

Surfing for mouth guards: assessing quality of online information

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Abstract – *Introduction:* The Internet is an easily accessible and commonly used source of health-related information, but evaluations of the quality of this information within the dental trauma field are still lacking. *Aim:* The aims of this study are (i) to present the most current scientific knowledge regarding mouth guards used in sport activities, (ii) to suggest a scoring system to evaluate the quality of information pertaining to mouth guard protection related to World Wide Web sites and (iii) to employ this scoring system when seeking reliable mouth guard-related websites. *Materials and methods:* First, an Internet search using the keywords ‘athletic injuries/prevention and control’ and ‘mouth protector’ or ‘mouth guards’ in English was performed on PubMed, Cochrane, SvedMed+ and Web of Science to identify scientific knowledge about mouth guards. Second, an Internet search using the keywords ‘consumer health information Internet’, ‘Internet information public health’ and ‘web usage-seeking behaviour’ was performed on PubMed and Web of Science to obtain scientific articles seeking to evaluate the quality of health information on the Web. Based on the articles found in the second search, two scoring systems were selected. Then, an Internet search using the keywords ‘mouth protector’, ‘mouth guards’ and ‘gum shields’ in English was performed on the search engines Google, MSN and Yahoo. The websites selected were evaluated for reliability and accuracy. *Results:* Of the 223 websites retrieved, 39 were designated valid and evaluated. Nine sites scored 22 or higher. The mean total score of the 39 websites was 14.2. Fourteen websites scored higher than the mean total score, and 25 websites scored less. The highest total score, presented by a Public Institution Web site (Health Canada), was 31 from a maximum possible score of 34, and the lowest score was 0. *Conclusion:* This study shows that there is a high amount of information about mouth guards on the Internet but that the quality of this information varies. It should be the responsibility of health care professionals to suggest and provide reliable Internet URL addresses to patients. In addition, an appropriate search terminology and search strategy should be made available to persons who want to search beyond the recommended sites.

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Accepted 12 April, 2011

Traumatic dental injuries (TDIs), which are common in both primary and permanent teeth, have become a major public dental health challenge. They are mostly irreversible, often involve long-term sequel and present expensive follow-up costs (1–3).

One of the most common causes of facial injuries is sporting injuries, with dental injuries being the most common type of orofacial injuries (2). Despite this, in only a few sports (e.g. American football, boxing, ice hockey and lacrosse) is the use of a mouth guard (also known as a mouth protector, mouth piece or gum shield) mandatory (4). In a Swedish county, approximately 25% of tooth and maxillary injuries in the age interval 7–30 years during the period 1989–1990 were caused by sports (5). Reports have indicated that approximately 33% of all TDI episodes and up to 19% of injuries to the head and face were sports related (6–9).

Evidence shows that use of a mouth guard has a protective role in reducing TDIs and soft tissue injuries

during sport activities (10). However, they also have disadvantages, such as lack of comfort, tissue reaction, and breathing and speaking difficulties, which influence their use (2, 10).

Different kinds of health information are widespread on the Internet, and therefore, members of the public commonly use the Internet to obtain confirmation given by health professionals. The Internet may also gather additional health information in case of dissatisfaction with the information provided by professional caregivers (11).

Riordáin & McCreary (12) explored the utilization of the Internet among dental patients, by giving a self-administered, anonymous questionnaire to fill in. The result was that the majority of the patients used the Internet daily for variable purposes. They also found that every third patient looked for or had a family member and looked for information concerning his or her present dental/oral condition. Among patients who

looked for information, Google was the most frequently used search engine, and the majority affirmed that the information obtained had medium or high quality.

The problem is no longer finding health information but assessing the quality of this information. Quality of health information is often related to the concept of reliability, accuracy, trustworthiness, currency and authoritativeness. But completeness and relevance of this information are dimensions with a growing value regarding the definition of quality of health information (13). Incomplete and misleading health or medical information has a potential harmful effect and as the interpretation of this kind of information is an acquired skill, the quality of web information should therefore be ensured (14).

Health on the Net Foundation (HON) is a non-profit, non-governmental organization accredited to the Economic and Social Council of the United Nations. The organization aims to provide individuals with information about the reliability of web documents with medical content to protect citizens from misleading information (15, 16). HON has three major features of its activity: a HONcode of Ethical Conduct, a database of accredited medical websites and automatic tools to help users and human reviewers assess the quality of medical sites (15).

Although numerous strategies to assess the quality of health-related information websites have been discussed in the literature, no studies, to our knowledge, are available evaluating the quality of dental information.

Some articles assess reliability based on the criteria identified by Eysenbach et al. (17) in their systematic review of assessing the quality of health information for consumers on the World Wide Web (WWW) (18–21). Other studies have employed an organization's generic tools or established principles. Generic tools that have been used are the HONcode toolbar, Information Quality (IQ) tool and DISCERN (22). Established principles that have been employed are HON principles and the European Commission Quality Criteria for health-related websites (23, 24). Other researchers have developed their own scoring systems to evaluate the contents on the websites (14, 19–21, 23). Consensus, however, has not yet been achieved. Furthermore, all instruments have limitations, and quality of online health information is still only partially guaranteed.

Therefore, the aims of this study are (i) to present the most current scientific knowledge regarding mouth guards used in sport activities, (ii) to suggest a scoring system to evaluate the quality of website information pertaining to mouth guards and (iii) to use this scoring system when seeking reliable and informative websites on issues related to mouth guards.

Material and methods

Scientific knowledge of mouth guards

To gather scientific knowledge about mouth guards, an Internet search was performed using the keywords 'athletic injuries/prevention and control' and 'mouth protector' or 'mouth guards' in English on PubMed, Cochrane, SvedMed+ and Web of Science.

The categories resulting from the Internet search were the following: type of mouth guards, materials, fabrication, physical properties, physiological effects and efficacy in reducing the incidence of TDIs.

Development of a website scoring system

By using the keywords 'consumer health information Internet', 'Internet information public health' and 'web usage-seeking behaviour', an Internet search was performed on PubMed and Web of Science. This search was performed in an effort to obtain scientific articles that evaluated the quality of mouth guard information on the web. Two scoring systems were selected. The first scoring system was used to evaluate reliability of the information in the websites. Reliability measures to what extent it is possible to trust the information contained in a website, i.e. the credibility of the website. Reliability was assessed using Corcoran et al.'s (19) 'Chronic Pain Quality Score' (Table 1). The authors applied the principles of Health on the Net code (16) and the 26 terms described by Eysenbach et al. (25, 26) as being used by multiple health care websites reviews. This scoring system was chosen because in the current study, only one person (MM) rated the websites, and the scoring developed by Corcoran et al. (19) does not include the items with the lowest inter-rater reliability.

The reliability score comprises the following elements:

- 1 Authorship: the authority of the information of the websites, i.e. who is responsible for the written contents.
- 2 Credentials and qualifications of the author
- 3 Availability of contacting the provider: e-mail, contact information
- 4 Copyright
- 5 Reference quantity and quality
- 6 Ownership
- 7 Purpose
- 8 Original date and date of the last updating of content.

This section can result in a total score of 14 points. Authorship, contact information, copyright/trademark, ownership, original date and revised updates score 1 if present or 0 if absent. Qualification, reference quantity, reference quality and purpose have three levels of scoring: 0, 1 and 2, and these scores are exclusive, i.e. if a site scores 1, it cannot score 2, and vice versa. Thus, the maximum score of these four items is two each, yielding a total score of 14 (Table 1).

A second scoring system evaluated accuracy and was developed after identifying knowledge related to mouth guards based on the categories presented in 'scientific knowledge of mouth guards'. Accuracy measures to what extent there is agreement between the information presented in peer-reviewed articles and in websites. The accuracy criteria are an arbitrary selection of topics derived from the literature reviewed. The evaluation comprises a certain amount of topics included in the following areas (Table 1).

- 1 Risk factors
- 2 Definition
- 3 Type of mouth guards
- 4 Materials
- 5 Fabrication

Table 1. Criteria and scoring system for evaluating the reliability (Chronic Pain Quality Score reference number 19) and accuracy of the retrieved websites

Criteria reliability	Score	Criteria accuracy	Score
Authorship		Risk factors	
Names(s) identified	1	Discussed and totally correct	2
No author identified	0	Discussed and partially correct	1
		Not discussed	0
Qualification		Definition	
Health care professional	2	Discussed and totally correct	2
Vague qualification or personal experience	1	Discussed and partially correct	1
No information/no experience	0	Not discussed	0
Contact information		Type of mouth guard	
Telephone, email or address	1	Discussed and totally correct	2
No contact information	0	Partially correct	1
		Not discussed	0
Copyright/Trademark		Materials	
Present	1	Discussed and totally correct	2
Absent	0	Discussed and partially correct	1
		Not discussed	0
Reference quantity		Fabrication	
Attribution for all factual statements	2	Discussed and totally correct	2
Attribution for some but not all	1	Discussed and partially correct	1
No references	0	Not discussed	0
Reference quality		Physical properties: protective capability, durability and stability	
Contacts provided for all references	2	Discussed and totally correct	2
Contacts not readily accessible	1	Discussed and partially correct	1
Contacts ambiguous or non-functional	0	Not discussed	0
Ownership		Physiological effects	
Ownership rights/Sponsorship/Organization/Company clearly stated	1	Discussed and totally correct	2
No ownership information	0	Discussed and partially correct	1
		Not discussed	0
Purpose		Indications of use	
Distinction made that the information is for commercial/educational use or both	2	Discussed and totally correct	2
Stated as educational but with potential for financial profit	1	Partially correct	1
No statement of purpose	0	Not discussed	0
Original date		Benefits and protection	
Original date provided	1	Discussed and totally correct	2
No date	0	Discussed and partially correct	1
		Not discussed	0
Revised updates		Ideal characteristics	
Any dates of revision or frequency of updates stated	1	Discussed and totally correct	2
No revision dates provided	0	Discussed and partially correct	1
		Not discussed	0

The addition of the numbers in bold gives the maximum total reliability and total accuracy score of 14 and 20.

6 Physical properties

7 Physiological effects

8 Indication of use

9 Benefits and protection

10 Ideal characteristics.

A three-point scale (Yes, Partly/Not sure, No) was used to score whether the information on the specific issue is present or not in the website.

Each one of these 10 items has a three-point scoring system: 2 if discussed and totally correct, 1 if discussed and partially correct and 0 if not discussed. These scores are exclusive because a website cannot have a subject totally and partially discussed at the same time. The maximum score is 2 for each item. A maximum score of 20 points is possible (Table 1).

The categories were formulated into items assessing whether the website contained this information or not.

Identification and evaluation of websites

An Internet search using the keywords 'mouth protector', 'mouth guards' and 'gum shields' in English was performed on the search engines Google (<http://www.Google.com>), MSN (<http://www.msn.com>) and Yahoo (<http://www.Yahoo.com>). These keywords were chosen in accordance with what a consumer might use as search terms. Because of time restraints and because most searches performed by individuals only access the first page of search results and rarely examine beyond 50 sites (14, 22, 25), only the first three pages given by each search were checked, and the first 10 valid hits of each query were considered for analysis. The evaluation was conducted on the first page that appears after clicking a link.

Websites were regarded as invalid if the links were broken, if the website did not contain information

related to the search term, if they only contained advertising items for sale or if they required membership or payment for access to the information. Peer-reviewed articles were not considered. The identified sites were screened using a HONcode toolbar function (downloaded from <http://www.hon.ch/>), which detected the HONcode status of a website (15). When the HON logo was present at the website, the quality criteria of the HON Foundation have been met and the site is accredited. The quality criteria of the HON Foundation are authoritative (indicates the qualification of the author), complementarity (information should support and 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 and medical and health pages), justifiability (site must backup claims relating to benefits and performance), transparency (accessible presentation and accurate email contact), financial disclosure, (identify funding sources) and advertising policy (clearly distinguish advertising from editorial content) (16).

All the websites were then evaluated for reliability and accuracy using the two scoring systems described previously.

Results

Scientific knowledge about mouth guards

Custom-made mouth guards are constructed in a dental laboratory on a stone cast taken from a dental impression designed and made by a dentist (27). They are superior to stock type and self-adapted mouth guards in terms of margin adaption, stability and retention (28). Because they are tailor-made, custom-made mouth guards are more protective and more easily accepted by the individual (29). There is evidence that properly fitted custom-made mouth guards show optimal comfort and wear stability (30, 31). In addition, coaches and trainers have reported minimal complaints (10). Custom-made mouth guards are more expensive than other types (30), but should be recommended to reduce problems, such as breathing difficulties and speaking problems. Custom-made or self-adapted mouth guards with a proper retention and without bulky margins do not alter ventilation at rest or during exercise (30). A boil and bite mouth guard supervised by a dentist is considered a 'properly fitted mouth guard' by the Academy for Sports Dentistry (10).

EVA mixture (ethylene vinyl acetate) is thought to be the ideal mouth guard material. After taking into account such factors as tear strength and water absorption, 18% of PVA (polyvinyl acetate) is recommended (27).

To protect the tooth–bone complex during traumatic events, the mouth guard material should have rigid stress-dissipating capability and soft shock-absorbing ability (10).

The few studies with acceptable design and proper statistical analysis have reported that mouth guards are effective in reducing TDIs (10). However, because of a

lack of randomized clinical trials, further studies are needed, which, because of ethical concerns, may be difficult to accomplish. There is also evidence that the protective role of custom-made mouth guards is higher than the effect of commercial mouth guards (10). Further studies should be undertaken to improve materials and design, as well as to develop an instrument to test protection, comfort, resilience, tear-resistance, odour, taste, cost, fabrication and interference with speech (27).

General evaluation of websites

Totally, 223 websites were retrieved. However, of these 223 sites, 152 were excluded for the following reasons: advertising (86), no relevant information (60), scientific articles (4) and broken links (2). Thirty-two websites were duplicated among the 71 that were eligible for analysis, leaving a final sample of 39 unique websites to be scored (Fig. 1).

The majority of websites were from commercial organizations (17) followed by newspapers (8) and professional associates (6) (Table 2). Table 2 lists the total number of websites for each authority category, their maximum and minimum score and their mean total score. In the 'authority category', commercial organizations scored the lowest (7.8).

The list of the 39 unique websites is shown in Appendix 1. Every website has a number, which is employed as nomenclature in Tables 3 and 4.

Reliability and accuracy scores, including HON status and authority category, are shown in Table 3, which also includes the search engine by which each website was retrieved: Google (G), Yahoo (Y) and MSN (M). In some cases, more than one engine retrieved the same website.

The professional associations were the American Dental Association (ADA, websites 1 and 2), the International Academy for Sports Dentistry (IASD, website 2), the American Academy of Paediatric Dentistry (AAPD, website 9), the California Dental Association (CDA, website 18), the British Dental Health Foundation (BDHF, website 19) and the Academy of General Dentistry (AGD, website 36).

Reliability score

In terms of reliability (Tables 1 and 3), 20 of 34 websites had identified an author and 19 of these 20 had a qualified author (health care professional). Website 12

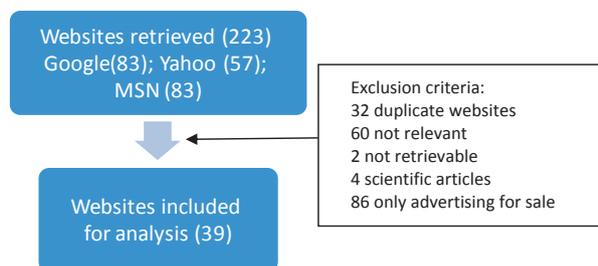


Fig. 1. Web site selection process.

Table 2. Authority category of the websites

	Number	Mean total score	Min	Max
Commercial organization	17	7.8	0	17
Newspaper/News/Health info site	9	20.4	6	28
Professional association/Health care org.	7	16.3	12	25
Government agency/Public institution	2	28.5	13	31
Private person	1	28	28	28
Social media	1	17	17	17
Encyclopaedic	1	16	16	16
University	1	13	13	13
Total	39	14.2	0	31

had identified author but no information about that person's experience or qualification. The majority of the websites without an author were commercial websites

(websites 6–8, 13–17, 23–26, 29 and 39) but also encyclopaedic (number 5), news/newspapers (websites 22 and 34), health care organization (website 10) and university (website 30).

Twenty-two of the websites had contact information, 29 had a copyright and 28 ownership.

Only 2 websites had attribution for all factual statements: one commercial site (website 7) and one social media site (website 20); 13 websites had attribution for some statements but not all. Nine sites scored 2 and five scored 1 in relation to reference quality. Websites 7 and 20 provided contacts for all the references. Only 11 websites stated a clear purpose, only 9 had an original date, while 10 provided revised updates.

Accuracy score

In terms of accuracy (Tables 1 and 4), the less-discussed subjects were physical properties, materials, physiological

Table 3. Tabulation of the unique websites evaluated in this study

Link	Authority of the information	Search engine			HONcode status	Reliability score	Accuracy score	Total score
1	Prof assoc (ADA)	G	Y	M	Non-accr	8	9	17
2	Prof assoc (ADA/IASD)		Y	M	Non-accr	12	13	25
3	Health info site	G	Y	M	Non-accr	11	17	28
4	Newspaper	G			Accredited	10	13	23
5	Encyclopaedic	G	Y	M	Non-accr	8	8	16
6	Commercial org	G	Y		Non-accr	3	3	6
7	Commercial org		Y	M	Non-accr	6	6	12
8	Commercial org	G			Non-accr	1	10	11
9	Prof association (AAPD)	G	Y	M	Non-accr	6	10	16
10	Health care org	G		M	Non-accr	4	10	14
11	Private person	G	Y	M	Accredited	12	16	28
12	Commercial org	G		M	Non-accr	4	7	11
13	Commercial org	G		M	Non-accr	1	10	11
14	Commercial org		Y	M	Non-accr	3	7	10
15	Commercial org	G		M	Non-accr	0	4	4
16	Commercial org	G		M	Non-accr	2	4	6
17	Commercial org		Y		Non-accr	2	0	2
18	Prof association (CDA)	G			Non-accr	4	10	14
19	Prof association (BDHF)	G		M	Non-accr	5	7	12
20	Social media	G			Non-accr	10	7	17
21	Public institution	G			Non-accr	5	8	13
22	News	G			Non-accr	2	4	6
23	Commercial org	G	Y		Non-accr	2	5	7
24	Commercial org		Y		Non-accr	3	2	5
25	Commercial org		Y		Non-accr	2	3	5
26	Commercial org			M	Non-accr	3	3	6
27	Newspaper	G			Accredited	10	12	22
28	Commercial org		Y		Non-accr	7	10	17
29	Commercial org		Y		Non-accr	3	6	9
30	University		Y		Non-accr	4	9	13
31	Public institution		Y		Non-accr	13	18	31
32	Newspaper	G	Y		Accredited	9	14	23
33	Newspaper		Y		Accredited	11	18	29
34	Newspaper		Y	M	Non-accr	3	9	12
35	Commercial org			M	Non-accr	6	6	12
36	Prof association (AGD)		Y		Non-accr	7	11	18
37	Newspaper		Y		Non-accr	8	10	18
38	Newspaper		Y		Accredited	8	15	23
39	Commercial org	G	Y	M	Non-accr	0	0	0

G, website retrieved by Google search engine; Y, website retrieved by Yahoo search engine; M, website retrieved by MSN search engine (In some cases, more than one engine retrieved the same website).

Accredited: accredited status by HON according to the HONcode Tool bar.

Websites in bold text scored 22 or higher.

Table 4. Total number of websites scoring 2, 1 or 0 for each item on the accuracy score questionnaire

	Accuracy score		
	2	1	0
Risk factors	12 (sites 2, 3, 7, 8, 9, 11, 12, 18, 29, 31, 32, 33)	16 (sites 1, 4, 5, 6, 10, 13, 14, 15, 16, 19, 21, 27, 28, 30, 34, 36)	11 (sites 17, 20, 22, 25, 26, 27, 28, 35, 37, 38, 39)
Definition	13 (sites 4, 5, 8, 11, 19, 20, 21, 31, 32, 33, 36, 37, 38)	6 (sites 2, 9, 10, 23, 24, 28)	20 (1, 3, 6, 7, 12–18, 22, 25–27, 29, 30, 34, 35, 39)
Type of mouth guard	16 (sites 1, 3, 4, 10, 11, 13, 14, 18, 27, 30, 31, 32, 33, 36, 37, 38)	12 (sites 2, 5, 9, 19, 20, 21, 22, 23, 28, 29, 34, 35)	11 (sites 6, 7, 8, 12, 15, 16, 17, 24, 25, 26, 39)
Materials	1 (site 33)	13 (sites 3, 5, 11, 13, 14, 18, 20, 25, 26, 27, 31, 32, 38)	25 (sites 1, 2, 4, 6, 7, 8, 9, 10, 12, 15, 16, 17, 19, 21, 22, 23, 24, 28, 29, 30, 34, 35, 36, 37, 39)
Fabrication	10 (sites 3, 13, 18, 27, 31, 32, 33, 36, 37, 38)	18 (sites 1, 2, 4, 5, 9, 10, 11, 14, 19, 20, 21, 22, 23, 25, 26, 28, 30, 34)	11 (sites 6, 7, 8, 12, 15, 16, 17, 24, 29, 35, 39)
Physical properties	3 (sites 3, 8, 31)	9 (sites 2, 4, 10, 11, 12, 26, 27, 33, 38)	27 (sites 1, 5, 6, 7, 9, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 28, 29, 30, 32, 34, 35, 36, 37, 39)
Physiological effects	1 (site 3)	17 (1, 2, 4, 9, 10, 11, 13, 15, 16, 27, 28, 30, 31, 33, 34, 35, 38)	21 (5, 6, 7, 8, 12, 14, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 29, 32, 36, 37, 39)
Indications of use	18 (2, 3, 7, 8, 11, 12, 13, 18, 28, 29, 30, 31, 32, 33, 34, 36, 37, 38)	15 (1, 4, 5, 6, 9, 10, 14, 15, 16, 19, 21, 22, 23, 27, 35)	6 (17, 20, 24, 25, 26, 39)
Benefits and protection	19 (1, 2, 3, 4, 7, 8, 9, 11, 12, 21, 30, 31, 32, 33, 34, 35, 36, 37, 38)	17 (5, 6, 10, 13, 14, 15, 16, 18, 19, 20, 22, 23, 24, 25, 27, 28, 29)	3 (sites 17, 26, 39)
Ideal characteristics	9 (2, 3, 4, 11, 27, 28, 31, 33, 38)	7 (1, 9, 10, 20, 32, 34, 35)	23 (5, 6, 7, 8, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25, 26, 29, 30, 36, 37, 39)

effects and ideal characteristics. The most discussed subjects were benefits and protection, indications of use, type of mouth guard, fabrication and risk factors. One website scored 2 in materials (website 33) and in physiological effects (website 3). Three sites scored 2 in physical properties (websites 3, 8 and 31).

Scoring results

Nine websites (in bold text in Appendix 1 and Table 3) scored 22 or higher.

The total number of HON accredited sites was 6 or 15.4% of the total hits, with a mean total score of 24.7 (maximum score 34) (Table 3). The highest total score, attained by a Public Institution website (Health Canada, number 31 in Table 3), was 31 from a maximum possible score of 34. The lowest scoring site was a commercial website, with a total score of 0. The mean total score of the 39 websites was 14.2. Fourteen websites scored higher than the mean total score, and 25 websites scored less.

Discussion

The overall aim of this study was to assess the quality of online information regarding mouth guards, because the

Internet has permitted quick access to a high volume of medical/dental information. The main result was that out of 223 websites, only 39 websites seemed to provide some form of information and were chosen for analysis. Almost a third of the websites had a total score of < 10, which might indicate low reliability and/or accuracy of the information provided.

A Public Institution website attained the highest total score (31 from a maximum score of 34), and the lowest score was 0 attained by a commercial website. Commercial websites offer stock-type or self-adapted mouth guards. Based on the literature, these mouth guards are not the best in terms of margin adaptation, stability and retention. In addition, they do not offer the best protection against dental trauma. The number of commercial websites and their low mean score (7.8) are probably the reasons for the overall low mean total score (14.2).

The present analysis shows that the Internet phenomenon has made copious amounts of information available, although it is not so easy to obtain relevant information on the subject, and the credibility of this information is suspect. Earlier studies about information on osteoporosis, anxiety disorders treatment and knee arthroscopy experienced a similar situation during identification of relevant websites (18, 32, 33).

The amount of information available on the Internet is increasing, and thus, concern has been expressed about the quality of this information. Despite this concern, only a handful of studies have recently assessed the quality of health-related information on different topics, such as epilepsy (34), anaesthesia (19, 35), breast cancer (23, 36), menopause (37), asthma (38), osteoporosis (33), chronic pain (19), scoliosis (39), urology (14, 22), anxiety disorders (18) and cystic fibrosis (21). Among these studies, only one was found in the area of dental health describing dental patients' use of the Internet, but this study did not assess the quality of the dental health information (12). Our study is therefore unique in this respect.

Among search engines, Google is the most popular with its 150 million searches per day (40). Several studies have therefore used Google, Yahoo and MSN as search engines (18–20).

The number of websites evaluated in this study is likely satisfactory and representative in that a regular Internet user would visit the first 10 results of every search, i.e. the first page of search results and rarely examine beyond 50 sites (14, 22, 25).

A high degree of overlap was observed during the nine searches (three per search engine). After excluding non-relevant websites, the number of duplicated websites was 32. Some of these websites were even triplicate or more, i.e. they were retrieved in almost every search. A high degree of overlap might indicate that saturation was achieved, suggesting that a sufficient number of search engines and search words were used.

The accuracy and reliability scores used in this study were developed based on the score systems utilized in studies with a similar aim in different health-related topics. However, no studies were found in the area of dental health and specifically in dental traumatology or studies related to mouth guards.

Websites designed to educate patients have the potential to become a powerful instrument among the tools of health care professionals: the education of patients about their condition has a positive effect in their relationship with health care professionals. Informed patients tend to cooperate in a better manner with treatment plans and to have improved health outcomes (41).

The majority of the websites were sponsored by a commercial organization (17 websites), a professional association (seven websites) and health magazines or newspapers (nine websites). The university-sponsored site did not score higher, a finding consistent with one study concerning evaluation of the quality and contents of asthma education on the web and another on management of childhood diarrhoea (38), but it is not possible to draw any conclusions because only one university website was retrieved in this study.

Only six of 39 websites presented the logo of the HON Foundation in the website HONcode tool, which might indicate a low interest for accreditation. This attitude could be as a result of a lack of widespread acceptance and public awareness about the existence of standardized tools for evaluating websites (34) or because there is no regulation related to health information websites.

Accreditation is voluntary, and the website's owner must actively apply for it to the HON Foundation. To know whether a non-accredited site meets the quality criteria requested of the HON Foundation, it is possible to answer a questionnaire available online (42). This study does not include manual evaluation of the accomplishment of HON principles, nor does the study allow any statistical comparison between the scores of accredited and non-accredited sites.

There were some differences in availability of relevant websites among the three search words used. The term 'gum shield' resulted in more non-relevant and advertising sites than the terms 'mouth protector' and 'mouth guard' in all search engines. This finding indicates the importance of having adequate terminology to access the correct information. Nowadays, patients and consumers can quickly access a high volume of medical information, but they need to be informed about appropriate search terminology and search strategy. Because online health information influences decision-making regarding health care choices and treatment, it is paramount that these patients gather the right information (43).

When comparing scientific knowledge regarding mouth guards and information included in the websites evaluated online, information was, in general, correct but in some cases incomplete. Only some commercial websites tended to mislead the decision-making process by omitting relevant information and not because of false statements. Most websites (1–5, 9–11, 13, 14, 18–23, 27–38) presented clear information about different kinds of mouth guards and recognized the custom-made mouth guard as the best but also as the most expensive option.

The most popular subjects were types of mouth guard, fabrication, risk factors, indications of use, benefits and protection. Less popular topics were physical properties, physiological effects, materials and ideal characteristics (Table 4). The lack of information about physiological effects might be because the topic is not yet completely understood. Ideal characteristics should probably be discussed more often to guide the consumers in their choice.

During the evaluation process, the topic 'how to take care of the mouth guard' appeared in some websites. This item was not included in the accuracy score but should be included in further studies because of its relevance, especially from a consumer's standpoint.

There is probably a relationship between reliability and accuracy scores, as suggested by the observation that only two commercial websites (websites 8 and 13) presented a high difference between reliability and accuracy scores, having 1 score in reliability and 10 scores in accuracy. Further studies are therefore needed to confirm this relationship to find out whether there is any relationship between reliability and accuracy scores. Ogunwale et al. (44) reported a strong, positive correlation between the score of every website in each assessment category (credibility, usability, currentness, total content and disclosure/bias) and the total score for that website.

When comparing reliability and accuracy scores, the expected result should be that websites with higher reliability scores are more likely to include information

that is more accurate. If this association exists, Internet users should start getting information about how to assess reliability of a website with such items as authorship and ownership disclosure, references and contact information. It is much easier to develop a generic tool to evaluate reliability than to evaluate accuracy, because the latter must be specific to each topic.

Corcoran et al. (19) proposed 'information prescription' as a way to assure the patient would obtain the right information. Information prescription is a list of websites directing patients to relevant and reliable information about the subject matter. This might be a good suggestion depending on the types of patient and their age group.

In Sweden, all county councils sponsor the website <http://www.1177.se>, which is a forum for searching scientific knowledge in health care. Qualified health professionals write and control all information presented in this website. Via this link, consumers have access to reliable information and can obtain advice through the Internet and telephone.

The majority of TDIs occur during childhood and adolescence, i.e. before the age of 19 (1). During sport activities, the age interval for TDIs is higher (between 21 and 30 years) for both men and women (45). This finding indicates that our target groups for promotion and information about mouth guards are children and their parents, teenagers and young adults. These are groups that in general present middle to high competence in the use of online search tools. Information prescription might function as a starting point but it is far from being a total solution. Education as a means to develop a critical way of viewing online information is crucial. It is our belief that such responsibility must be shared by different sectors, including the education system, professional health care providers and the media.

Limitations of the study

The accuracy and reliability of the questionnaires used for the evaluation were not validated and their reliability was not checked. Hence, their use for similar purposes in other studies is questionable. Further studies must therefore validate the scoring systems proposed in this study. One possible change to the reliability score questionnaire (Table 1) is to include the item 'presence of a third-part certification/independent quality level': for example, the use of the HON certification as used in Ogunwale et al. (44).

In addition, because only one observer (MM) rated the websites, inter-rater reliability could not be assessed. However, the generic HONcode tool was developed by an authoritative organization (HON Foundation), and the reliability score used in this study was based on the scoring system used by previous researchers.

HONcode principles have been described, used and assessed in several studies (15, 22, 24, 33, 46). Boyer et al. (15), for instance, have presented the HON strategies to inform citizens about the reliability of medical content on the web, and Gaudinat et al. (46) presented the design and evaluation of the automatic system developed to categorize medical and health documents according to

the HONcode ethical principles. Lawrentschuk et al. (22) applied HON principles in their article on assessing quality of uro-oncological websites, and Yegenoglu et al. (24) employed HON principles to evaluate quality of Turkish community pharmacy websites. Whelan et al. (33) employed the HONcode toolbar to conduct a preliminary assessment of accreditation of quality of medical information related to the treatment of osteoporosis.

Corcoran et al. (20) excluded from their questionnaire items with the lowest inter-rater reliability, leaving a distilled score, which was utilized in our study to measure reliability. To decrease observer bias, the evaluation of each site was made on three separate occasions during a period of 3 weeks.

Because of the cross-sectional design, the descriptive nature of this study and the dynamic nature of the Internet, it is not possible to generalize the information for future usage. Furthermore, because the evaluation was limited to 'mouth guard' information, one cannot generalize to other dental health subjects. Finally, only websites in English were included, which made generalization to other languages difficult.

The compliance with HON standards or the standards included in the reliability and accuracy scores used in our study does not mean satisfaction from the user perspective. Despite these limitations, this study might be recognized as one step in the development process of a valid and reliable scoring system to evaluate the reliability of health information on the Internet and especially about information related to sport dental injuries and mouth guards.

Conclusions

This study shows that there is a large amount of information available concerning mouth guards on the WWW but that the quality of this information varies greatly. The benefits obtained from health-related websites depend in part on the quality of this information. Access to reliable and accurate information is not a self-evident truth. Most sites lack objective and independent certification, and thus, the responsibility of quality assessment relies on non-qualified users who seek information.

It should be the responsibility of health care professionals to suggest and provide reliable Internet URL addresses to patients and users in general. Appropriate search terminology and search strategy should also be suggested to those who want to search beyond the recommended sites.

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Appendix 1

List of unique web sites evaluated.

http://www.ada.org/public/topics/mouth_guards_faq.asp
http://www.ada.org/prof/resources/pubs/jada/patient/patient_40.pdf
http://www.sportsdentistry.com/mouth_guards.html
http://sportsmedicine.about.com/od/injuryprevention/a/mouth_guards.htm
http://en.wikipedia.org/wiki/Mouth_guard
<http://www.dentagard.com/>
http://www.dentagard.com/mouth_protector-statistics.html
http://www.animated-teeth.com/mouth_guards/a1-mouth-guards.htm
<http://www.aapd.org/publications/brochures/mouth-pro.asp>
http://www.healthunit.org/dental/mouth_guards/mouth_guards.htm
http://www.dentalgentlecare.com/mouth_guards1.htm
<http://www.articlesbase.com/sports-and-fitness-articles/brainpads-coaches-and-parents-have-each-athlete-wear-a-mouth-protector-1768512.html>
<http://www.gkcads.org/id125.html>
<http://www.beale.af.mil/news/story.asp?id=123119527>
<http://www.guardkit.com/en/>
<http://www.guardkit.co.uk/>
<http://www.guardkit.com/en/Gumshield-Essential-Gear-for-rugby.asp>
http://www.cda.org/popup/mouth_guards
<http://www.dentalhealth.org.uk/faqs/leafletdetail.php?LeafletID=25>
<http://knol.google.com/k/mouth-guards#>

<http://www.idph.state.il.us/HealthWellness/oralhlth/oralinjury.htm>
http://news.bbc.co.uk/sport2/hi/rugby_league/rules_and_equipment/4216926.stm
<http://gumshield.net/>
<http://www.gumshieldsuk.com/>
<http://www.gummiegumshields.ie/index.htm>
http://www.21stcenturydental.com/Mouth_guards.htm
http://dentistry.about.com/od/basicdentalcare/f/mouth_guardtype.htm
<http://www.johnpoirierdmd.com/protectors.html>
http://www.oralhealthforall.com/family_care/sports_mouth_guards.htm
<http://www.nwhealth.edu/healthyU/getMoving/sport10.html>
<http://www.hc-sc.gc.ca/hl-vs/iyh-vsv/life-vie/mouth-dents-eng.php>
<http://www.webmd.com/oral-health/mouth-guards>
<http://www.yourdentistryguide.com/mouth-guards/>
http://dentalhealthonline.net/prevention_mouth_guards.html
http://www.totaldentistryonline.com/page.php?content=hightech&service=mouth_guards
http://leaguelineup.com/clwizards/files/Mouth_guards.htm
http://your-doctor.com/patient_info/dental_info/dental_disorders/mouth_guard.html
http://www.medicinenet.com/mouth_guards/article.htm
http://www.whiterthanwhite.com/products/proformgumshields/google/mouth_guard&rw.cm=Google%252C PPC%252C Gum%2520Shield