Oral health benefits of chewing gum
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Societal *versus* Scientific impact of "Quantification and qualification of bacteria trapped in chewed gum"
Research output can be assessed in various ways. Within the academic world, research impact is stooled upon publication in a high impact factor journal and the number of citations in other research papers. Outside academia, impact is harder to assess but can be measured by their influence on society, e.g. the general public, business and government (1). As the article "Quantification and qualification of bacteria trapped in chewed gum" received a substantial amount of attention in the press, we here describe the societal impact our article has had and compare the societal impact with its scientific one.

The research article was published online in PLoS ONE (Impact Factor 3.234, ranked no. 8 in the field of multidisciplinary sciences (2)) on January 20th 2015. Despite that PLoS ONE is a decent journal, statistically based on the journals impact factor, the number of citations of this article, the main judgement of academic success, are unlikely to reach high levels. This is mainly because research in dentistry, especially on oral health care benefits of chewing gum, is a relatively small field and very little research papers concerning chewing gum are published. This is reflected in the number of citations up until this date (26-10-2015), which is 0.

However, directly after publication online, the article did receive a lot of attention outside academia. It was picked up almost immediately on an internet blog that reported quite accurately on the outcome of the article stating “Chewing gum removes up to 100 million bacteria” (see Fig. 1, this Appendix) (3). From here on multiple news sites started reporting this message among which: FoxNews.com, DailyMail.co.uk and ScienceAlert.com (4–6), all greatly aided by Twitter and Facebook causing it to reach other parts of the world like China and India (see Fig. 2) (7–10). In The Netherlands it was covered by De Telegraaf.nl, nu.nl and HPdeTijd.nl (11–13).

![Figure 1](https://scienceblog.realclearscience.com)

Figure 2
Written press coverage in foreign media.
A: Zaobao Singapore
B: Yahoo Taiwan
C: The times of India

Besides written press coverage, radio stations (3FM, RTV Noord) showed interest in the research results and a couple of video coverages on the internet were made, among which a video of DNews (a Discovery.com news medium), which showed an accurate report (14).

Unfortunately, in the process of more media reporting on the research, the actual content of the article was sometimes misinterpreted or construed in the wrong manner. Especially the comparison in the discussion section of the article between the number of bacteria trapped in a piece of chewing gum and a the number found on a piece of floss wire, was misconstrued as “chewing gum is equal or better than flossing”. This comparison in the article was made solely to put the number of trapped bacteria in gum in perspective and was most certainly not meant as a comparison of effectiveness of both techniques. Chewing gum is and will not be a replacement of flossing or brushing, as was
insinuated by some media. Luckily, after having our own press release, websites of dental practices, dental magazines and most written newspapers, influential on the behavior of patients and dental professionals, reported correctly with the side note that chewing gum is not a replacement of flossing or brushing (see Fig. 3) (15,16).

The attention in the press, can be ascribed to a couple of factors. First of all, an open-access journal might have accelerated news coverage, allowing anyone without subscription to access the full text. Secondly, the main subject of this research, a common daily life product such as chewing gum relates to many people, opposite to more fundamental research topics.

Opposite to the number of citations, the number of views of the article on the PLoS ONE website is very high, 10.332 views up until 26-10-2015. This clearly indicates that research with societal impact does not necessarily mean scientific impact, and vice versa. Smith (17) clearly illustrates this with the following example: “scientists would think of the original work on apoptosis (programmed cell death) as high quality, but 30 years after it was discovered there has been no measurable impact on health. In contrast, research that is unlikely to be judged as high quality by scientists — say on the cost effectiveness of different incontinence pads — may have immediate and importance social benefits” (17).

One important difference between scientific impact and societal impact is the way of measuring impact. The academic world has clearly defined grading systems, such as ISI Web of Science or institutional requirements to publish in top 25% journals in the research field. Consequently, more and more research is driven towards achieving a high ranking in these areas. However this could have consequences for the impact on society. Mostert et al. (18) strikingly state: “… high scientific quality of research groups is not necessarily related to communication with society, and that in order to increase societal quality of research groups, additional activities are needed.

**Figure 3**
Dutch magazine for dental professionals (Nederlands Tandartsenblad)
Therefore societal quality is not simply the consequence of high scientific quality. Obviously, in a university medical center, scientific quality prevails, and is a prerequisite, which cannot be replaced by aiming instead for high societal quality.” Here it is also suggested that assessment of societal quality should be evaluated more synergistically with scientific quality and should have a more important role in the evaluation of research organizations (18).

Societal impact or quality is not as clearly defined and more difficult to measure than scientific impact (19), although it is receiving more emphasis and new methods for assessment are being developed. Mostert et al. (18) proposed an assessment system of societal impact of health research in The Netherlands based on outreach to the different stakeholders; the general public, healthcare professionals and the private sector according to various indicators (see Table 1).

Table 1
Societal quality indicators (Mostert et al. (18))

<table>
<thead>
<tr>
<th>Knowledge production</th>
<th>Healthcare professionals</th>
<th>Private sector</th>
</tr>
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<tbody>
<tr>
<td>Contributions to television programmes</td>
<td>Publications in medical journals (non peer reviewed)</td>
<td>Patents</td>
</tr>
<tr>
<td>Contributions to radio programmes</td>
<td>Contributions to professional websites</td>
<td></td>
</tr>
<tr>
<td>Contributions to newspapers or journals (non peer reviewed)</td>
<td>Contributions to medical charts or protocols</td>
<td></td>
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<tr>
<td>Contributions to public websites</td>
<td></td>
<td></td>
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<tr>
<td>Contributions to public news forums</td>
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<td></td>
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<tr>
<td>Contributions to schoolbooks or study material</td>
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Knowledge exchange
- Memberships of public funding agencies or patient organisations
- Speeches for general public or contributions to public forums
- Information for scholars
- Memberships of advisory committees or professional associations
- Speeches at medical conferences
- Cooperation with companies

Knowledge use
- Use of schoolbooks or study material in medical education programmes
- Use of new medical charts or protocols in medical practice for diagnosis or therapy
- Use of technology by companies to produce new products or therapies

Earning capacity
- Charity funding (3rd money stream)
- Indirect funding (2nd money stream)
- Contract funding (1st money stream)

In this system our article “Quantification and qualification of bacteria in chewed gum” will mainly contribute to knowledge production for the general public (see Table 1). Overall it raised awareness on the oral health benefits of sugar-free chewing gum. Unfortunately, it also raised a false general consensus due to misinterpretation in some media, insinuating the false notion that chewing gum would be better than flossing. It is regrettable that this occurred, although it can be easily understood in the view of fast acting media trying to comply with high demand for news with headlines that contain quick catchphrases. Next to the general public, there was knowledge production for healthcare professionals in magazines or websites for dental health professionals (15,16) and
knowledge exchange on a dental research conference (20). Lastly, as this project is in collaboration with industry, in the private sector a patent was filed for the developed methods and more importantly the research is a contribution to the development of a new product. Obviously ways of measuring societal impact vary, and can include current internet media such as Researchgate, Google Scholar or even Facebook (21).

Regardless of the specifics of the measurement system, the media attention for “quantification and qualification of bacteria in trapped in chewed gum” invoked an important realization that besides the classic assessment of academic research also societal impact should be taken into account for the evaluation of research organizations. If not only to shift research goals more towards practical uses for society, also to aid researchers in certain fields in receiving grants in the competitive world of research funding.

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