reliable indicator of website quality (Bruce-Brand et al., 2013) and is displayed as a HON seal on the website. In the case of a criterion being not visible on the initial webpage, the three-click rule was applied. The three-click rule is an unofficial website navigation rule, which suggests that the information should be available within three clicks

(Zeldman, 2001). If the information is not accessible within three clicks, it was considered absent and given a score of 0.

Manual classification was done by one researcher (IB) and then checked by two independent ones (PP and PG). In case of a discrepancy, this was discussed and we came to an agreement.

Data analysis

Data analysis was performed following an approach used in our previous studies. (Yaqub and Ghezzi, 2015) (Chumber et al., 2015). JAMA scores in different groups of websites were compared using the Mann-Whitney test for comparing two groups and the Kruskal-Wallis test followed by the Dunn's test for more than two groups, using the GraphPad Prism Software (GraphPad Prism Software Inc., La Jolla, USA). Data are reported as median and interquartile range (IQR).

To analyse whether one type of website was differentially represented in the top 10 results from Google (that is, if it was over- or under-represented) we compared its frequency in the top 10 results vs its frequency in the remaining 186 websites. Statistical analysis was performed using contingency tables analysed by a two-tailed Fisher's exact test using GraphPad.

The top ten results were archived using Webcitation.org to allow them to be always accessed by the reader. The spreadsheet with the list of websites returned by Google and MedlinePlus, with their classification, is available as Supplementary online information.

RESULTS

Distribution of websites

The majority of websites found by Google was from Dental Practices (48%), while the majority of websites found by MedlinePlus was Professional (72.5%) (Figure 2).

Google's first ten results presented a different pattern of distribution from the total search. The majority of websites found was Professional (50%), followed by Health Portals (19.4%). Dental practices websites were significantly less represented in the top 10 websites returned by Google comparing to the remaining websites in the SERP (P=0.0022 by Fisher's exact test). Commercial websites were also not found in the top 10.

Analysis of trustworthiness (JAMA score)

Overall, the median JAMA scores of websites returned by MedlinePlus (median, 2; IQR, [2,3]) was significantly higher than that of websites returned by Google (median 1, IQR, [1, 2]); P<0.0001 by Mann-Withney test).

The proportion of websites with a JAMA score ≥ 3 was significantly higher with MedlinePlus (Google, 42/196, 21.4%; MedlinePlus, 59/149, 39.6%, P< 0.0002 by Fisher's exact test).

We then analyzed the JAMA score of websites returned by Google and MedlinePlus according to their affiliation (Figure 3). Google highest JAMA score was found in Journalism websites (median 3, IQR, [2, 3.25]) followed by Health Portals (median 2, IQR, [1, 4]) (Figure 3). On the contrary, Commercial websites scored the lowest (median 1, IQR, [1, 1]), followed by Dental Practices (median 1, IQR, [1, 4]).

Because a JAMA score ≥ 3 is considered high quality (Silberg et al., 1997) we also calculated the percentage of these websites for each category. Percentage of ≥3 JAMA score websites was 21.4% in the whole search, with the following distribution: Commercial, 0%; Dental practices, 3.2%; Health Portals, 47%, Journalism, 72.7%; Professional, 30.2% and Other, 0%. It is evident that Journalism websites scored the highest, followed by Health Portals, while Commercial and Other websites scored the lowest. In MedlinePlus, similarly to what observed in the websites returned by Google, the highest JAMA score was for Journalism and Health Portals (median 2.5, IQR, [2, 3]; median 3, IQR, [2, 3], respectively). If we look at the percentage of websites that have a JAMA score of ≥3, Health Portals score the highest, followed by Journalism, and Other websites the lowest. Percentage of ≥3 JAMA score websites was overall 39.6% with the following breakdown by affiliation: Health Portals, 55.2%, Journalism, 50%; Professional, 38.9% and Other, 0%.

The JAMA score of the top 10 websites returned by Google (median:2.5; IQR: [1.75,4]) was significantly higher (P=0.0008 by Mann Whitney test) than that of the remaining 186 websites of the Google SERP (median:1; IQR: [1,2]). Top 10 results also had a higher proportion of websites with a JAMA score ≥3 (50% **≥3)**.

Comparison of the four components of the JAMA score between affiliations

In order to identify the reasons for the different JAMA scores, we disaggregated the total score in its 4 components, and analyzed them in the different affiliations of websites (Table 3).

It is possible to see that disclosure was not a problem for all the websites categories, with only websites on the 'other' category scoring lower, while several websites lacked in terms of authorship and attribution. In particular, Commercial and Dental Practices websites scored low in most of the components. The percentage of websites meeting the currency criteria was higher in MedlinePlus than Google, with exception of 'Other' websites.

HONCode-certified websites

We then analyzed the number of HONCode-certified websites for the two search engines, in the different affiliations. The proportion of HONCode-accredited sites was very low for both Google and MedlinePlus. Google presented only 7 HONCode+ websites, 5 of them Health Portals (29.4%) and 2 Professional (4.6%). MedlinePlus presented 3 HONCode+ websites, all Professional websites (2.8%). It is interesting to note that most of websites returned by Google with the HONCode accreditation are in the top 10. Google's first ten results presented 4 websites with the accreditation, 3 of which Health Portals (100%) and 1 Professional (20%).

Relationship between JAMA quality criteria and HONCode accreditation

We investigated the relation between the JAMA score and HONCode certification, as shown in Table 4. There was no statistically significant difference in the JAMA score of MedlinePlus websites with ($HONCode^{+}$) or without ($HONCode^{-}$) HONCode accreditation. As for Google's websites, JAMA score was significantly higher in the HONCode+ compared to the HONCode-. HONCode+ websites in Google's first ten results also had a significantly higher JAMA score than the ones without HONCode certification.

DISCUSSION

This study assessed the reliability of health online information related to 'Gum Disease'. We analysed different classes of websites in two search engines, Google and MedlinePlus, using two instruments to measure the trustworthiness of the websites, a basic dimension of information quality. The scientific content of the information provided was not evaluated. The reliability of websites varied between different classes and search engines.

The first thing to note is the difference of trustworthiness between Google and MedlinePlus results. MedlinePlus presented a significantly higher JAMA score than Google. This may happen because while Google just use an algorithm, MedlinePlus is a curated database, which collect and evaluate data before publishing on the website. Therefore, MedlinePlus' results may be more trustworthy than Google's results.

In addition, if we compare Google's first ten results with the remaining websites, the JAMA score was higher in the top 10 results. We may conclude that Google algorithm in some way takes into account some features that are indicators of trustworthiness. In fact, one of the important features for a website to rank well in Google is its structure. It is possible that websites that meet all the JAMA criteria are structurally better organized. This is important because users usually do not go beyond the first results in the SERP (Cutrell E, 2007).

Furthermore, our study found that different affiliations presented different trustworthiness scores. Journalism and Health Portals were the most reliable, with significantly higher JAMA scores. The highest JAMA score of Journalism websites can be explained by the fact that they usually present author and date. Commercial websites had a lower JAMA score, which is in agreement with previous studies (Maki et al., 2015); (Chumber et al., 2015); (Yaqub and Ghezzi, 2015)). This is due to lack of key information in terms of authors' name, date and references.

We also found that Health Portals and Professional websites are more likely to have a HONCode accreditation. In further analysis, we correlated the HONCode certification with the JAMA score and found that Google websites having HONCode accreditation also have a higher JAMA score. We also found that Google ranked higher those websites having a HONCode accreditation. Nevertheless, MedlinePlus websites presented no difference with or without the HONCode. This may be due to the low number of HONCode accredited websites. It is interesting to hypothesize that the accreditation may not spread so much, because the websites must apply for the HONCode and there is a cost for that.

There have been several concerns that patients using the Internet may find wrong or misleading information. However, the general conclusion we can make within the search query studied is that Google seems to favour websites with high quality information, at least in terms of JAMA score or HONCode accreditation. We also found that commercial websites are not ranked high by Google, in agreement with the previous studies (Yaqub and Ghezzi, 2015, Maki et al., 2015). This suggests that the use of the Internet can prepare patients better to the dentist's appointment, improving the professional-patient relationship. Our study on websites returned by Google complements a previous study on information on implant dentistry provided in YouTube videos, that identified potential misinformation (Ho et al., 2016).

The study includes a large number of websites comparing a search engine with a curated database, and a sub-analysis by website typology. However, the study has some limitations: results may be different with different search queries or with localized Google searches (uk, au, nz etc.) and may change over time. Another issue is that the previous search history may affect the results, a phenomenon which was called the "filter bubble", by which we receive a SERP tailored to what we like. However, a recent study has found no evidence of this is health search queries (Haim, 2016). Our study was performed on 200 websites returned by Google, and this is a relatively large number, and as such probably represent a good sample of the websites on this subject, but, in consideration of what discussed above, one cannot generalize these findings, particularly with respect to the ranking given to websites. On the other hand, given that Google is the most used search engine (with around 70% of the market

share for search engines), these are probably the websites that are made visible to the vast majority of the population and patients.

One conclusion that can be made from this study is that Google ranks highly websites with high JAMA score. This is not surprising as author credentials is considered one of the ranking criteria in Google. The fact that the top websites returned in the SERP have higher JAMA score is important because lay persons will preferentially read the first few websites in the SERP. A llimitation of this study is that we only analysed the JAMA score criteria and the HON certification. While these are probably the most used criteria in studies on health information quality, they only measure some aspects of it. Information quality in general has many dimensions (Wang and Strong, 1996) and the JAMA score only measures some of them, mostly around transparency/trustworthiness. Nevertheless, these are considered essential ones in all instruments for the evaluation of health information quality. Nevertheless, our findings point out that some components of the JAMA criteria are more often met than others. For instance, disclosure is met by the vast majority of websites and its lack can probably be a good proxy for lack of transparency that, for instance, the lack of authorship that is more common. Likewise, while most websites, whether news websites or dental practices, meet the “disclosure” criterion as they declare who they are, it is the lack of indication of either ownership, conflicts of interest or advertising policy that is probably an indicator on a non-trustworthy website. Nevertheless, given the correlation of JAMA score and Google ranking, as well as the fact that studies have shown that patients want to be able to check the author’s credentials (Diviani et

al, 2016), suggesting that professional websites, such as dental practices, should include authors' names to improve their ranking and trust.

Finally, like most studies of this type, we analyzed the most basic dimensions of health information quality, and future research will be needed to address other dimensions such as the scientific correctness of the information provided.

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Table 1. Classification of website affiliation

Affiliation	Description	Examples
Professional (P)	Website created by a person or organization with professional knowledge of the information e.g. government, institutions, libraries, universities, publishers, online journals	www.nhs.uk www.nidcr.nih.gov
Commercial (C)	Websites that buy, sell, or provides a service for a fee e.g. profit organizations	www.colgate.com
Health Portal (HP)	Web site with health information on a variety of health topics	www.webmd.boots.com www.medicinenet.com
Dental Practices (D)	Websites of dental clinics or dentists	https://www.marshfieldclinic.org http://www.londonprosthodontics.co.uk
Journalism (J)	Websites from newspapers, magazines or TV.	www.telegraph.co.uk http://thedailyhealth.co.uk
Other (O)	Websites from non-profit organizations or websites that do not fit into any of the other affiliations. E.g. social networking sites.	www.bsperio.org.uk/ www.dentistry.co.uk

(Modified from (Chumber et al., 2015))

Table 2. JAMA and HON Criteria

JAMA Criteria	**Authorship**	Identify of authors/contributors
	Attribution	List sources of information or references
	Disclosure	Declare of ownership, advertising, conflict of interests
	Currency	Indicate of date content was posted or updated
HON Criteria	**Authoritativeness**	Indicate the qualifications of the authors
	Complementarity	Information should support, not replace, the doctor-patient relationship
	Privacy	Respect the privacy and confidentiality of personal data submitted to the site by the visitor
	Attribution	Cite the source(s) of published information, date medical and health pages
	Justifiability	Site must back up claims relating to benefits and performance
	Transparency	Accessible presentation, accurate email contact
	Financial disclosure	Identify funding sources
	Advertising policy	Distinguishes advertising from editorial content

Table 3. Percentage of websites in each affiliation meeting the specific criteria.

	Website class	Authorship	Attribution	Disclosure	Currency
Google	**Commercial**	8.3	16.6	100	0
	Dental Practices	9.6	3.2	100	4.2
	Health Portals	41.2	52.9	94.1	52.9
	Journalism	68.2	31.8	100	90.9
	Professional	30.2	34.9	97.6	48.8
	Other	25	12.5	62.5	62.5
	Total (196)	24	18.9	97.4	30.1
MedlinePlus	**Commercial**	-	-	-	-
	Dental Practices	-	-	-	-
	Health Portals	51.7	10.3	100	86.2
	Journalism	50	0	100	100
	Professional	25	32.4	100	83.3
	Other	0	10	100	20
	Total (149)	28.8	26.2	100	79.9

Percentages are calculated on the total number of websites.

Table 4. JAMA score of websites with or without HONCode certification

	HONCode-	**HONCode+**
Google	M=1; IQR=1,2 (n=189)	M=4; IQR=4,4 (n=7)**
MedlinePlus	M=2; IQR=2,3 (n=146)	M=3; IQR=1,3 (n=3)
Google (top 10)	M=2; IQR=1,2.25 (n=6)	M=4, IQR=4,4 (n=4)*

M, median; IQR=Interquartile Range. The JAMA scores of HONCode- and HONCode+. were compared by the Mann-Whitney test. * $P<0.005$; ** $P< 0.0001$.

FIGURE LEGENDS

Figure 1. Data collection and analysis process

Figure 2. Distribution of websites generated from search in Google or MedlinePlus according to their affiliation.

Figure 3. JAMA score in different affiliations and search engines. Panel A, Google; panel B, Google top 10; panel C, MedlinePlus. Data are median and IQR. Values bearing the same symbol are significantly different from each other, capital letters, $P<0.0001$; lowercase letters, $P<0.001$; numbers, $P<0.05$ by Kruskal-Wallis test.

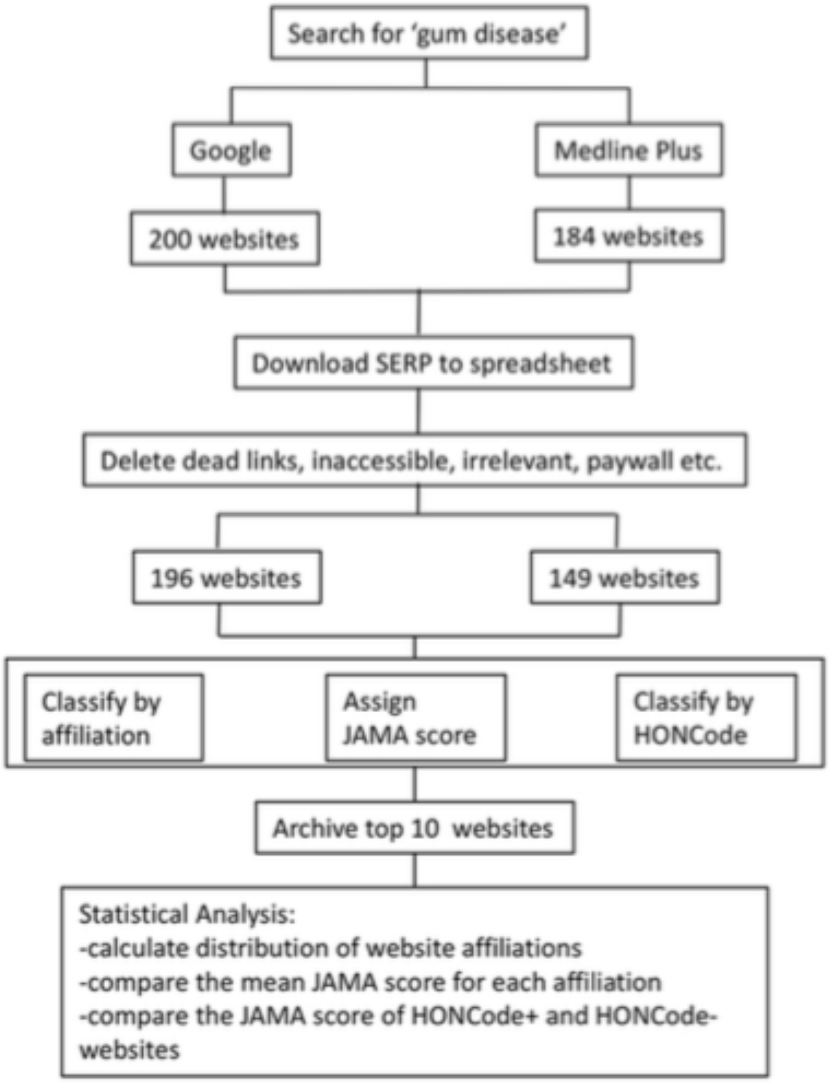


Figure 1. Data collection and analysis process

Figure 1

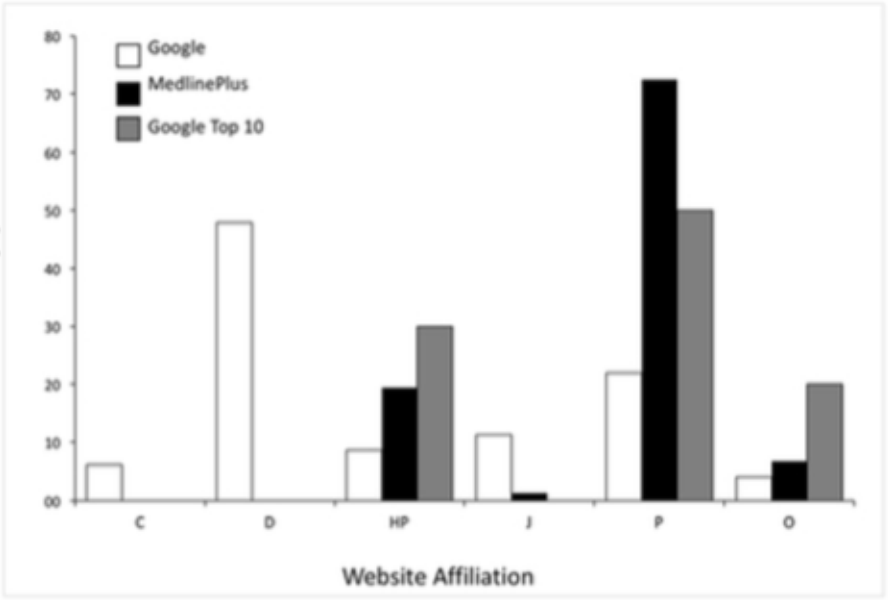
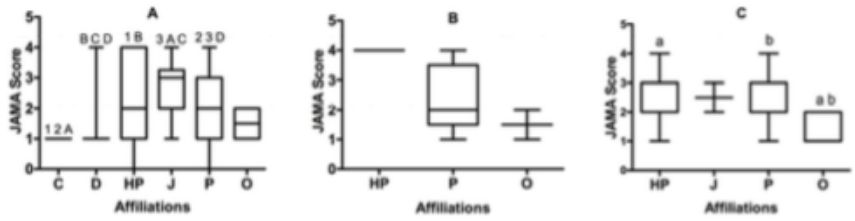


Figure 2. Distribution of websites generated from search in Google or MedlinePlus according to their affiliation

Figure 2



Caption : Figure 3. JAMA score in different affiliations and search engines. Panel A, Google; panel B, Google top 10; panel C, MedlinePlus. Data are median and IQR. Values bearing the same symbol are significantly different from each other, capital letters, P<0.0001; lowercase letters, P<0.001; numbers, P<0.05 by Kruskal-Wallis test.