



Should I freeze my sperm?—readability and quality of health resources for sperm banking

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Background: Sperm banking refers to the collection and storage of sperm cells for future use. Despite the recommendations of major medical societies, sperm banking is not discussed sufficiently with patients at risk of future fertility. Majority of Americans utilize the internet regarding health information. The aim of this study is to assess the reading level and the quality of online health information on sperm banking.

Methods: The top 50 search results from Google, Bing, and Yahoo were selected after searching for the term “sperm banking”. Duplicate pages, advertisements, news and magazines, blog posts, videos, paid subscriptions, articles intended for health professionals, and non-related pages were excluded. Four validated readability and two quality assessment tools were used to score the text. Websites were divided into five categories: academic, hospital-affiliated, commercial, non-profit health advocacy, and non-categorized. Descriptive statistics, one sample *t*-test, and Pearson’s correlation coefficient were used to analyze the data.

Results: Forty-one webpages were included. The mean Flesch Reading Ease Score (FRES) for all pages was 46.9/100 and the mean reading level was 11th grade, compared to the recommended 6th grade level, across various assessment tools. Utilizing the DISCERN Instrument, quality of online health information was fair. Seven percent of pages received a “good” quality score and no pages received a score of “excellent”. On average, 1.5 out of 4 criteria categorized by the JAMA Benchmark, a validated quality assessment tool, were met. The hospital-affiliated webpages received the best reading scores and commercial pages received the highest quality scores.

Conclusions: Online health information on sperm banking available in English is of poor quality based on several quality assessment tools and at a reading level significantly higher than what is recommended. Further efforts are needed by providers and healthcare institutions to improve the quality of information available to patients.

Keywords: Cryopreservation; readability; sperm bank; consumer health information

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Introduction

Sperm banking is the process of collecting, freezing, and storing sperm cells primarily for future reproductive use. The first human conceived from preserved sperm was born well over 40 years ago, and since then, over 8 million children have been conceived via in vitro fertilization (IVF) worldwide (1). A wide range of health conditions can affect sperm quality, such as treatments for cancer, diabetes, rheumatological and autoimmune conditions, and patients undergoing treatment for gender affirmation, and as such, cryopreservation of sperm remains the mainstay of ensuring fertility preservation for many. The American Urological Association (AUA) recommends providers discuss sperm cryopreservation with patients diagnosed with testicular cancer, and it is recommended that any male patient undergoing chemotherapy or radiation for any form of cancer be advised on the benefits of sperm banking to preserve fertility (2-4). However, studies suggest that there may be a gap between those who could reasonably undergo sperm cryopreservation and those who do (4-6).

It is estimated that well over half of the U.S. population uses the internet to learn about their healthcare (7). For this reason, many credible institutions such as the National Institute of Health (NIH) and the American Medical Association (AMA) recommend patient education material be written for a 6th grade reading level (8). Previous studies evaluating the quality and readability of online material across other disciplines of medicine have shown that patient education materials are often of low quality, do not address specific topics, and are too complex to comprehend by an average person (9-14). Despite there being several validated

tools that have been utilized extensively in evaluating the readability, quality, and timeliness of online health information, no studies have applied them to online health information for sperm banking.

In this study, our primary aim was to investigate the quality and readability of patient-educational material that can be found online for sperm cryopreservation. We also sought to determine the degree to which mail-in semen cryopreservation kits, which are a relatively new technology and could increase the availability of sperm cryopreservation, are mentioned in online information about sperm banking.

Methods

The term “sperm banking” was searched on the three most frequently used English search engines Google, Yahoo, and Bing in December 2022. We utilized incognito mode to avoid webpage tracking and stored cookies that may interfere with our results. The first 50 search results from each of the search engines were selected for the study for a total of 150 links. Duplicate webpages, advertisements, news and magazines, blog posts, videos, paid subscriptions, articles intended for health professionals, and non-vasectomy related pages were all excluded. *Figure 1* demonstrates the exclusion process. All the material was further categorized into academic, hospital-affiliated, commercial, non-profit health advocacy, and non-categorized. To assess the timeliness of the online health information, the publication and modification dates were recorded. We recorded whether the author of the content was listed on the webpage. We also evaluated whether the webpages mentioned mail-in or at-home semen collection kits.

Readability of online content

To assess the readability and the corresponding grade level of the webpages included in this study, a single reviewer (IF, one of the study authors) utilized four validated assessment tools: Flesch Reading Ease Score (FRES), Flesch Kincaid Grade Level (FKGL), Gunning Fog Index (GFI), and Simple Measure of Gobbledygook Index (SMOG) (15-17). All four tests use a unique formula derived by word count, character count, number of syllables, quantity of sentences, and words per sentence. The AMA recommended 6th grade reading level corresponds to a score of 80 on the FRES and a score of <6.9 on GFI and SMOG indices.

Highlight box

Key findings

- Online health information on sperm banking available in English is of poor quality and difficult to understand for the average reader.

What is known and what is new?

- Over half of the U.S. population uses the internet to learn about their medical conditions and the recommended reading level for health information should be 6th grade level.
- Patient education material for cryopreservation is written at a university reading level and the quality of material is fair.

What is the implication, and what should change now?

- Collaborative effort by the healthcare community could improve access to high quality and easily comprehensible information about sperm banking.

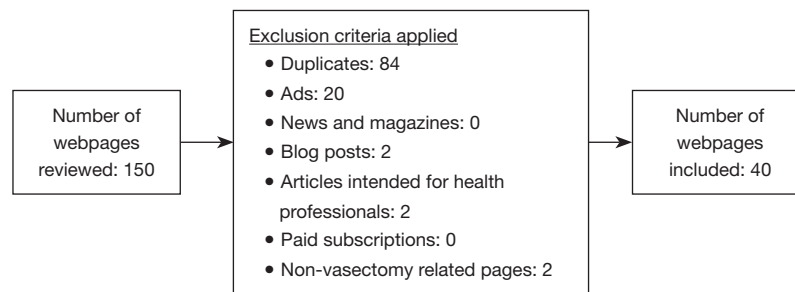


Figure 1 Depiction of excluded online health information.

Quality assessment

To assess the quality of the patient-education material, a single reviewer (IF, one of the study authors) utilized two quality assessment tools: DISCERN instrument and JAMA Benchmark (18,19). The JAMA Benchmark includes four categories in its scoring system: authorship, attribution, disclosures, and currency. One point is given in each category if the webpage successfully lists information fulfilling each category (i.e., if the authors are listed, one point is awarded, if the information is attributed to a cited source, a point is given, etc.). The total possible score is 4. The DISCERN tool, in contrast, consists of 3 categories of questions, reliability, quality of information on treatment choices, and overall assessment. There are a total of 16 questions, each scored 1–5 for a total score of 80 possible points. Subsequent researchers have stratified the DISCERN numeric score into quality strata which they have named: very poor (score 16–26), poor (score 27–38), fair (scores 39–50), good (scores 51–62), and excellent (>62) (20).

Statistical analysis

Descriptive statistics were utilized. SPSS software (IBM Inc., NY, USA) was used to perform a Pearson's correlation coefficient for the assessment tools we utilized to measure readability and quality. One-sample *t*-test was used to compare Flesch Reading Ease with the score corresponding to the AMA recommendations. The alpha level was set to 0.05.

Results

Forty online patient education webpages on sperm banking/cryopreservation were included in this study (Figure 1). Twelve webpages were academic, 3 were hospital-affiliated, 15 were commercial webpages, 8 were non-profit webpages,

and the remaining 2 were non-categorized. Thirty-four (85%) of the webpages did not list the names of the authors of the content of the webpage. Thirty-three (82.5%) of the webpages did not list the date of their publication or modification. Fifteen pages (37.5%) mentioned at-home or mail-in semen collection kits.

Readability

The average readability score and standard deviation measured by Flesch Reading Ease was 46.9 ± 12.4 , corresponding to an 11th grade reading level. This was significantly lower (i.e., less easily understood) ($P < 0.001$) than 80/100, the score recommended by the AMA. Similarly, the Gunning Fog and the SMOG indices both predicted college reading level required to understanding the text of the online health information, with the mean scores of 14.8 ± 2.9 and 13.6 ± 2.1 respectively.

Table 1 illustrates the average readability of the different categories of online health information. In general, commercial, and non-categorized webpages had the lowest readability scores. In contrast, hospital-affiliated webpages had the easiest reading level.

Lastly, Pearson's correlation coefficient indicated a strong association ($r = -0.807$, $P < 0.001$) between the readability scores obtained by all four readability assessment tools, indicating that each tool was producing a similar result.

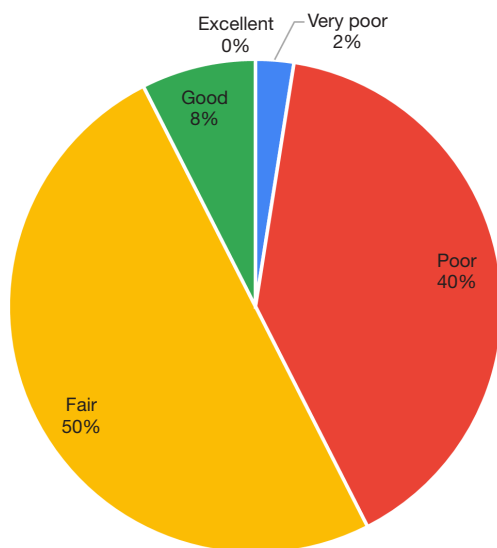
Quality

Using the DISCERN instrument, the vast majority (90%) of the webpages were scored either poor or fair (Figure 2). For the JAMA Benchmark Quality tool, we found that only two webpages (5%) fulfilled all 4 criteria of the tool, and two-thirds (68%) of the webpages fulfilled only one criterion. Figure 2 depicts DISCERN scores for all

Table 1 Average readability scores and grade level of online health information

Categories [n]	Flesch Reading Ease Score ^a	Flesch Kincaid Grade Level ^a	Gunning Fog Index Score ^b	SMOG Index Score ^c
Academic [12]	46.3±10.9	11th grade	14.4±2.1	13.3±1.5
Hospital-Affiliated [3]	60.0±7.7	9th grade	12.5±2.0	12.0±1.5
Commercial [15]	43.1±12.2	12th grade	16.1±3.3	14.7±2.3
Non-profit Health Advocacy [8]	51.3±14.4	11th grade	13.6±2.3	12.6±1.9
Non-categorized [2]	42.3±9.3	Undergraduate level	15.7±3.2	14.2±2.1

Data are shown as mean ± SD. ^a, Flesch Reading Ease Score the reading complexity of a given text from 0–100 (higher score is less complex grade level). The Flesch Kincaid Grade Level reports the education grade level corresponding to the readability ease score. ^b, the Gunning Fog Index measures readability as a score from 6–17 with a higher score indicating a more complex grade level. Score of 6 corresponds to 6th grade and a score of 17 corresponds to college graduate level. ^c, the SMOG Index measures readability as a score ≥3.12 with a higher score indicating a more complex grade level. Scores corresponding to grade level is broken down into: ≤4.9 (Elementary school), 5–8.9 (Middle school), 9–12.9 (High school), 13–16.9 (Undergraduate), and ≥17 (Graduate). SMOG, Simple Measure of Gobbledygook; SD, standard deviation.

**Figure 2** Breakdown of DISCERN Instrument Scoring System in assessment of quality of online health information.

40 webpages. Ninety percent of the webpages scored either “poor” or “fair”.

Table 2 illustrates the average quality scores of online health information stratified by webpage category (e.g., academic, hospital-affiliated, etc.). Commercial pages had the worst quality of information presented. Non-profit health publications had the best quality of the published material. Pearson’s correlation coefficient test demonstrated a poor association between the readability scores and the quality scores of the online webpages ($r=0.117$).

Table 2 Quality assessment of online health information

Categories [n]	DISCERN Instrument Score ^a	JAMA Benchmark Score ^b
Academic [12]	41.6±7.5	1.2±0.4
Hospital-Affiliated [3]	40.3±8.1	1.0±0.0
Commercial [15]	36.7±6.3	1.2±0.6
Non-profit Health Advocacy [8]	45.4±6.0	2.6±1.2
Non-categorized [2]	46.0±1.4	2.5±0.7

Data are shown as mean ± SD. ^a, DISCERN Instrument is a validated quality assessment tool comprised of 3 categories with a total of 16 questions, maximum score is 80. Descriptive cutoffs are further broken down into very poor (scores 16–26), poor (scores 27–38), fair (scores 39–50), good (scores 51–62), and excellent (scores >62). ^b, JAMA Benchmark is a validated quality assessment tool comprised of 4 criteria (authorship, attribution, disclosure, and currency) that a high-quality resource should meet, maximum score is 4. SD, standard deviation.

Discussion

In this study, we evaluated the quality and readability of online patient-education health information for sperm banking, as well as assessed whether at-home or mail-in semen collection was discussed. We found that the average reading level across all webpages calculated by the four readability assessment tools was equivalent to an undergraduate level reading level, well below the recommended 6th grade reading level. Commercial webpages that earn financial benefits from sperm banking

had some of the worst readability scores. Hospital-affiliated webpages outperformed academic webpages in terms of ease of readability. We also found that the quality of online health information on sperm banking was poor. Most of the webpages met only one of the four criteria for a high-quality publication according to the JAMA Benchmark, and on average, academic resources only met 1.2 ± 0.4 of the JAMA Benchmark criteria. Two of the 40 webpages had a perfect score on the JAMA Benchmark, both of which belonged to a non-profit health advocacy site. Finally, less than half of the webpages we evaluated included any information on at-home or mail-in semen collection kits.

Various studies evaluating the quality and readability of online health information in other domains of urology have yielded results similar to ours (9-14). All the studies, except one by Borgmann *et al.*, found the reading level of online health information to be more complex than the recommended 6th grade level (9-14). The quality of online information, however, was variable among different topics. For example, 87% of articles on prostate cancer fulfilled the JAMA criteria indicating high-quality information, however, only 22% of webpages on benign prostatic hyperplasia were considered as high quality in another study (9,12). The reasons for this variability are unknown. Given our findings that non-profit health advocacy sites tended to have higher quality information when compared to commercial websites, it may be that health topics that are less commonly covered by insurance, such as reproductive health services, may more commonly fall in the domain of commercial self-pay providers, who have a tendency to produce poorer quality online information.

It has long been recognized that lower reading levels are associated with poorer understanding of health conditions, and with worse health outcomes (21-24). A study by Williams *et al.* found that patients with poor health literacy performed on average less than one of the four tasks required to properly use an inhaler (21). Similar studies have shown that patients with lower reading abilities present with prostate cancer at later stages, and that those struggling with diabetes are less able to achieve glucose control (22,23). Poor health literacy has also been associated with significantly lower utilization of preventative care, such as screening mammography (24).

While our study was not designed to assess the effect that this online information had on the rate of cryopreservation, we believe that the inadequate quality and high reading level required to digest the online health information on sperm banking may be in part responsible for the underutilization

of cryopreservation among the US population. Improving health information regarding sperm cryopreservation could improve access to this critical fertility-preserving resource. The Centers for Disease Control and Prevention (CDC) has provided guidance on techniques that can be utilized to improve the readability of health information. These techniques include limiting the number of messages and key ideas per document, telling the audience only what they need to know, and choosing words wisely (25). Ensuring that credible authors write online health information and are mentioned in the document, citing credible resources, providing financial disclosures, and providing upload and modification dates are four ways to improve the quality of health information and to establish trust and credibility with the readers (18).

In the field of male reproductive medicine, several professional societies serve as important resources for clinicians, researchers, advocacy groups, and patients. These include the American Society for Reproductive Medicine, The Society for Male Reproduction and Urology, The Society for the Study of Male Reproduction, and the American Urological Association. Each of these organizations hosts a website with patient-directed content. Given the findings of the present study, these organizations may benefit from evaluation of the readability and the quality of content on these websites, and potential revision toward a 6th grade level readability standard. Those seeking to evaluate and improve on patient-targeted health information will likely want to choose a single tool to measure readability, especially given the high correlation among the four tools we used. Based on our experience in this study, we feel that the FKGL is an easy-to-interpret readability tool that can be readily used. Although developed by the same research group, the FKGL is more intuitive than the FRES, because the formula yields grade levels rather than scores that need to be correlated to grade levels. Furthermore, compared to the GFI and SMOG indices, the use of the Flesch Kincaid readability tools is more widespread in the literature and the presence of the term “grade level” in FKGL could possibly make this tool easier to understand for the average reader compared to the GFI and SMOG.

Limitations of this study include only searching for the terms “sperm banking” as well as only using the most common search engines in English. Previous publications have pointed towards the poor utilization of sperm banking in minority groups as well, and therefore, more study is needed to assess the quality and readability of online

information in non-English speaking populations (26). Another limitation of this study is having only one author evaluate the readability and the quality of information. To address this limitation, the reviewer used an automated calculator to calculate the readability of information. We were also unable to directly assess how the poor quality and readability of online resources impacted patients seeking information about sperm cryopreservation online. We hypothesize that the poor readability and quality of online information likely contribute to the underutilization of sperm cryopreservation, however, we were unable to directly test this hypothesis in the study herein.

Conclusions

Sperm banking is a critical tool for fertility preservation and could potentially be used to preserve fertility in a substantial number of patients with a wide range of fertility-threatening health conditions, yet it is likely underutilized. The study herein demonstrates that the available online material is both too complex for many to understand and that the quality of content is poor. Collaborative efforts by the healthcare community could improve access to high-quality and easily comprehensible information about sperm banking, which could potentially help improve rates of sperm cryopreservation for men whose fertility is at risk.

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Footnote

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Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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