Luciano Ruggia

Benzopyrene, smoke and money

The perfect Philip Morris International recipe for toxic scientific research

AT Research Series

Impressum

February 8th, 2024

Author: Luciano Ruggia

In 2023, a concerning case reminiscent of classic tactics employed by the tobacco industry has come to light, exposing Philip Morris International's (PMI) continued influence on scientific research. The focus of PMI's efforts appears to be the promotion of their 'new' and 'innovative' tobacco products, casting a shadow over the credibility of these claims. Our investigation aims to unveil the extent of PMI's financial sway over select Swiss researchers, revealing that the targeted involvement of PMI employees in research is not an isolated incident. We conducted in-depth research to expose the meaning and ramifications of this new case of tobacco industry manipulated research.

Suggested citation: Ruggia, L. (2024*). Benzopyrene, smoke and money. The perfect Philip Morris International recipe for toxic scientific research*. Bern: Swiss Association for Tobacco Control.

Living research: This paper is conceived as a living and dynamic research. The current version is the first one published, but we will adapt end enrich this research according to any new information. We also strive for quality, and we are open to criticism and improvements. Our aim with this research is to promote full transparency, accountability and quality in scientific research.

Further information:

www.at-schweiz.ch

Abstract

In 2023, a concerning case reminiscent of classic tactics employed by the tobacco industry has come to light, exposing Philip Morris International's (PMI) continued influence on scientific research. The focus of PMI's efforts appears to be the promotion of their 'new' and 'innovative' tobacco products, casting a shadow over the credibility of these claims. Our investigation aims to unveil the extent of PMI's financial sway over select Swiss researchers, revealing that the targeted involvement of PMI employees in research is not an isolated incident. We conducted in-depth research to expose the meaning and ramifications of this new case of tobacco industry manipulated research.

An obscure title : a new example of a smoke screen!

The study in question, titled “Quantification and Mapping of Alkylation in the Human Genome,” conducted by the ETH Zurich's Department of Health Sciences and Technology, initially appears unrelated to tobacco. However, a closer examination reveals PMI’s influence. The publication focuses on benzopyrene, a known carcinogen in tobacco smoke, and its impact on DNA modification. ETH Zurich, one of the top world technology universities, acknowledged collaboration with PMI scientists and financial support from the tobacco company for this study. The study was co-financed by the Swiss National Science Foundation (SNSF), but the SNSF was never informed that PMI was co-funding the research, therefore the ETH research team violated explicit SNSF rules.

Language and Claims in Tobacco Industry

PMI has shifted its narrative, claiming to aim for a “smoke-free world” by promoting new tobacco products like IQOS. These products are marketed as “reduced risk” and “smoke-free,” but independent scientific evidence to support these claims is lacking. PMI's dual narrative – harm reduction for public health policy and continuing as a leading cigarette manufacturer for investors – is contradictory and brings PMI’s intentions into question. The ETH study allows PMI to reinforce their biased claims about their “innovative” heated tobacco products.

The Research’s Ethical Quandaries

The involvement of PMI employees in designing and supervising the study raises doubts about its independence. The extent of PMI's financial contribution remains undisclosed, further obscuring the research's impartiality. The lack of clarity on the necessity of PMI's involvement in this study adds to the ethical dilemmas. At the same moment of this publication, another almost identical article was publish by the same mix of authors from ETH and PMI, adding to the ethical confusion.

This ETH/PMI collaboration raises significant ethical concerns regarding transparency, conflicts of interest, and the true intent behind the research.

Previous Collaborations and Implications

From our research, it also appears that there have been previous collaborations between the lead researcher and PMI, including publications co-financed by PMI and prominently displayed on their website. This enduring relationship also contribute brings the researcher's impartiality into question, especially considering PMI's history of manipulating scientific findings.

The Need for Transparency and Independence in Research

The case at ETH Zurich underscores the crucial need for scientific research to be transparent and independent, criteria that cannot be fulfilled when research is under the influence of industries with vested interests. This situation highlights the ethical responsibility of researchers and institutions in upholding scientific integrity. It also emphasizes the importance of scrutinizing industry-funded research to safeguard public health and maintain the integrity of scientific discourse.

Benzopyrene, smoke and money

The perfect Philip Morris International recipe for toxic scientific research

In 2023, a concerning case reminiscent of classic tactics employed by the tobacco industry has come to light, exposing Philip Morris International's (PMI) continued influence on scientific research. The focus of PMI's efforts appears to be the promotion of their 'new' and 'innovative' tobacco products, casting a shadow over the credibility of these claims. Our investigation aims to unveil the extent of PMI's financial sway over select Swiss researchers, revealing that the targeted involvement of PMI employees in research is not an isolated incident. In recent research published by a team of the ETH in Zurich, a substantial portion of the research funding came directly from PMI, though precise figures have not been disclosed yet. PMI employees were also deeply involved in the ETH research and publications. This close association between an ETH scientific research and a major tobacco industry player, whose primary objective is the profit-driven sale of harmful and deadly products, raises critical ethical questions concerning transparency, independence, conflicts of interest, scientific integrity, and the overall trustworthiness of the findings.

A first read: smoke or no smoke?

In February 2023, we stumbled upon a scientific article that appeared to be extremely technical, scientifically serious and not even directly linked to tobacco. The title itself was already a promise of a less than inviting reading: “Quantification and Mapping of Alkylation in the Human Genome Reveal Single Nucleotide Resolution Precursors of Mutational Signatures” (we will call it for later clarity the “Quantification” article).[1] Who would wish to read an article with such a sexy title? Furthermore, nothing in the keywords associated with this article was suggesting a link with tobacco or smoke.[2]

When we began reading it, initially with very little interest, the article seemed to bear all the hallmarks of a serious and reputable scientific publication. However, quite quickly, we started to detect a hint of something amiss: we smelled smoke, and more specifically PMI smoke! Typically, especially in the case of technical publications like this, few readers delve beyond the abstract. Yet, the figurative 'smoke' we started to discern compelled us to read on.

The study was conducted by a team of researchers of the Department of Health Sciences and Technology of the ETH Zurich. Before going further, we should stress that ETH Zurich, also known as Eidgenössische Technische Hochschule Zürich in German, is one of the world's leading universities in the fields of science, technology, engineering, and mathematics (STEM).

Image 1: On its web page PMI Science stress proudly its transparency and scientific rigor. Of course, those are only empty words (the black bubbles are from us).

The object of the study

The study investigated how certain chemical substances can cause DNA modifications leading to the development of some cancers, with a focus on benzopyrene, which, as the study's abstract says, is "*a ubiquitous environmental carcinogen*", but is found in high concentrations in tobacco smoke.[3] Benzopyrene is a polycyclic aromatic hydrocarbon and the result of incomplete combustion of organic matter at temperatures between 300 °C (572 °F) and 600 °C (1,112 °F). The fact that it is a major cause of lung cancer is well established in scientific literature.[4] WHO classify benzopyrene as a Class I carcinogen substance. Its impact on DNA modification and cancer has also already been studied extensively.[5]

From "smelling smoke" to "finding the money"

On 23 February 2023, ETH Zürich announced online in its "News & Events" web page, under the headline "Where do toxins from tobacco attack DNA?", the publication of the "Quantification" study which was led by Mrs Shana J. Sturla (*Department of Health Sciences and Technology, ETH Zurich).*[6] This ETH News clearly indicates that *"For this study, the ETH Zurich scientists collaborated with scientists from the Philip Morris tobacco company. The company also helped finance the research. Additional funding for this study came from the Swiss National Science Foundation*." Nowhere, it is ever explained why this collaboration was necessary. It is only on January 25th, 2024, that this passage was corrected online: "*For this study, the ETH Zurich scientists collaborated with scientists from*

the Philip Morris tobacco company. The company also helped finance the research. Additional funding for aspects of the published work performed independently from Philip Morris came from the Swiss National Science Foundation. * This passage was adjusted for precision on 25 January 2024.*" What aspects of the published work were performed "*independently*" from Philip Morris? As long as PMI employees were among the principal authors that designed and conducted this study and wrote the article, how does the ETH define the concept of "*independence*"? It is interesting to note that in the ETH publication database, on the page presenting the publication, the PMI founding is not recognized even after the correction of January 25th.[7]

On January 25th, 2024, a correction was also published for the article itself in the journal ACS Central Science. This correction reformulated the funding acknowledgment in a somewhat strange way. The initial article stated, "*We acknowledge funding from Philip Morris International and the Swiss National Science Foundation (185020, 186332)*." The correction is published with this statement "*The funding statement is amended to clarify the independent nature of projects from which results are reported in the article*" and the correction read: "*We acknowledge funding from Philip Morris International and funding from the Swiss National Science Foundation (185020, 186332), which funded independent research projects*." [8] Can anyone grasp the signification of this difference? The publication discusses a single research project (the article consistently is using the wording "*this study*" and never "*those studies*"), and "*this study*" was conducted in very close collaboration by ETH researchers and PMI employees, with funding from PMI and the SNSF. However, the correction states that the SNSF funded "*independent research projects*." Independent from whom? Should we stress again that among the main authors of this study we find some PMI employees? Where is a clear differentiation line between what was financed by PMI and what was financed by the SNSF? Clearly, this correction was published in response to the pressure and criticism received, yet it fails to clarify any specifics about the funding—who used which funds and for what purpose? The authors do not seem willing to fully disclose the funding details and in our opinion this correction was a poor attempt to placate the criticism that such a publication provoked. This correction not only fail to satisfy our criticism but add confusion to the whole question.

Implications of language

As is generally the case in the public health domain, public health stakeholders in tobacco control are frequently confronted with the far-reaching impact of language and word choice used by the tobacco industry. Recently, the tobacco marketplace has become increasingly diversified, with the tobacco industry marketing and claiming that their "*new products*" are "*smoke-free*" and less harmful than cigarettes. Big tobacco companies, like Philip Morris International (PMI) and Japan Tobacco International (JTI), use terms like "*reduced risk products*", "*emerging and novel*", and "*smoke-free*" in their communications, thereby implying substantive improvements over older products (cigarettes) associated with disease and mortality.[9] This language is intentionally used to

shape the thinking of consumers, but also the attitude of the wider public and policy makers towards the actions of those companies.

PMI narrative

PMI has changed its narrative for some years now, pretending to aim for a "*smoke-free world*" with the goal of ending cigarette sales and shifting to new "*smokeless*" tobacco products that, they contend, bring reduced risks.[10] But PMI is running two parallel and very different narratives. On the one hand, they claim "*harm reduction*" in order to market their new products and influence public health policies; on the other hand, they continue to present themselves to their investors as a leading cigarette manufacturing company, with no sign of ditching their main lethal product.[11] A very good example of the double language of PMI is that, while the pretend to aim at a "*smoke free world*", at the same time the continue to invest and increase their production capacity in countries where they continue to see a potential to increase their cigarette production, like is the case in Egypt.[12] Clearly their real goal is to diversify and to introduce new deadly products, without getting rid of the old ones, in order to maintain and even increase their profits.

The tobacco industry's reduced-risk claim is not supported by independent scientific evidence.[13] IQOS, produced by PMI, has the largest share of the heated tobacco product (HTP) market, especially in Switzerland. In their marketing and communication, PMI continuously insists that IQOS reduces one's exposure to harmful substances found in traditional cigarettes; for example, they claim a 95,9% reduction of benzopyrene emissions.[14] This figure of about 95-96% is regularly used by PMI in their advertisement, talking sometime about reduction of "*components*" and sometime about reduction of "*risks*". We want to stress that those claims have no valid independent (i.e. non-PMI paid) scientific base. We abundantly demonstrated that this "95%" claim is a lie and a manipulation.[15]

In March 2022, the American Food and Drug Administration (FDA) declared that, even if a very specific heated tobacco product under consideration significantly reduces the production of harmful and potentially harmful chemicals (without accepting any specific figure), it cannot be considered any safer than traditional cigarettes. The FDA, while authorizing the device under consideration to be marketed as a modified risk tobacco product (MRTP), also stressed that "*Importantly, this action does not mean this product is safe or 'FDA-approved.' There are no safe tobacco products."* [16] However, recent studies, fully independent from the tobacco industry, have highlighted several problematic issues regarding the yields of harmful and potentially harmful constituents generated by the heated tobacco products of PMI. Among those, this research has clearly stressed that the PMI's HTP are producing tar in significant amounts.[17]

Image 2: example of an advertisement by PMI for its IQOS product, November 2023, or of an online IQOS advertisement stating that IQOS does not produce TAR.

All marketing and advertisements for IQOS cleverly manipulate the concept of truth, leading consumers to believe their products are safer without explicitly stating so. In certain countries, such as Dubai, the marketing for IQOS explicitly claims that their products are safer than cigarettes.

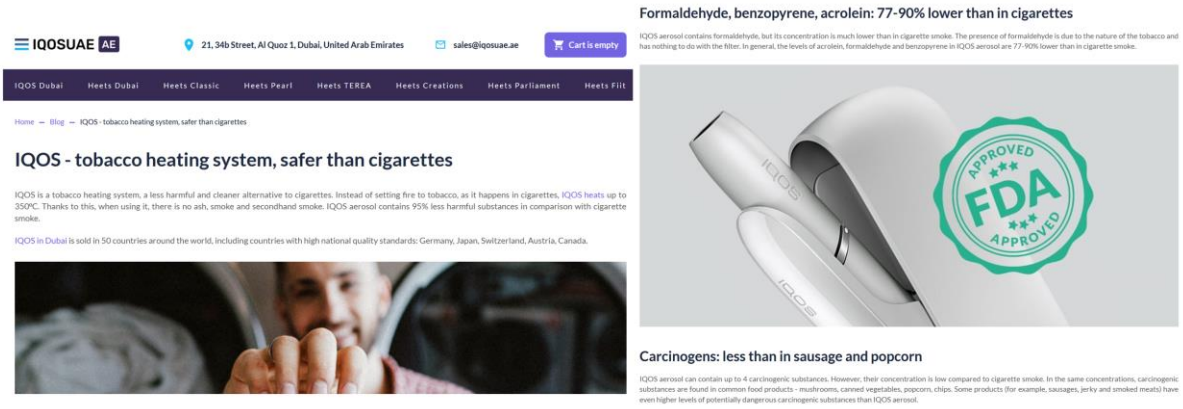

Image 3: the IQOSUAE website claiming IQOS is safer than cigarettes, using an image using a "FDA approved seal" as a marketing tool, and stating than IQOS has less carcinogens than sausages and popcorn.[18]

PMI's financing of research is part of their persistent effort to support such disputable claims, as other examples of PMI-funded research clearly show.[19] A commonly applied PMI rhetorical trick is to assert that IQOS does not burn tobacco, rather it merely heats it. So rather than using 'heated tobacco product (HTP)', the commonly preferred term in the scientific and tobacco control community, PMI uses the term "heat-not-burn" in order to stress the supposed absence of combustion in comparison to traditional cigarettes. But it's important to note that benzopyrene is also generated by the pyrolysis occurring in HTPs and that "*IQOS emissions contain carbon*

particles with most of the compounds released being formed by chemical reactions provides further evidence that IQOS emissions fit the definition of being both an aerosol and a smoke.".[20] TEREA tobacco sticks, used in the newest version of IQOS called ILUMA, contain a tiny metal blade that is heated by induction to a temperature that is not disclosed by the manufacturer, but could potentially be much higher than previous IQOS models. This raises the suspicion of a release of heavy metals, in addition to other toxic volatile components. Additionally, the diversity of HTP systems makes toxicology measurements and comparison very difficult.

Image 4: ETH tweet dated 23.02.2023 referring to the "Quantification" article.

An ETH tweet dated 23 February 2023 clearly highlights that the cause of lung cancer is tobacco smoke. Again, we wish to point out that, in our opinion, such a statement contributes to the instrumentalization by PMI of "*scientific*" statements that appears to support their claim that their smoke-free products (like IQOS) are less dangerous.

The general independent scientific consensus is that HTP users are still exposed to high levels of harmful substances, with the long-term consequences still unknown; thus, precaution is crucial in view of any promotion of these products as "*reducing harm*".[21] By promoting or tolerating non-independent and clearly biased research that allows PMI to further support their claims that HTPs present almost no danger compared to cigarettes, a prestigious scientific institution like ETH is in fact allowing PMI's efforts to manipulate scientific information and to increase the sale of their deadly products.

Directing the research

Two fundamental problems with the "Quantification" study are evident, the most troubling of which is that among the article's main authors, three are employees of Philip Morris.[22] All three are among the six that "*designed and supervised the study*." Particularly concerning is the unknown extent to which they may have controlled the narrative of the study with the aim to support the interests of PMI. The production of evidence is

a social construction and the role of research framing, problem definition, and choice of language all have a direct influence on the research results. Scientific knowledge is produced within a social context and is influenced by the norms, values, interests, and power structures of the society in which it is generated. The tobacco industry has a clear and well-established strategy of funding research that directly supports their views and interests.[23]

The second problem is the financing of the research and the size and proportion of it in relation to the SNSF funding. PMI explicitly funded the study along with the Swiss National Science Foundation (185020[24], 186332[25]), with the news article on the ETH web page stating that "*The company also helped finance the research. Additional funding for this study came from the Swiss National Science Foundation*." How significant this PMI financial contribution was remains unclear, yet the ETH news implies that PMI was the primary funder. For full transparency, we believe that the amounts should be fully disclosed. Exactly how much was granted by PMI and under which terms? If the research was already funded by 2 SNSF grants, why the ETH needed additional money from PMI? What was this money used for?

In addition, another central question should be asked: who exactly initiated this research? Was it PMI that approached the ETH team requesting such research? Or was it the ETH team that initiated the research and requested funding from PMI? What was the exact timeline of the research development and funding requests between the parties involved (ETH, PMI, SNSF)?

The Sturla/PMI publication is presented by PMI as one of their own studies. The PMI Publications webpage states that "*PMI Publications: We believe scientific results are meant to be shared. More than 1,180 scientists, engineers, technicians, and support staff are working on our smoke-free products. Transparency and open sharing of results and methods promote the use of best practices in scientific research, and the resulting scientific publications and presentations are the base upon which science-based discussions are built. As of 2022, we have published 511 scientific publications since 2008. We welcome you to browse our publications library and see the details of our research for yourself*."[26] When PMI is openly referring to "*our*" publication library and "*our*" research, it appears that the Sturla study can in no way be considered as an independent study if PMI openly promotes it as one of their own products. This begs the following questions: was the Sturla article an ETH/SNSF study or was a PMI study? What is the ETH position on this confusing situation?

Image 5: PMI webpage screenshot (21.12.2023)[27]

And a second "research" ….

A few days apart from the "Quantification" study, a second study was published by almost the same authors on almost the same topic under the title "*Dissection of Cancer Mutational Signatures with Individual Components of Cigarette Smoking*" (we will call it for later clarity the "Dissection" article)[28] This parallel study was entirely financed by PMI and 3 authors from PMI are also among those of the "Quantification" article.

The "Dissection" article, of which Mrs. Sturla is corresponding author, was published in the journal Chemical Research in Toxicology, for which Mrs. Sturla is also Editor-in-chief since early 2018.[29] This last element raises itself serious questions of compliance with peer reviews procedures and independence.

What is the exact connection between the "Quantification" and the "Dissection" articles? The "Quantification" was published on the 22 February 2023 and the "Dissection" was published online first on 28 February 2023. What a perfect timing! As one could expect the "Dissection" study quote the "Quantification" study (reference 52) indicating therefore a close connection between the 2 studies.

The "Dissection" study is reported as being fully and uniquely financed by PMI (but the exact amount again was not disclosed). The Conflict-of-interest statement of this article is formulated as it follows "*The authors declare no competing financial interest*.", by which we suppose we should understand that no interest competing with the PMI financial interests were involved in this study. It is also interesting to

notice that in the ETH database webpage referring to this publication the PMI funding is not mentioned at all.[30]

Not only several authors of the two studies are the same, but the content of the two articles is very similar and closely interrelated. In fact, the content appears so close that it seems to be difficult to make a real difference and state that the two research were independent from each other. This close connection of topic, financing, authors and publication timing raises strong ethical questions regarding transparency and independency of the research. It also strengthens the impression that both studies were conducted on behalf and for the interest of PMI.

The objective of the "Dissection" study was, as explicitly stated, "*to characterize mutational signatures arising from individual constituents of tobacco smoke and evaluate how they relate to tobacco-associated cancer mutational signatures.*" The "Quantification" study does not openly state what its objective was but says "*In this study, we defined a first single-nucleotide resolution genome-wide map of N2-BPDE-dG in human lung cells and elucidated relationships between DNA adducts and local sequence contexts, genomic features, and mutational signatures associated with smoking-related lung cancers, as well as how these relationships may be modulated by increasing chemical exposure concentrations.*" The "Quantification" article appears to be poorly written (we would expect a good scientific article to be written along classical parts, like a research question and hypothesis, a clear description of the methodology, how data was collected and analysed, what where the results, a discussion and a conclusion) and we qualify its writing quality as rather "sloppy".

Many methodological criticisms could be found in both publications, but we don't consider it necessary to invest too much time in deconstructing them in detail. However, one important question could be raised: why the authors never addressed the relationship between the two articles? Both articles appeared in publications of the American Chemical Society (ACS) but during the submission process was the ACS aware of the closeness of the scope of the articles? Who peer-reviewed those two articles? Had the peer-reviewers any link with the tobacco industry themselves?

Previous collaboration between Mrs. Sturla and PMI

Faced with those two very problematic publications, we could not but ask ourselves if there was already an history behind it. Delving deeper into our research, we uncovered further unsettling findings. A search for "Sturla" on the PMI science page reveals some past collaborations, with those articles also prominently displayed on the PMI's website. Those past collaborations also demand scrutiny, particularly because they help to shed light on the real nature and depth of the relationship between Mrs Sturla and PMI.

We find a first problematic connection of Mrs Sturla with PMI 10 years ago, in 2014, when Mrs Sturla published an article on systems toxicology. Overall, systems toxicology represents a dynamic and interdisciplinary field that has emerged in response to the need for a more comprehensive understanding of the effects of toxicants on biological systems.[31]

This publication, prominently listed in the database of PMI Science, has Mrs Sturla as first author, but Mr Peitsch, Chief scientific officer of PMI as corresponding author. This publication was already co-financed by PMI and the SNSF. For this study the funding is disclosed as it follows "*The authors are funded by their respective institutions. S. Sturla acknowledges support by the Swiss National Science Foundation (grant no. 136247)",* but we doubt that the fact that this grant was used to support this publication was ever declared to the SNSF.[32]

If Mr Peitsch was the corresponding author, we should consider this as a publication initiated and mainly funded by PMI. In absence of precise data on founding and on the role of each author, it is difficult to consider it otherwise.

Regarding the funding declared by Mrs Sturla, in the database of the SNSF grant n° 136247 correspond to a project for "Systems-wide responses of colon cells to food components and impact on cancer drug action". We searched for the word "colon" in the text of the article, and we were not able to find it. We do not understand how this SNSF grant relates with this PMI publication. Was the SNSF informed that part of its grant was used to write a publication with PMI that does not appear to be directly related to the aim of the grant?

We wonder again how the funding was really composed of. In this study one of the authors is Julia Hoeng of PMI, another is the chief scientific officer of PMI Manuel Peitsch, which, we need to stress this again, was the lead author of this publication and is also indicated as corresponding author. We find Mrs Hoeng again in the 2023 publication of Mrs Sturla. This prove that Mrs Sturla collaboration with PMI dates back at least 10 years. How many fundings has Mrs Sturla really received over the years from PMI (including funding to participate to conference or any other non-direct research related funding)?

Secondly, we discovered a chapter authored by Mrs. Sturla and her team in a book edited by Manuel Peitsch and Julia Hoeng of PMI in 2015.[33] Of the 16 chapters in this book, 6 are directly authored by PMI's employees, and another 6 by private commercial laboratories or consultancies, where we cannot rule out financial interests linked to PMI. This leaves only 4 chapters authored by seemingly independent academics.

The book is published by Springer, a commercial publisher, and its contents are not open access but must be purchased. Mrs. Sturla's chapter is priced at CHF 39.95. However, the chapter acknowledges that "*This work was financially supported by the Swiss National Science Foundation (Sinergia Project 136247)*." Therefore, this chapter was funded under the same grants as the previously mentioned article on systems toxicology. It raises a question: Is it acceptable that a work financed by SNSF is published in such a commercial way? Interestingly, in the ETH publication database, on the page presenting this publication, the SNSF funding is not acknowledged. [34]

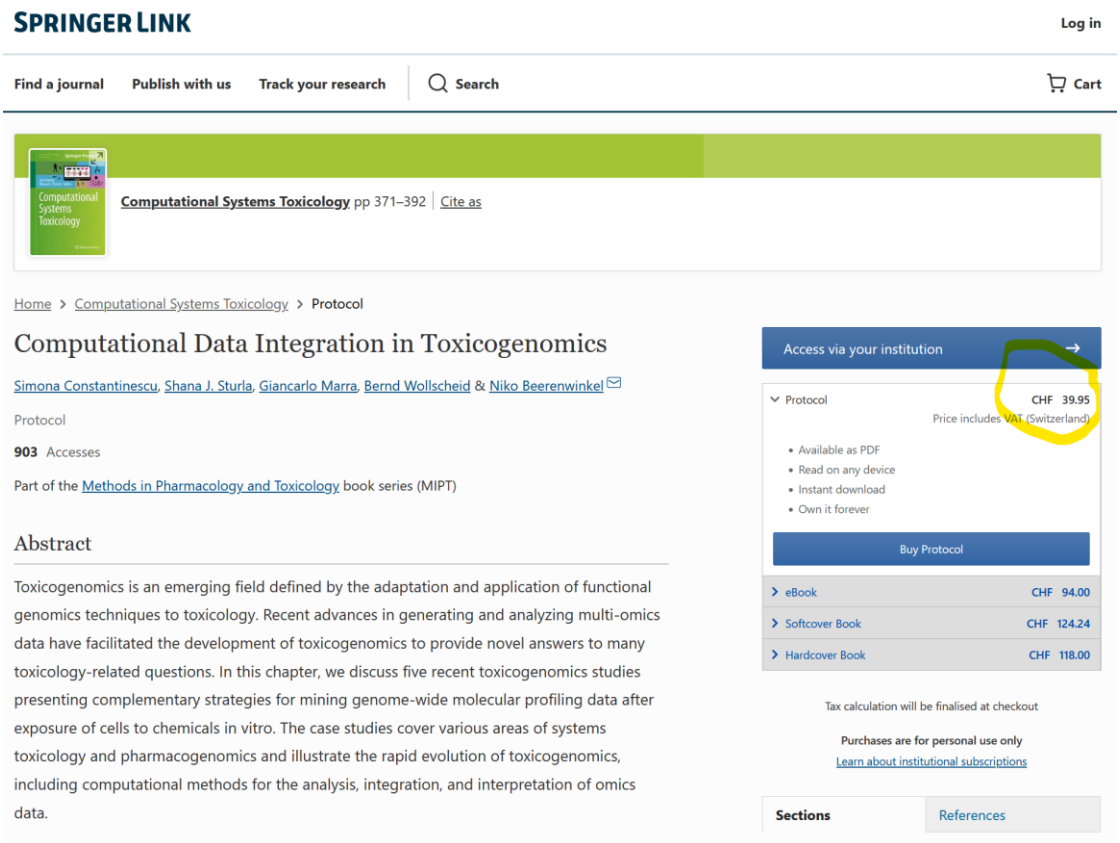

Image 6: Screenshot of the Spinger website, where is it possible to buy the Computational Data chapter (29.01.2024)

Mrs Sturla was the corresponding author of **another** study, also listed in the PMI Science page. In 2017, in Chemical Research on Toxicology, appeared an important article on system toxicology.[35] This study reports several funding (including the SNSF) but none openly by PMI. However, among the authors, we find again the main PMI research officer Manuel Peitsch, which raises again serious ethical questions. The article highlights the importance of Mr Peitsch by stressing "*At PMI he leads the department responsible for the assessment of candidate Reduced Risk Tobacco Products through pre-clinical toxicology, systems toxicology, and clinical studies, as well as for their regulatory submissions*." Was the research truly devoid of funding from PMI? If an author, employed by a commercial entity like PMI, contributes to a study in their capacity as a PMI employee, this contribution constitutes indirect funding from PMI, which should have been appropriately disclosed. Moreover, there's an inherent risk associated with the tobacco industry's involvement in systems toxicology. Although systems toxicology offers a promising and innovative method for exploring the intricate interactions between toxicants and biological systems, it is not without its challenges and limitations.

The field of systems toxicology, like any scientific discipline, is subject to ethical considerations and potential conflicts of interest. It is possible for industries, including the tobacco industry or any other, to try to manipulate or selectively interpret research findings to promote their products. Funding bias, selective reporting, conflict of interest and transparency are some potential concerns related to the tobacco industry's involvement in research on reduced-risk products and that also apply to system toxicology. It is interesting to note that the very same year the Sturla article on system toxicology, a team of PMI scientist, under the lead of Mr Peitsch, published an article using this approach to try to show that the new heated tobacco products of PMI are better than traditional cigarettes.[36]

It's evident that the collaboration between Mrs. Sturla and PMI isn't recent but rather stems from an enduring financial relationship and close personal ties. Such connections raise significant concerns about the integrity and independence of her research. Given these findings, we consider it challenging to believe in Mrs. Sturla's impartiality, particularly considering PMI's monetary influence and interests. Her involvement with the tobacco industry, known for decades of distortion of scientific findings and misleading the public about tobacco's adverse effects, further deepens these doubts.

By aligning with PMI in this manner, scientific publications run the risk of becoming instruments for the company's promotional efforts. Currently, as we demonstrated earlier, PMI is promoting their heated tobacco devices, IQOS, championing the notion that the absence of combustion nearly nullifies health risks. Several of the studies that we mentioned here are cited in numerous PMI publications with a clear motive: to validate PMI's claims about the reduced risk associated with their IQOS product.

For instance, PMI has released a document titled: "The Science behind the Tobacco Heating System: A Summary of Published Scientific Articles 2017," where Mrs. Sturla's work is notably acknowledged.[37] Should we be surprised in the future to find the 2023 Sturla/PMI publications quoted and used by PMI in their "scientific summaries" or in conference's presentations to further demonstrate that smoking causes cancer (but IQOS does not!)?

Another ETH research getting PMI money: different researchers, same manipulation?

After uncovering various research projects of Mrs. Sturla funded by Philip Morris International (PMI), we conducted further investigations. Our research revealed additional ETH researchers who have also received funding from PMI.

In 2020, a different team at ETH published a study titled "*Tracing the composition of single e-cigarette aerosol droplets in situ by laser-trapping and Raman scattering*" (we will refer to it as the "Tracing » article).[38] This study, examining electronic cigarette aerosols, was co-financed by PMI. The acknowledgements in the published article state, « *This work was supported by the Swiss National Science Foundation (SNSF grant no. 200020_172472), ETH Zurich, and Philip Morris International*. » However, similar to the situation with Sturla's publications, only the SNSF grant is mentioned on the ETH website, omitting any mention of PMI's financial contribution.[39] The SNSF web page presenting the various results and publications generated by this grant, mention also various "collaborations", but the one with PMI is not mentioned.[40] This raises questions: Was the SNSF informed about PMI's involvement, and how much funding did PMI provide?

Image 7: The « Tracing" study promoted by the PMI science web page (last consulted on 28.01.2024)

Subsequently, the same authors published another article in Chimia, albeit under a different title. [41] This publication appears to be nothing more than a concise, one-page summary of the "Tracing" article. Notably, it omits any reference to the funding sources. The article concludes with the statement, "*The measured partitioning of the main e-cigarette compounds between the droplet and gas phase as a function of time will improve our understanding of their deposition in the respiratory tracts and hence of their impact on health.*" However, this raises a critical question: Is the primary focus of this research on understanding the health impacts, or is it more about optimizing aerosol delivery of nicotine to the lungs of Electronic Nicotine Delivery Systems (ENDS) users? It is probably a major understatement to suggest that the benefits of this research for consumer health improvement are unclear.

This research utilized a PMI product initially named Nicocig MESH, which was later rebranded as Veev. The current Veev version employs a hybrid nicotine mixture, combining free-base nicotine with nicotine salts. PMI claims that "*It emits on average 99 percent lower levels of harmful chemicals compared to cigarettes*" [42], a statement that lacks verification from independent scientific research. Moreover, the Veev product has undergone significant modifications since its initial release, meaning the version studied should be considered as substantially different from the one currently available on the market. This lack of representativeness is a significant issue, considering the study focused solely on a single PMI product, whereas the market features thousands of diverse ENDS and e-liquids with vastly varying

compositions. Ideally, in line with standard academic practices, this should have been acknowledged as a limitation of the study (no limitations are mentioned in this study).

In the study, Nicocig MESH's e-liquids were tested with nicotine concentrations of 2%, 3.5%, and 5%. However, the study does not clarify whether the nicotine in these liquids was in the form of free-base, salts, or a mixture, as is the case with the current market version of Veev. Notably, e-liquids with nicotine concentrations above 2% in closed systems, akin to those tested in the study, are illegal in Europe and Switzerland. This brings into question the decision to test e-liquids with such high nicotine concentrations, especially if consumer health was a primary concern. Why test concentrations that are already deemed illegal and potentially harmful? This raises significant questions about the actual intent and rationale of the study.

The "Tracing" article's failure to specify whether the nicotine used was free-base or in salt form is a notable oversight, especially considering the varying pH levels (ranging from 3.4 to 9.9) of the tested nicotine concentrations. This pH variation is critical because it directly correlates with the nicotine type, raising important questions the article does not address. Nicotine salts are produced by adding an acid, usually benzoic acid, to freebase nicotine, which typically has an alkaline pH around 9. Adding acid lowers this pH, resulting in a more neutral solution that is less harsh on the throat, making it appealing for new vaping product users. This modification allows for higher nicotine levels to be delivered more comfortably than the concentrations found in freebase nicotine. Nicotine salts are also known for their rapid absorption into the bloodstream, similar to traditional cigarettes, and their enhanced molecular stability, allowing for longer storage without degradation.

The absence of a clear distinction between the types of nicotine in the "Tracing" article leaves a significant gap in understanding the implications of the tested concentrations and pH levels. Given that nicotine with a pH below 7 is acidic, it's plausible that some of the tested liquids contained nicotine salts. The lack of mention of the nicotine type raises questions about the rigor of the article's peer-review process and the credibility of its scientific research. Such an omission, particularly in a study testing nicotine concentration already deemed illegal in certain regions, casts doubt on the study's relevance and validity in the context of consumer health and scientific integrity.

In research funded by PMI, it's often more revealing to note what is omitted rather than what is studied. The study in question defines the composition of e-liquids as primarily consisting of propylene glycol (PG), vegetable glycerol (VG), nicotine, flavoring supplements, and water. However, this framing potentially overlooks other common e-liquid components, such as diethylene glycol, acetaldehyde, formaldehyde, acrolein, benzene, diacetyl, and heavy metals like cadmium, nickel, tin, and lead. These omissions raise questions about whether such chemicals were present in the Nicocig MESH e-liquids

and why they were not considered in the study. By neglecting to mention these substances, the article seems to align with PMI's objective of downplaying the potential risks of their products, thereby contributing again to the promotion of their commercial interests.

The research's focus, and PMI's motivation for funding it, are highly questionable. The "Tracing" study itself emphasizes the importance of its results for "*advancing e-liquid research and manufacturing*" suggesting a commercial rather than a health-oriented objective. It appears that the SNF Grant was potentially utilized to support PMI's commercial interests, rather than prioritizing consumer health. Discovering this PMI-funded study leads to further speculation about the extent of PMI's financial involvement in other studies at ETH.

Tobacco industry influencing science.

The tobacco industry, and PMI in particular, have a long history of influencing and distorting science[43] and the tactics used have been researched extensively.[44] Among the main nine tactics used by the tobacco industry to undermine health policies, one has clearly been identified as: "*Produces and disseminates misleading research and information: As scientific evidence revealed more and more harmful effects of smoking, amounting to tens of thousands of research papers, the industry countered by funding its own scientific studies. While historically such efforts focused on disputing the harm from tobacco, more recently the industry has been funding and producing misleading "research" and information focused on countering effective public health policies."*[45] As written by Briggs and Vallone (2022), "*The tobacco industry is once again infiltrating scientific spaces and presenting a direct threat to the vital work of unbiased tobacco control scientists. With the popular introduction of e-cigarettes and other new nicotine products, the tobacco industry has remade itself into a self-proclaimed concerned corporate entity—and one that will go to great lengths to prop up their new products while opposing credible scientific findings. Both JUUL and Philip Morris have injected their narrative into scientific circles by publishing sponsored research in scientific journals*."[46]

Tobacco industry attempts to manipulate scientific research to influence public health policies has been demonstrated in Germany.[47] More recently, in Switzerland, when Swiss independent researchers published a study that went against PMI claims on heated tobacco products[48], PMI attacked those researchers and tried to force them to retract their paper by pressuring the University of Lausanne.[49]

The newly highlighted cases of PMI openly influencing research at the ETH brings back nasty memories of a previous case, dating back more than 20 years ago, at the University of Geneva. It was uncovered and demonstrated that a professor at the University of Geneva worked for years for PMI. Prof. Rylander had secretly received funds for research from the tobacco industry, which amounted to as much as US $ 85'000 a year for 30 years. He was among the most paid consultants at Philip Morris. The public health experts that denounced the

case, proved this money was used in INBIFO, a secret lab in Cologne, to produce findings which were subsequently distorted to underplay the dangers of passive smoking. In one of Rylander reports, published in 1997, the conclusion stated that "*diet and lifestyles ought to be taken into consideration when considering the health effects of passive smoking*".[50] Prof. Rylander attacked the public health experts for defamation in a well-known legal case and lost.

A recent and important article titled "The Science for Profit Model—How and why corporations influence science and the use of science in policy and practice" conducted an analysis on the strategies used by the industry to manipulate scientific research. This model shows "*how these strategies work to maximise the volume, credibility, reach, and use of industry-favourable science, while minimising these same aspects of industry-unfavourable science. This creates doubt about harms of industry products/practices or efficacy of policies affecting industry; promotes industry favoured policy responses and industry products as solutions; and legitimises industry's role as scientific stakeholder. These efforts ultimately serve to weaken policy, prevent litigation, and maximise use of industry products/practices—maximising corporate profitability. We provide an accessible way to understand how and why corporations influence science, demonstrate the need for collective solutions, and discuss changes needed to ensure science works in the public interest*."[51]

In particular, serious independent researchers are challenging the statements of tobacco industry regarding the heated tobacco products. A recent publication highlighted the fact PMI invested hundreds of millions of dollars to promote their "smoke free world" claim. This publication states very clearly that "*Among the researchers who choose to remain independent of the tobacco industry, we do not know anyone supporting HTPs as a harm reduction tools*."[52]

Rejecting research funded by the tobacco industry.

Since 2013, all journals linked to the BMJ refuse any research funded by the tobacco industry.[53] Other journals that have previously introduced such bans include PLOS Medicine in 2010[54] and the journals published by the American Thoracic Society in 1995.[55] The American Journal of Public Health also has a strict policy banning the publication of any research funded by the tobacco industry.[56] The Lancet has not yet implemented such a policy, but there has been a recent call to develop and implement one.[57]

Important international global health institutions, like the Union Internationale Contre le Cancer (UICC) also oppose the "*smokescreen of the tobacco industry's use of science*".[58] Some research funding agencies already took a stand in the late 1990s. The Cancer Research Campaign in the United Kingdom, the Norwegian Cancer Society, and some members of the Union Internationale Contre le Cancer—European Cancer League, no longer fund research in institutions that accept tobacco funds.[59]

In 2004, Switzerland signed the Framework Convention on Tobacco Control (WHO-FCTC), but has yet to ratify this convention, due to a lack in adequate national policies. This 20-year delay in ratification is largely due to the powerful tobacco industry lobby in the Swiss Parliament, which is blocking any progress in tobacco control. So far, Switzerland is one of the few European countries still lacking basic tobacco control policies, such as a full ban on the sale of tobacco and nicotine products to minors. One of the key provisions of the FCTC is art. 5.3, which reads: "*In setting and implementing their public health policies with respect to tobacco control, Parties shall act to protect these policies from commercial and other vested interests of the tobacco industry in accordance with national law*."[60] Switzerland plans to ratify the FCTC as soon as the new law on tobacco products enters into force in 2024. In the meantime, we actors of the public health domain consider that a correct interpretation of international public law already requires Switzerland and all its public agencies and official bodies to act in accordance with the FCTC provision. We consider that the ETH, should set an example, exhibiting the values of independence and transparency in support of public health and scientific research.

Did the SNSF know that it was co-financing research designed and supported by PMI?

The very clear, simple and direct answer is: no!

In early March 2023, we contacted the Swiss National Science Foundation (SNSF) to voice our concerns to the fact that the SNSF accepted to fund research directed and co-financed by PMI. The SNSF was exemplary in its transparency and communication with us. We met and discussed the issue with representative of the SNSF, and we understand that the principal investigator of the study had not given any indications of a planned collaboration with or co-financing from PMI nor had they informed the SNSF of any involvement of PMI employees in the project. The SNSF has strict regulations safeguarding the values of research freedom and research independence. Due to the strong suspicion of a breach of these regulations, we understand that the SNSF is currently investigating this case.

We hope this will lead the SNSF to more explicitly exclude and co-financing of research directed, designed and/or co-sponsored by the tobacco industry, which is simply one of the most destructive industries on the plant, in all aspects of its activities.

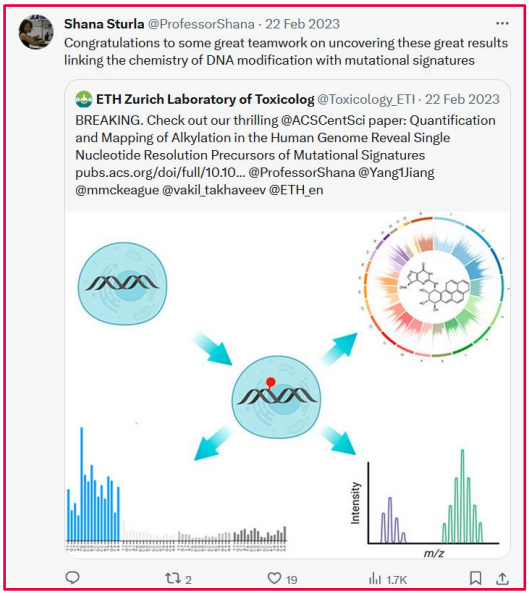

Image 8: A proud tweet by Mrs. Sturla about "some great teamwork": with the tobacco industry? (22.03.2023)

What is next?

In December 2023, we wrote to the president of the ETH to ask for some explanation and for the documents related to the collaboration with PMI.

Many questions remain open from our point of view, and we submitted them to the ETH:

1. **ETH's Stance on Tobacco Industry Research Collaboration**: Does ETH Zurich generally consider it acceptable to conduct research that is co-directed and financed, either fully or partially, by the tobacco industry?

2. **ETH's Ethical Guidelines on Industry Collaborations**: What are ETH Zurich's ethical guidelines regarding collaborations with industries that are considered problematic or controversial?

3. **Initiation and Development of the Research Collaboration**: Which party, ETH Zurich or PMI, initiated the contact regarding the research ideas and financing for the studies published in early 2023? What was the detailed timeline of how this relationship evolved?

4. **Timeline of PMI's Involvement and Funding**: Was the collaboration and financing agreement with PMI established before the submission of grant requests to the Swiss National Science Foundation (SNSF) and/or the awarding of those grants?

5. **Disclosure of PMI Collaboration to SNSF**: We understand that there might have been a failure to inform the SNSF about the collaboration and funding from PMI, which could be a breach of SNSF's ethical guidelines. Did Mrs. Sturla inform the SNSF about this collaboration? If so, when? If not, why

not? Furthermore, what steps does ETH Zurich plan to implement to prevent similar issues in the future?

6. **Funding Details for the 2023 Studies**: What were the exact amount of funding provided and received from PMI for the two studies published in 2023?
7. **Nature of the Grant Request to PMI**: Did ETH Zurich initiate a grant request to PMI, or was the financing offered spontaneously by PMI?
8. **Terms of PMI's Grants**: Under what specific terms were the PMI grants awarded for the studies?
9. **Necessity of PMI Financing**: Was PMI's financial contribution essential for the execution of these studies?
10. **ETH's View on PMI's Presentation of Research**: Does ETH Zurich find it acceptable that PMI presents Mrs. Sturla's publications on its website as if they are PMI studies, or at least gives that impression? If this portrayal is misleading, what actions does ETH plan to take to rectify this representation?
11. **Mrs. Sturla's Previous Financial Relationship with PMI**: Mrs Sturla appears to have a long-standing relationship with PMI. Has Mrs. Sturla received any financial support from PMI or any other entity related to the tobacco industry prior to the study published in early 2023? If so, how much was provided and for what purposes?

We are currently waiting for the answers from ETH and we will adapt this text when we will receive their answers.

Conclusion

Over the years, tobacco companies such as Philip Morris have employed a sophisticated strategy of funding biased research to influence scientific understanding and public perception regarding the health effects of smoking. Central to this strategy is the selective funding of research projects. These companies strategically cherry-pick topics, often favoring studies that would likely yield results minimizing the role of smoking, and today of heated tobacco products, in lung cancer, such as those focusing on genetic factors. This is coupled with supporting studies that produced contradictory or inconclusive results about the harms of smoking, and now concentrate on minimizing the impact of new tobacco and nicotine products, thereby creating a cloud of doubt and confusion both in the scientific community and among the public.

Philip Morris exert significant control over the outcomes of the research they fund. This control extend to influencing the design of research studies, including the selection of specific variables and methodologies. Even the interpretation of data is not immune to their influence, as these companies often play a role in how results

are reported and presented, consistently in a way that downplayed the risks associated with tobacco and nicotine products.

The selective publishing of research findings is another tactic. Tobacco companies like Philip Morris would often publish only those findings that are favourable to them while withholding or downplaying harmful results. They even go as far as sponsoring scientific journals or specific articles that would publish research supporting their narrative.

These strategies effectively contribute to a significant misrepresentation of the scientific consensus on smoking and health. Tobacco companies amplify their funded research to propagate a false narrative of significant scientific disagreement about the harms of smoking. They champion the rhetoric of "sound science," calling for unreasonable levels of proof about the harms of smoking and setting an almost impossibly high bar for evidence.

The impact of these strategies is profound. They successfully undermine public health messages, making it difficult for clear and unequivocal health warnings to reach the public. This obfuscation delay regulatory actions and litigation against tobacco companies. Moreover, such practices raise significant ethical concerns about the integrity of scientific research when influenced by corporate interests with a vested agenda.

In recent years, as the overwhelming evidence about the dangers of smoking has become indisputable, these tactics have been increasingly scrutinized and criticized. Regulatory measures, legal actions, and a more informed public have constrained the ability of tobacco companies to blatantly fund biased research. However, the “new normal” of the tobacco industry is to admit the harm of smoking tobacco and to pretend they want now to help smokers to quit with the help of their new commercial products. The way they continue to manipulate scientific research is thus moving away from denying the harm of cigarettes. Now they try to demonstrate that heated tobacco products (which provide an increasing source of benefits for those companies) are almost with no harm in comparison to cigarettes.

Therefore, their manipulative practices continue to influence current debates on corporate-funded research, underscoring the critical need for transparency and integrity in the scientific field. This narrative outlines the strategic approach taken by tobacco companies in manipulating scientific research, highlighting the ethical implications and long-term impact on public health and policy.

Luciano Ruggia, AT Director

[1] Jiang Y, Mingard C, Huber SM, et al. Quantification and Mapping of Alkylation in the Human Genome Reveal Single Nucleotide Resolution Precursors of Mutational Signatures. ACS Cent. Sci. 2023.
[2] The listed keywords were "Adducts, Cancer, Genetics, Genomics, Peptides and Proteins". When some keywords are missing (in this case smoking, tobacco, etc.) makes the article difficult to find and can contribute to hide it from scrutiny.
[3] Jiang, Yang; Mingard, Cécile; Huber, Sabrina M.; Takhaveev, Vakil; McKeague, Maureen; Kizaki, Seiichiro et al. (2023): Quantification and Mapping of Alkylation in the Human Genome Reveal Single Nucleotide Resolution Precursors of Mutational Signatures. In ACS Cent. Sci., Article acscentsci.2c01100. DOI: 10.1021/acscentsci.2c01100.
[4] Li, Wentao; Hu, Jinchuan; Adebali, Ogun; Adar, Sheera; Yang, Yanyan; Chiou, Yi-Ying; Sancar, Aziz (2017): Human genome-wide repair map of DNA damage caused by the cigarette smoke carcinogen benzoapyrene. In Proceedings of the National Academy of Sciences of the United States of America 114 (26), pp. 6752–6757. DOI: 10.1073/pnas.1706021114.
[5] Wang H, Liu B, Chen H, et al. Dynamic changes of DNA methylation induced by benzo(a)pyrene in cancer. Genes Environ 2023;45(1):21. doi:10.1186/s41021-023-00278-1 [published Online First: 1 July 2023].
[6] https://ethz.ch/en/news-and-events/eth-news/news/2023/02/where-do-toxins-from-tobacco-attack-dna.html (last consulted on 21.12.2023)
[7] https://www.research-collection.ethz.ch/handle/20.500.11850/603875 (last consulted 03.02.2024)
[8] Jiang Y, Mingard C, Huber SM, et al. Correction to "Quantification and Mapping of Alkylation in the Human Genome Reveal Single Nucleotide Resolution Precursors of Mutational Signatures". ACS Cent. Sci. 2024.
[9] O'Connor R, Durkin SJ, Cohen JE*, et al,* Thoughts on neologisms and pleonasm in scientific discourse and tobacco control, *Tobacco Control* 2021;30:359-360. https://tobaccocontrol.bmj.com/content/30/4/359
[10] Davies, Madlen; Stockton, Ben; Chapman, Matthew; Cave, Tamasin (2020): The 'Unsmoke' screen: the truth behind PMI's cigarette-free future. In The Bureau of Investigative Journalism, 2/24/2020. Available online at https://www.thebureauinvestigates.com/stories/2020-02-24/the-unsmoke-screen-the-truth-behindpmis-cigarette-free-future.
[11] Fitzpatrick, Iona; Dance, Sarah; Silver, Karin; Violini, Marzia; Hird, Thomas R. (2022): Tobacco industry messaging around harm: Narrative framing in PMI and BAT press releases and annual reports 2011 to 2021. In Frontiers in public health 10, p. 958354. DOI: 10.3389/fpubh.2022.958354.
[12] https://tobaccoreporter.com/2022/09/01/utc-to-manufacture-philip-morris-products-for-egypt/
[13] Tobacco Tactics page on Heated Tobacco Products: https://tobaccotactics.org/wiki/heated-tobacco-products/ (last consulted on 21.12.2023)
[14] https://www.pmiscience.com/en/research/product-assessment-approach/platform-development/ths-mainstream-aerosol-compared-to-reference-cigarette-smoke/ (last consulted on 21.12.2023)
[15] https://www.at-schweiz.ch/at-blog/95percent
[16] https://www.fda.gov/tobacco-products/ctp-newsroom/fda-authorizes-reduced-exposure-claim-iqos-3-system-holder-and-charger (last consulted 30.01.2024)
[17] Uguna CN, Snape CE. Should IQOS Emissions Be Considered as Smoke and Harmful to Health? A Review of the Chemical Evidence. ACS Omega 2022.
[18] https://iqosuae.ae/blog/iqos-heating-system-safer-than-cigarettes/ (last consulted 01.02.2024)
[19] Szostak, Justyna; Boué, Stéphanie; Talikka, Marja; Guedj, Emmanuel; Martin, Florian; Phillips, Blaine et al. (2017): Aerosol from Tobacco Heating System 2.2 has reduced impact on mouse heart gene expression compared with cigarette smoke. In Food and chemical toxicology : an international journal published for the British Industrial Biological Research Association 101, pp. 157–167. DOI: 10.1016/j.fct.2017.01.013.

[20] Uguna, Clement N.; Snape, Colin E. (2022): Should IQOS Emissions Be Considered as Smoke and Harmful to Health? A Review of the Chemical Evidence. In ACS Omega, Article acsomega.2c01527. DOI: 10.1021/acsomega.2c01527.
[21] Tattan-Birch, Harry; Hartmann-Boyce, Jamie; Kock, Loren; Simonavicius, Erikas; Brose, Leonie; Jackson, Sarah et al. (2022): Heated tobacco products for smoking cessation and reducing smoking prevalence. In Cochrane Database of Systematic Reviews 2022 (1). DOI: 10.1002/14651858.CD013790.pub2.
[22] Julia Hoeng, Nicolas Sierro, Nikolai V. Ivanov - Philip Morris Products SA, Quai Jeanrenaud 3, Neuchatel 2000, Switzerland.
[23] Bero, Lisa A. (2005): Tobacco industry manipulation of research. In Public health reports (Washington, D.C. : 1974) 120 (2), pp. 200–208. DOI: 10.1177/003335490512000215.
[24] From the SNF Grants Database, Grant 185020: Status: Ongoing, Start: 01.01.2020, End: 31.12.2023, Approved amount: 588,000 CHF. See https://data.snf.ch/grants/grant/185020 .
[25] From the SNF Grants Database, Grant 186332: Status: Ongoing Start: 01.01.2020 End: 31.12.2023 Approved amount: 2,027,990 CHF. See https://data.snf.ch/grants/grant/186332 .
[26] https://www.pmiscience.com/en/research/publications-library/ (last consulted on 21.12.2023)
[27] https://www.pmiscience.com/en/research/publications-library/quantification-and-mapping-of-alkylation-in-the-human-genome-rev/ (last consulted on 21.12.2023)
[28] Mingard C, Battey JND, Takhaveev V, et al. Dissection of Cancer Mutational Signatures with Individual Components of Cigarette Smoking. *Chem. Res. Toxicol.* 2023;36(4):714–23. doi:10.1021/acs.chemrestox.3c00021 [published Online First: 28 March 2023].
[29] https://www.acs.org/pressroom/newsreleases/2017/november/shana-sturla-new-editor-in-chief-of-chemical-research-in-toxicology.html (last consulted on 31.12.2023)
[30] https://www.research-collection.ethz.ch/handle/20.500.11850/610051 (last consulted 02.01.2024)
[31] Sturla SJ, Boobis AR, FitzGerald RE, et al. Systems toxicology: from basic research to risk assessment. Chem. Res. Toxicol. 2014;27(3):314–29. doi:10.1021/tx400410s [published Online First: 21 January 2014].
[32] In the SNSF web page related to this grant, this publication is not mentioned: https://data.snf.ch/grants/grant/136247 (last consulted on 10.01.2024).
[33] Constantinescu S, Sturla SJ, Marra G, et al. Computational Data Integration in Toxicogenomics. In: Peitsch MC, Hoeng J, eds. Computational Systems Toxicology. New York, NY: Springer Verlag 2015:371–92.
[34] https://www.research-collection.ethz.ch/handle/20.500.11850/112846 (last consulted 29.01.2024)
[35] Hartung T, FitzGerald RE, Jennings P, et al. Systems Toxicology: Real World Applications and Opportunities. Chem. Res. Toxicol. 2017;30(4):870–82. doi:10.1021/acs.chemrestox.7b00003 [published Online First: 31 March 2017].
[36] Iskandar AR, Martinez Y, Martin F, et al. Comparative effects of a candidate modified-risk tobacco product Aerosol and cigarette smoke on human organotypic small airway cultures: a systems toxicology approach. Toxicol Res (Camb) 2017;6(6):930–46. doi:10.1039/c7tx00152e [published Online First: 28 September 2017].
[37] Smith M, Haziza C, Hoeng J, et al. The Science behind the Tobacco Heating System: A Summary of Published Scientific Articles 2017.
[38] David G, Parmentier EA, Taurino I, et al. Tracing the composition of single e-cigarette aerosol droplets in situ by laser-trapping and Raman scattering. *Sci Rep* 2020;10(1):7929. doi:10.1038/s41598-020-64886-5 [published Online First: 13 May 2020].
[39] https://www.research-collection.ethz.ch/handle/20.500.11850/414847 (last consulted on 25.01.2024)
[40] https://data.snf.ch/grants/grant/172472 (last consulted on 28.01.2024)
[41] David G, Parmentier EA, Taurino I, et al. Assessment of the Chemical Evolution of E-Cigarette Droplets. Chimia (Aarau) 2020;74(9):733.
[42] https://www.pmi.com/glossary-section/glossary/veev (last consulted on 25.01.2024)
[43] Tobacco Tactics page on Influencing Science: Commissioning Research and Reviews https://tobaccotactics.org/wiki/influencing-science-commissioning-research-and-reviews/ (last consulted on 13.12.2023)

[44] Freeman, B.; Vittiglia, A.; Winstanley, M. (2018): 10A.3 Mechanisms of influence—Industry-funded research. In M. M. Scollo, M. H. Winstanley (Eds.): Tobacco in Australia: Facts and issues. Melbourne. Available online at https://www.tobaccoinaustralia.org.au/chapter-10-tobacco-industry/indepth-10a-strategies-for-influence/10a-3-the-mechanisms-of-influence-industry-funded-.

[45] Vital Strategies (2019): Crooked Nine. Nine ways the tobacco industry undermines health policy. New York. Available online at https://exposetobacco.org/resources/crookednine/.

[46] Briggs, Jodie; Vallone, Donna (2022): The Tobacco Industry's Renewed Assault on Science: A Call for a United Public Health Response. In Am J Public Health 112 (3), pp. 388–390. DOI: 10.2105/AJPH.2021.306683.

[47] Grüning, Thilo; Gilmore, Anna B.; McKee, Martin (2006): Tobacco industry influence on science and scientists in Germany. In Am J Public Health 96 (1), pp. 20–32. DOI: 10.2105/AJPH.2004.061507.

[48] Auer, Reto; Concha-Lozano, Nicolas; Jacot-Sadowski, Isabelle; Cornuz, Jacques; Berthet, Aurélie (2017): Heat-Not-Burn Tobacco Cigarettes: Smoke by Any Other Name. In JAMA internal medicine 177 (7), pp. 1050–1052. DOI: 10.1001/jamainternmed.2017.1419.

[49] Philip Morris attaque une étude. Un article de l'Université de Lausanne mis en cause. (2017). In Le Nouvelliste, 6/9/2017. Available online at https://www.lenouvelliste.ch/suisse/philip-morris-attaque-une-etude-677015.

[50] Neroth P. Tobacco ties. *Lancet* 2004;364(9438):925–26.

[51] Legg T, Hatchard J, Gilmore AB. The Science for Profit Model-How and why corporations influence science and the use of science in policy and practice. PLOS ONE 2021;16(6):e0253272. doi:10.1371/journal.pone.0253272 [published Online First: 23 June 2021].

[52] Gallus S, Garattini S. Heated tobacco products in Italy. Tabaccologia 2023;21(31.07.2023). https://www.tabaccologiaonline.it/article/view/80.

[53] Godlee, Fiona; Malone, Ruth; Timmis, Adam; Otto, Catherine; Bush, Andy; Pavord, Ian; Groves, Trish (2013): Journal policy on research funded by the tobacco industry. In BMJ (Clinical research ed.) 347, f5193. DOI: 10.1136/bmj.f5193.

[54] A new policy on tobacco papers (2010). In *PLOS Medicine* 7 (2), e1000237.

[55] Knight I, Rattan R (2013). Medical journals refuse to publish tobacco-funded research. The Conversation, 16 October 2013. Available at: https://theconversation.com/medical-journals-refuse-to-publish-tobacco-funded-research-19201.

[56] Morabia, Alfredo (2022): Scientific Publishing and the Tobacco Industry. In Am J Public Health 112 (7), p. 951. DOI: 10.2105/AJPH.2022.306916.

[57] Pattemore, Philip; Edwards, Richard (2022): Tobacco company funding and conflict of interest. In *The Lancet*. DOI: 10.1016/S0140-6736(22)01289-2.

[58] 1 UICC. The smokescreen of the tobacco industry's use of science 2021. Available at: https://www.uicc.org/news/smokescreen-tobacco-industrys-use-science. (last consulted on 21.12.2023)

[59] Cohen, J. E.; Ashley, M. J.; Ferrence, R.; Brewster, J. M.; Goldstein, A. O. (1999): Institutional addiction to tobacco. In Tob Control 8 (1), pp. 70–74. DOI: 10.1136/tc.8.1.70.

[60] WHO (2003): WHO Framework Convention on Tobacco Control. Geneva: World Health Organization.